RECLAMATION

Managing Water in the West

Delta-Mendota Canal Recirculation Feasibility Study

Plan Formulation Report

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

California Department of Water Resources
Sacramento, California

January 2010
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Volume 1: Executive Summary and Text

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Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

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

The mission of the California Department of Water Resources is to manage the water resources of California in cooperation with other agencies, to benefit the State's people, and to protect, restore, and enhance the natural and human environments.

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Delta-Mendota Canal Recirculation Feasibility Study

Plan Formulation Report

Prepared for Reclamation by URS Corporation under Contract No. 06CS204097A

U.S. Department of the Interior
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Executive Summary

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) is evaluating the feasibility of using recirculation strategies to improve water quality and flow in the lower San Joaquin River (SJR). Specifically, Reclamation is evaluating the feasibility of the Delta-Mendota Canal (DMC) Recirculation Project (Project) in which water from the Sacramento–San Joaquin River Delta (Delta) would be recirculated through the Central Valley Project (CVP) pumping and conveyance facilities to the SJR upstream from Vernalis.

The DMC, which is part of the CVP, would be the primary conveyance facility utilized. The DMC is 120-mile canal that begins at the C.W. "Bill" Jones Pumping Plant (Jones) and ends at Mendota Pool, near the town of Mendota. Jones pumps water from the Delta into the canal. Water would be released from the canal into either Newman Wasteway or Westley Wasteway and would flow back into SJR near its confluence with the Merced River (Newman Wasteway) or with the Tuolumne River (Westley Wasteway). The water would re-enter the Delta near the town of Vernalis. See **Figure ES-1** for a map of the Project study area.

In 2004, Reclamation initiated the DMC Recirculation Project Feasibility Study (Study). The Study is authorized by the CALFED (California Federal Bay-Delta Program) Bay-Delta Authorization Act of 2004 (118 Stat. §§ 1681-1702.; Public Law 108-361) and a similar study is required by the State Water Resources Control Board (SWRCB) as part of Water Right Decision 1641 (D-1641).[1]

The purposes of the PFR are (1) to provide information on the existing and potential resources that may be affected by the Project and (2) to present the results of the evaluation of the alternative plans that were carried forward from the 2008 Initial Alternatives Information Report (IAIR). The alternative plans are compared and ranked and the next steps in the study are presented.

[1] State Water Resources Control Board, Revised Water Right Decision 1641, In the Matter of Implementation of Water Quality Objectives for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: A Petition to Change Points of Diversion of the Central Valley Project and the State Water Project in the Southern Delta; and a Petition to Change Places of Use and Purposes of Use of the Central Valley Project (December 29, 1999, revised in accordance with Order WR 2000-02 [March 15, 2000]).

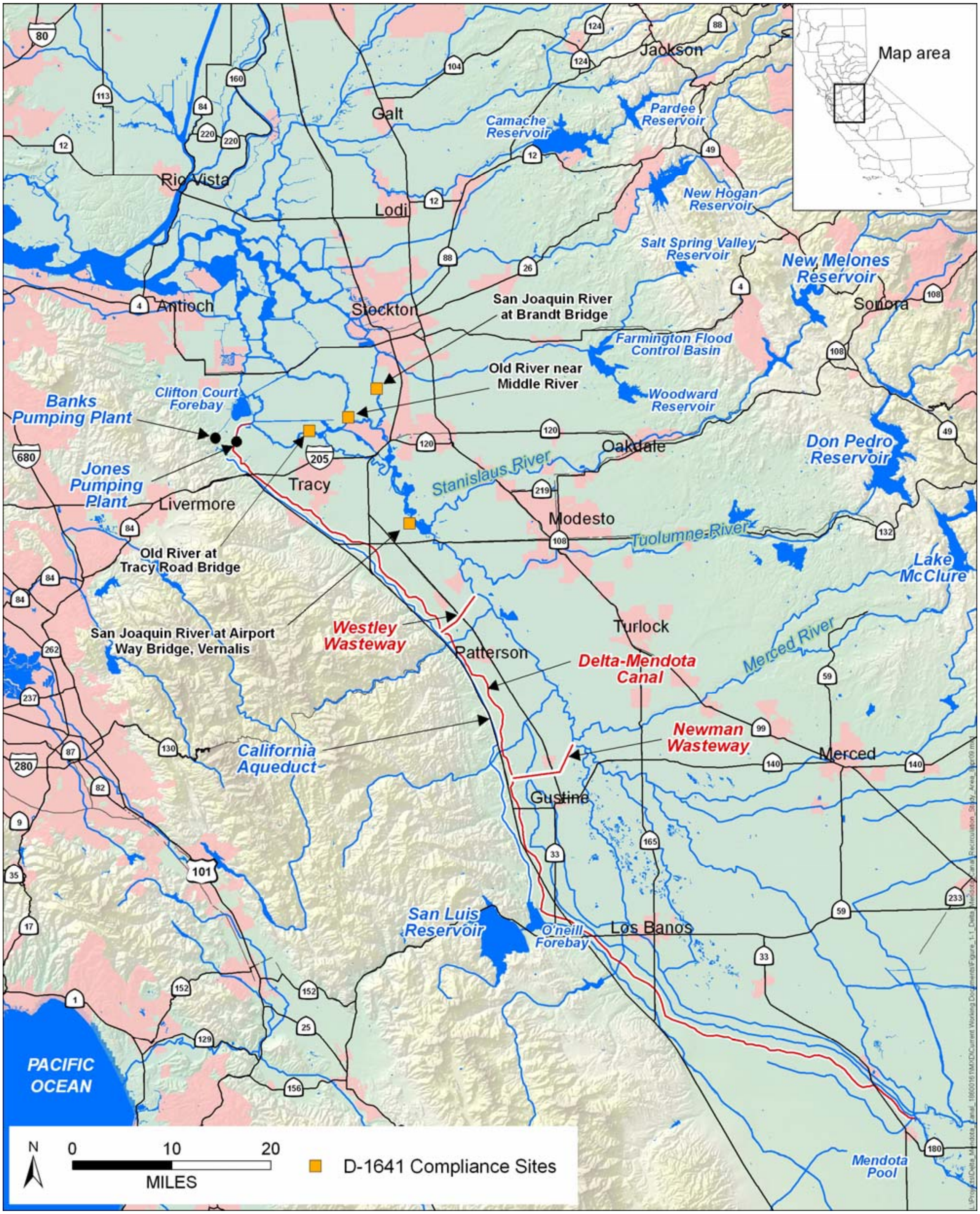


Figure ES-1. Delta-Mendota Canal Recirculation Project Study Area

Study Area

The Study area, shown in **Figure ES-1,** includes the areas that have the potential to be affected by the Project. The areas include the lower main stem of the SJR just above its confluence with the Merced River; the areas served by water districts supplied with water from the Merced, Tuolumne, and Stanislaus rivers on the western side of the Sierra Nevada Mountains; the areas served by the DMC, which include approximately 30 water agencies; and the south Delta area, which serves as a source of water supply for agricultural and urban uses in the Delta area.

Planning Objectives

The objectives of the Project are based on problems, needs, and opportunities and on legislative and regulatory directives. The Feasibility Study was authorized by the CALFED Bay-Delta Authorization Act of 2004 (118 Stat. §§ 1681–1702.; Public Law 108-361) to address specific problems and needs.

The problems and needs are:

- **San Joaquin River flow.** Recirculation could be used to provide flow to meet the fishery flow objectives at Vernalis set forth in D-1641 and *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay/Delta Plan),[2] increase operational flexibility, and improve the reliability of meeting the flow requirements at the Vernalis gauging station.
- **San Joaquin River water quality.** The lower SJR has been listed as an impaired water body by the SWRCB and the U.S. Environmental Protection Agency (EPA). Reclamation has been successful in meeting the Vernalis electrical conductivity (EC) objective set forth in D-1641, the Bay/Delta Plan, and the Basin Plan but relies on releases from the New Melones Reservoir. Several sequential dry water years could preclude the use of water from New Melones. Recirculation will be evaluated for its ability to help meet Vernalis EC objectives.
- **Water supply reliability.** Improvements in water supply reliability for Stanislaus River users are needed. Use of recirculation to improve water quality and flows may improve water supply reliability for CVP contractors in the Stanislaus River.

[2] State Water Resources Control Board, *Water Quality Control Plan for the San Francisco Bay/ Sacramento–San Joaquin Delta Estuary*. November 29, 2006.

The opportunities are:

- **Fisheries in the Delta, San Joaquin River, and Stanislaus River.** Recirculation could be used to augment flow to improve anadromous fish survivability.
- **South Delta water level.** Recirculation could be used to increase flow in the SJR, and the effect of these increased flows on south Delta water levels could be beneficial.
- **South Delta water quality.**[3] Recirculation could be used to improve south Delta water quality to meet the April through August EC objective of 0.7 mmhos/cm (700 µmhos/cm). The effect of recirculation on dissolved oxygen (DO) conditions in the Port of Stockton Deep Water Ship Channel (DWSC) is also evaluated.
- **Groundwater overdraft.** Recirculation could be used to reduce overdrafts in the Merced, Modesto, and eastern San Joaquin groundwater subbasins by helping to meet demand during drought conditions.

The primary planning objectives of the Project are:

- **Objective A**: Provide supplemental flow in the lower SJR for meeting fishery flow objectives through the use of excess capacity[4] in export pumping and conveyance facilities.
- **Objective B**: Provide lower salinity water to the SJR for meeting water quality objectives (WQOs) at Vernalis through the use of excess capacity in export pumping and conveyance facilities.
- **Objective C**: Provide greater flexibility in how existing water quality standards and objectives for the CVP are met to reduce the demand on water from the New Melones Reservoir and to assist the Secretary of the Interior in meeting obligations to CVP contractors from the New Melones Project.

The other potential benefits of the Project are:

- Improve DO in the SJR.
- Improve water quality and water levels in the interior south Delta through the use of excess capacity in export pumping and conveyance facilities.

[3] The SWRCB is currently reviewing the south Delta salinity water quality objectives (WQOs) for agriculture. Any changes in the WQOs will affect the need for, or implementation of, the DMC Recirculation Project.

[4] Two definitions of "excess capacity" were utilized to develop the PFR alternatives in response to request by various stakeholders: Capacity in CVP facilities in excess of that needed to meet (1) CVP authorized purposes; or, (2) CVP environmental requirements.

In the Study, water operations modeling using recirculation to achieve the primary objectives was conducted. Operations modeling results for the primary objectives were used to evaluate the effectiveness of recirculation in improving DO in the SJR and water quality and water levels in the interior south Delta. Also, water operations modeling sensitivity analysis was conducted on the ability to use recirculation to improve flow and water quality in the interior south Delta.

Study Process

As a Federal water resources investigation, the Study must follow the Federal plan formulation process, a six-step approach to problem solving. Technical and pilot studies and an IAIR were completed before the PFR. The PFR contains the results of the evaluation of the alternative plans that were carried forward from the IAIR. The Study would be completed by issuing an Environmental Impact Statement / Environmental Impact Report (EIS/EIR) and a Feasibility Study Report.

Reclamation is the lead Federal agency for compliance with the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. §§ 4321-4347 [2006]), and the California Department of Water Resources (DWR) is the lead State agency for compliance with the California Environmental Quality Act of 1970 (CEQA) (California Public Resources Code §§ 21000 et seq.).

Stakeholders and agencies have been involved at critical points in the Study. Stakeholder and agency involvement is designed to address issues of interest and concern to stakeholders and agencies engaged in local and regional water resource planning efforts.

Facilities and Features

The CVP facilities and features that may be used directly for recirculation are Jones, DMC, Westley or Newman Wasteway, and the SJR just above its confluence with the Merced River. Recirculation may also affect the operations of other CVP or joint-use facilities, either directly or indirectly, including the San Luis Reservoir (SLR), which is a joint Central Valley Project / State Water Project (CVP/SWP) facility, and New Melones Reservoir on the Stanislaus River, which is a CVP facility (see **Figure ES-1**). SWP facilities that may be used for recirculation include the Harvey O. Banks Pumping Plant (Banks) and the California Aqueduct.

Water from the Delta would need to be pumped into conveyance facilities to allow release for recirculation at locations upstream of Vernalis on the SJR. Jones and Banks could be used for this purpose.

Water could be moved from the DMC to the SJR through either the Newman or Westley wasteway. Water would be released from either wasteway into the SJR. Newman Wasteway is currently capable, with little or no modification, of carrying a wider range of recirculation flows than Westley Wasteway. However, modifications to the unlined portion of Newman Wasteway may be necessary to reduce turbidity. Westley Wasteway would require outlet modification to discharge as much water to the SJR as Newman Wasteway.[5]

Use of existing south of the Delta (SOD) water storage facilities was incorporated into four of the alternative plans. Use of storage would increase flexibility in the ability to use Delta pumps when excess capacity is available for recirculation. The water would be stored for later use or stored for later delivery to replace water that was used for recirculation when pumping capacity was not available.

Operational Assumptions and Strategies

The key operational assumptions and strategies considered in the formulation of the alternative plans are:

- **New Melones water supply.** Recirculation could be used before or after the release of water from New Melones. In practice, recirculation would probably occur based on a flexible priority that would be determined by water supply conditions at the time. For analysis purposes, recirculation both before and after the release of water from New Melones was evaluated to identify the range of potential effects of recirculation on New Melones water supply.
- **Direct pumping and release.** Recirculation would occur only when Delta export and conveyance capacity was not already allocated to the existing purposes of the facilities.
- **Pumping, storage, and release.** Storage at SLR would be used to offset wasteway releases that would otherwise reduce deliveries south of SLR.
- **Recirculation priority over CVP Delta export deliveries.** CVP pumping and conveyance capacity would be used with recirculation as a high priority in a subset of recirculation alternatives. This strategy would allow more water to be available for recirculation; however, it would reduce CVP Delta export deliveries and, to some extent, other CVP non-Stanislaus deliveries.
- **SWP integration and facilities.** SWP facilities would be used in a subset of recirculation alternatives to provide additional opportunities

[5] U.S. Department of the Interior, Bureau of Reclamation, *Draft Wasteway Improvement Appraisal Study* (2009).

for pumping, conveyance, and storage; however, no adverse water supply impact to the SWP would occur under any alternative plan.

No-Action/No-Project Alternative and Alternative Plans

The alternative plans were formulated using a range of facilities and operational strategies to accomplish the planning objectives. The alternatives in the PFR were developed from those in the IAIR.

No-Action/No-Project Alternative

The No-Action/No-Project Alternative is required for the analysis of environmental effects under NEPA (the No-Action Alternative) and CEQA (the No-Project Alternative). Under this alternative, no recirculation would occur.

Existing conditions were developed for each resource area based on the availability of modeling tools and data. In general, existing conditions for water operations were based on results using the modeling tool CalSim II. For other resource areas, existing conditions were based on recent data, generally encompassing the data from 2000 to present.

Future conditions for the No-Action Alternative were based on reasonably foreseeable actions that would occur without the Project, including projects that are currently authorized, funded, permitted, or highly likely to be implemented. The planning period for the future condition evaluation varies depending on the resource area. The conditions under the No-Action Alternative are the conditions that are predicted to exist in the Study area during the planning period if recirculation is not implemented.

Alternative Plans

The alternative plans that were carried forward from the IAIR for further study are summarized in **Table ES-1** and described more fully below.

All alternative plans include improvements to wasteway conveyance facilities. Options for improvements are stabilizing the unlined portion of Newman Wasteway to reduce elevated turbidity and constructing new conveyance facilities at the outlet of Westley Wasteway to allow passage of recirculation flows to SJR.

- **Alternative A1:** *Supplement Vernalis compliance using available Jones capacity.* This alternative plan uses only available capacity at Jones to supplement explicit New Melones flow and water quality releases. No changes in water supply for either CVP Delta export or New Melones water contractors would occur.

Table ES-1. Alternative Plans Evaluated for the Plan Formulation Report

Alt	Description	Delta Pumping Facilities	Delta Pumping Priority for Recirculation	Priority with New Melones Delta Operation
A1	Supplement Vernalis compliance using available Jones capacity	Jones	Low (no CVP/SWP or SOD impact)	Supplemental
A2	Enhance New Melones water supply and supplement Vernalis compliance using available Jones capacity	Jones	Low (no CVP/SWP or SOD impact)	Before
B1	Supplement Vernalis compliance using available Jones/Banks capacity	Jones/ Banks	Low (no CVP/SWP or SOD impact)	Supplemental
B2	Enhance New Melones water supply and supplement Vernalis compliance using available Jones/Banks capacity	Jones/ Banks	Low (no CVP/SWP or SOD impact)	Before
C	Limit reduction of CVP Delta export deliveries to enhance New Melones water supply and supplement Vernalis compliance using Jones/Banks capacity[6]	Jones/ Banks	Low for WQOs High for flow objectives (no SWP impact)	Before
D	Reduce CVP Delta export deliveries to enhance New Melones water supply and supplement Vernalis compliance using Jones/Banks[6]	Jones/ Banks	High (no SWP impact)	Before

Key:
Alt = alternative plan
Banks = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
Delta = Sacramento–San Joaquin River Delta
Jones = C.W. “Bill” Jones Pumping Plant
PFR = Plan Formulation Report
SOD = south of Delta
SWP = State Water Project
WQO = water quality objective

- **Alternative A2:** *Enhance New Melones water supply and Vernalis compliance using available Jones capacity.* This alternative plan is similar to Alternative A1 except that recirculation water is released prior to explicit New Melones releases for Vernalis flow and water quality purposes. Because only available capacity at Jones is used, no major changes in CVP Delta export water supply would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones.
- **Alternative B1:** *Supplement Vernalis compliance using available Jones/Banks capacity.* This alternative plan is similar to Alternative A1

[6] Carried forward at the request of certain stakeholders and consistent with the 2nd definition of excess capacity.

except that pumping from Banks is added when capacity is available. Recirculation flow supplements New Melones releases (i.e., no changes in New Melones operations). No changes in water supply for either CVP Delta export or New Melones water contractors would occur.

- **Alternative B2:** *Enhance New Melones water supply and Vernalis compliance using available Jones/Banks capacity.* This alternative plan is similar to Alternative A2 except that pumping from Banks is added when capacity is available. Water is released prior to explicit New Melones Delta releases, which may result in enhanced New Melones water supply. No major changes in Delta export water supply would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks.
- **Alternative C:** *Limited reduction of CVP Delta export deliveries for enhanced New Melones water supply and Vernalis compliance using Jones/Banks.* Alternative C was carried forward at the request of certain stakeholders. It is based on the definition of "excess capacity" as the capacity in CVP facilities in excess of that needed to meet CVP environmental requirements. This alternative plan is similar to Alternative D except that recirculation water that could affect CVP Delta export deliveries would be used only to comply with Vernalis flow requirements in the SJR. Recirculation could occur for water quality compliance if it is determined to be available at Jones/Banks without impact to deliveries. Recirculation flow would be released prior to explicit New Melones Delta releases to enhance New Melones water supply. Jones would be used as needed to contribute to flow compliance and water supply benefits to New Melones. Reductions in CVP Delta export deliveries are anticipated but would be less than those under Alternative D. No major changes to SWP deliveries would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks.
- **Alternative D:** *Reduced CVP Delta export deliveries to enhance New Melones water supply and Vernalis compliance using Jones/Banks.* Alternative D was carried forward at the request of certain stakeholders. It is based on the definition of "excess capacity" as the capacity in CVP facilities in excess of that needed to meet CVP environmental requirements. This alternative plan would use recirculation, as needed, to attempt to provide compliance with Vernalis WQOs and enhance New Melones water supply. Recirculation water would be released prior to explicit New Melones Delta releases for flow objectives and WQOs,

resulting in additional water supply in New Melones. Reductions in CVP Delta export deliveries are anticipated. No major changes to SWP deliveries would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks.

Comparison of Alternative Plans

This section contains the comparisons of the water system operational changes that would result from each alternative, the ability of each alternative to achieve the planning objectives, and the effects of each alternative on other environmental and socioeconomic resources.

The alternative plans are ranked in the PFR for the following units:

- **Achieving planning objectives.** These objectives include flow in SJR at Vernalis, EC in SJR at Vernalis, reliance on New Melones releases, DO in SJR at the Port of Stockton DWSC, EC at interior south Delta locations, and water level in SJR at Vernalis and the interior south Delta.
- **Water supply.** Water supply deliveries are evaluated for CVP Delta export and CVP Stanislaus contractor deliveries.
- **Water quality.** Additional water quality parameters include municipal and industrial water quality at key drinking water intakes in the Delta, turbidity in SJR above the Merced River, and temperature in Stanislaus River at Orange Blossom Bridge.
- **Fisheries.** Fisheries parameters include flow at the SJR at Vernalis, entrainment at Jones and Banks, salmonid straying in SJR, flow in Stanislaus River at Goodwin Dam, temperature in Stanislaus River at Orange Blossom Bridge, and DO in SJR at the Port of Stockton DWSC.
- **Energy.** Energy generation is evaluated for the CVP and SWP facilities.
- **Economics.** National Economic Development (NED) benefits for the U.S. and Regional Economic Development benefits for Statewide, San Joaquin County, and Fresno and Kings Counties.

Water System Operational Changes

The average annual total recirculation flows and the frequency of recirculation would be the lowest in Alterative A1, with progressively higher flows and frequency for each subsequent alternative (**Table ES-2**).

The annual total recirculation flows are predicted to vary substantially from year to year. Monthly recirculation flows would vary by alternative plan and by period for the periods during which recirculation is predicted to occur (**Figure ES-2**). Of the six alternatives, Alternative D would result in the greatest amount of recirculation and pumping at both pumping plants (**Table ES-2**).

Recirculation would occur principally from February through June with one occurrence in October. Flows would be highest in April regardless of alternative. Because of variable target flows from the Vernalis Adaptive Management Program, the greatest range in flows would occur in April, from approximately 20 to 1,900 cubic feet per second for Alternatives C and D.

Average flows would be relatively consistent across all alternative plans for March and April, but for other months, average flows would tend to be greater for Alternatives B1 and B2 (compared to Alternatives A1 and A2) and greatest for Alternatives C and D.

The cost of each alternative plan associated with construction (including wasteway improvement and mitigation costs), operation (excluding energy), and management would not be substantially different. The difference in cost is attributed primarily to energy.

Table ES-2. Alternative Plan Operational Characteristics

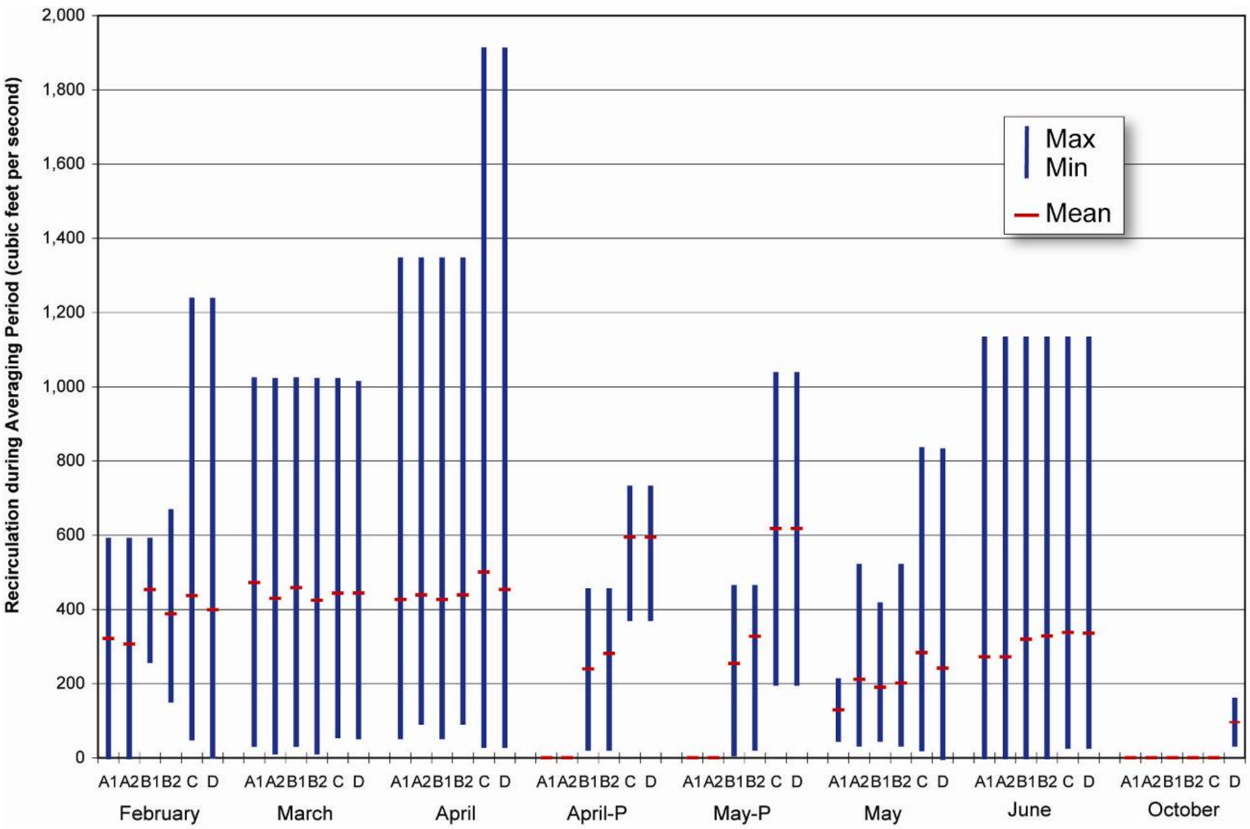
No-Action Alternative / Alternative Plans		Recirculation[1]			Pumping[1]	
		Total average recirculation (in TAF per year)	Years with recirculation (out of 82 years)	Periods with recirculation (out of 1,148 periods)	Average pumping at Jones (in TAF per year)[2]	Average pumping at Banks (in TAF per year)[2]
No-Action Alternative		0	0	0	2,423	3,528
Change Relative to No-Action Alternative, by Alternative Plan	A1	7.2	23	32	7.2	0
	A2	9.3	30	45	8.6	0
	B1	11.6	33	57	7.2	4.5
	B2	15.7	44	77	7.9	6.4
	C	28.2	54	124	7.9	6.5
	D	31.8	56	148	8.0	6.4

Source: CalSim II modeling.
[1] CVP/SWP operations based on pre-2007 operations.
[2] CVP/SWP average pumping evaluated over the 82-year CalSim II modeling period.

Key:

Banks = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
Jones = C.W. “Bill” Jones Pumping Plant

SWP = State Water Project
TAF = thousand acre-feet



Data for recirculation periods only. Data provided by CalSim II for future level of development over the 82-year modeling period (1922–2003). April-P = pulse flow period from April 16 through April 30; May-P = pulse flow period from May 1 through May 15.

Figure ES-2. Recirculation by Alternative Plan and Averaging Period

Energy costs would increase relative to the No-Action Alternative during long-term conditions under Alternatives A1, A2, B1, B2, and C. During drought conditions, energy costs would increase under all six alternative plans. Of the six alternative plans, Alternative B2 would have the highest costs during both long-term and drought conditions. Alternative D would have lower costs than the No-Action Alternative under long-term conditions because less water is pumped from the Delta and stored in SLR (**Table ES-3**).

Table ES-3. Predicted Effect on Average Annual Net Energy Revenue for the CVP and SWP Geographic Areas

No-Action Alternative / Alternative Plans		Net Energy Revenue	
		Average Conditions[1]	Dry Conditions[2]
No-Action Alternative		$231M	$154M
Change Relative to No-Action Alternative, by Alternative Plan	A1	–$203K	–$303K
	A2	–$213K	–$417K
	B1	–$292K	–$437K
	B2	–$313K	–$600K
	C	–$45K	–$306K
	D	$63K	–$70K

Notes:

[1] Average over Water Years 1922 to 2003

[2] Average over Water Years 1929 to 1934, 1976 to 1977, and 1987 to 1992 (14 of 82 water years or 17% of total)

Key:

CVP = Central Valley Project
K = thousand
M = million
SWP = State Water Project

Achieving Planning Objectives

Reclamation's ability to meet the planning objectives would increase with increasing amounts of recirculation (**Table ES-4)**.

Flow was evaluated by estimating how often an alternative plan would meet the Bay/Delta Plan flow objective for the SJR at Vernalis, as modeled by CalSim II. EC was evaluated by estimating how often an alternative would meet the Basin Plan WQO in the SJR at Vernalis, as modeled by CalSim II, and in the south Delta, as modeled by Delta Simulation Model 2. DO was evaluated by estimating how often an alternative would meet the Basin Plan WQO in the Port of Stockton DWSC during February through June of representative hydrologic years.

The flow, EC, and DO objectives would be met more often under the Project than the No-Action Alternative and would be met increasingly more often with greater recirculation.

Table ES-4. Predicted Effect of Recirculation on Planning Objectives

		Primary Planning Objective			Other Potential Benefit		
Objective		Flow	Electrical Conductivity	Reliance on New Melones	Dissolved Oxygen	Electrical Conductivity	Water Level
Geographic Area		SJR at Vernalis	SJR at Vernalis	New Melones	SJR at DWSC	Interior South Delta	SJR at Vernalis
Unit		Percentage of periods flow objective predicted to be met	Percentage of periods EC WQO predicted to be met[1]	Reductions in New Melones releases for water quality and flow (in TAF per year)	Percentage of periods (Feb-June) when WQO (5 mg/L) predicted to be met	Percentage of days EC WQO predicted to be met[2]	90th percentile change in average daily stage during recirculation, April-Aug (in feet)
No-Action Alternative		85.5%	98.2%[1]	14.75[3]	82.9%	98.1%	0
Change Relative to No-Action Alternative, by Alternative Plan	A1	2.2%	0.4%	0	—	—	—
	A2	2.0%	0.3%	2.1	—	—	—
	B1	3.6%	0.4%	0	8.6%	0.27%	1.0
	B2	3.3%	0.3%	3.8	8.6%	0.13%	1.0
	C[4]	6.8%	0.5%	5.3	—	—	—
	D[4]	6.8%	0.7%	8.1	14.3%	0.41%	1.2

Note:

[1] The EC WQO is always met with real-time operations

[2] The SJR at Brandt Bridge was selected as a representative site of the interior south Delta compliance sites. Note Brandt Bridge is not necessarily reflective of Old River at Tracy Road Bridge, which is highly influenced by agricultural barrier operations and Delta return flows.

[3] No-Action Alternative represents releases rather than reductions.

[4] Alternatives C and D carried forward at the request of certain stakeholders and is consistent with the 2nd definition of excess capacity.

Key:

— = Not modeled
mg/L = milligram(s) per liter
DWSC = Deep Water Ship Channel
EC = electrical conductivity
SJR = San Joaquin River
TAF = thousand acre-feet
WQO = water quality objective

Reliance on New Melones was evaluated by calculating the volume of releases from New Melones for each alternative plan. Reliance on New Melones would remain the same as under the No-Action Alternative for Alternatives A1 and B1 but would decrease under the other four alternatives.

Water level was evaluated by estimating the change in average daily stage occurring during the April through August agricultural season recirculation periods, as modeled by Delta Simulation Model 2. The 90th percentile changes at Vernalis were between 1 and 1.2 feet. In the south Delta, 90th percentile changes were smaller, ranging from 0 to 0.2 feet. Water levels are generally of most concern during late summer when SJR flow decreases. Recirculation does not occur during this period.

At the request of various stakeholders, an additional water operations modeling analysis was conducted to assess whether recirculation could be used to achieve additional objectives. Two additional objectives were evaluated: (1) meeting south Delta water quality standards and (2) achieving minimum flow targets at Vernalis during the April through August irrigation season.

Results of the modeling for south Delta water quality standards indicated that limited opportunities to use recirculation to help achieve these objectives existed at two of the three compliance stations (Brandt Bridge and Old River at Middle River). Use of recirculation to achieve standards at Old River at Tracy Road Bridge Station could not be evaluated because of the lack of a relationship between water quality at Vernalis and that station.

Results of the modeling for achieving minimum flow targets at Vernalis during the irrigation season indicated there were some opportunities to help achieve this objective using recirculation. The opportunities generally occurred during late summer months.

Resource Areas

The effects of the alternative plans on resource areas were compared using metrics that were developed for the Study. The results of the evaluation of each alternative for the affected resource areas are summarized in this section.

Water Supply

Water supply was evaluated by determining the annual volume of CVP Delta export and CVP Stanislaus deliveries under each alternative plan. Deliveries would remain the same as under the No-Action Alternative for Alternatives A1 and B1, but under the other four alternatives, deliveries to CVP Delta export contractors would decrease, while deliveries to the CVP Stanislaus contractors would increase (see **Table ES-5**).

Table ES-5. Predicted Effect of Recirculation on Water Supply

No-Action Alternative / Alternative Plans		CVP Contractor Deliveries in the Delta Export Area (in TAF per year)	CVP Stanislaus River Deliveries in the Stockton East Water District (in TAF per year)
No-Action Alternative		2,423	47.3
Change Relative to No-Action Alternative, by Alternative Plan	A1	0	0
	A2	–0.7	0.1
	B1	0	0
	B2	–1.5	0.1
	C	–13.9	0.3
	D	–17.6	0.4

Key:
CVP = Central Valley Project
TAF = thousand acre-feet

Water Quality

Water quality was evaluated, in part, by estimating the potential effects of each alternative plan on drinking water quality and by comparing the effects to WQOs. An increase or decrease of 5 milligrams per liter (mg/L) or more in chloride was considered to be indicative of potential detrimental or beneficial change, respectively, to drinking water. Turbidity was evaluated by estimating how often the WQOs from the Basin Plan[1] would be violated under each alternative. Water temperature was evaluated by estimating how often the Basin Plan WQO (no increases more than 5 degrees Fahrenheit [ºF]) would be violated in the Stanislaus River at Orange Blossom Bridge under each alternative.

In general, the effects on water quality would become increasingly detrimental with increasing recirculation. The number of days chloride concentrations at key drinking water intakes in the Delta (Jones, Clifton Court, Old River, Rock Slough, Antioch) would change by at least 5 mg/L would increase with recirculation (i.e., from Alternatives B1, B2, and D). Recirculation during periods of low flow may increase the portion of SJR source water at intakes, but decrease the amount of seawater intrusion. The SJR tends to have higher salinity than Sacramento River flow, but significantly less than seawater.

Without improvements to Newman or Westley wasteways, the turbidity WQO would be violated more frequently as recirculation increased because of

[1] Central Valley Regional Water Quality Control Board. *Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins*, 4th Edition (2007).

mobilization of sediment from the unlined portion of either wasteway. All alternatives would include improvements to Newman Wasteway or Westley Wasteway. The turbidity effects would be decreased if Newman Wasteway sediment were stabilized or if a new outlet to Westley Wasteway were constructed and used.

Temperature in the Stanislaus River at Orange Blossom Bridge would rise as New Melones releases decreased, with the greatest effects under Alternative B2. However, the largest of the predicted temperature increases are still small and infrequent: the temperature would increase by more than 5ºF during 0.23% or less of the time and by more than 2ºF during 1.9% or less of the time for any alternative plan.

Fisheries

The weighted index of flows in the SJR at Vernalis is predicted to increase by 12% to 20% from conditions under the No-Action Alternative when recirculation is occurring, with the smallest changes occurring under Alternatives A1, A2, and B2 (**Table ES-6**). All alternative plans would provide additional habitat for fish when recirculation is occurring. The additional flow would assist juvenile salmonids during their emigration to the ocean. The increase in flow may also provide some improvements in habitat quality in the SJR. These flow changes, however, are not expected to provide substantial habitat improvements or to be consistent through time. Thus, the alternative plans may not provide substantial flow-related benefits to fisheries resources over time. Although all alternatives would provide increased flows over the No-Action Alternative when recirculation is occurring, the less than 8% difference in flow among alternatives is not substantial, and all alternatives are therefore considered to perform equivalently.

Fish entrainment in the Delta was evaluated by calculating the weighted index of entrainment under each alternative plan for the following 11 species: Delta smelt (*Hypomesus transpacificus*), striped bass (*Morone saxatilis*), longfin smelt (*Spirinchus thaleichthys*), threadfin shad *(Dorosoma petenense)*, four runs of Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*), American shad (*Alosa sapidissima*), and Sacramento splittail (*Pogonichthys macrolepidotus*). The species were selected in consultation with fisheries resource management agencies. All alternatives would result in additional entrainment because of increases in pumping. The highest relative entrainment in the Delta would occur under Alternatives B1 and B2, ranging from 10% to 16% (**Table ES-6**).

Table ES-6. Fisheries Results by Alternative Plan

Component	Geographic Area	Unit	No-Action Alter-native	Change Relative to No-Action Alternative, by Alternative Plan					
				A1	A2	B1	B2	C	D
Flow	SJR at Vernalis	Weighted Index	NA	14%	12%	19%	16%	20%	19%
Entrainment[1]	Delta	Weighted index, by species	NA	3-9%	3-8%	10-14%	10-16%	4-7%	4-7%
Salmonid straying	SJR	Weighted index for proportion of Delta and Sacramento water in SJR below Merced River	NA	31%	33%	48%	50%	61%	60%
Flow	Stanislaus River at Goodwin Dam	Weighted index	NA	0%	–10%	0%	–11%	–12%	–15%
Temperature	Stanislaus River at Orange Blossom Bridge	90th percentile value of temperature where difference from the No-Action Alternative 90th percentile value of temperature is at least 0.9°F (critically dry year, Jan-Apr) (in °F)	56.9	—	0.2	—	0.2	0.2	1.1
Dissolved oxygen	SJR at DWSC	Percent of periods (Feb-June) when WQO (5 mg/L) is predicted to be met	82.9%	—	—	8.6%	8.6%	—	14.3%

Notes:
[1] Entrainment calculated compared to the No-Action Alternative; only for periods with recirculation.

Key:
— = Not modeled
ºF = degrees Fahrenheit
DWSC = Deep Water Ship Channel
NA = not available
SJR = San Joaquin River
WQO = water quality objective

Salmonid straying[1] was evaluated qualitatively by calculating the weighted index for the proportion of Delta and Sacramento River water in the SJR below the Merced River and at key locations in the Delta. Only minor changes (less than 5%) were found for the Delta locations. In the SJR at Vernalis, the changes ranged from 14% to 20%. Directly below the Merced River, changes ranged from 31% to 61%, with the largest increases occurring under Alternatives C and D (**Table ES-6**). These results indicate little potential for straying for fish that migrate up to Vernalis but some potential for straying for fish that migrate up to the Merced River.

Flow-related effects in the Stanislaus River from changes in New Melones operations were evaluated by calculating the weighted index of flow in the Stanislaus River at Goodwin Dam under each alternative plan. Alternatives A2, B2, C, and D would result in decreased flows during recirculation periods of up to 15% (**Table ES-6**). However, the change would not substantially alter habitat because water level changes would affect the margins of the River, which is generally where the least desirable habitat exists.

Temperature was evaluated by first calculating the 90th percentile values of temperature (the temperature for which 90% of data points are less and 10% are greater) by season in the Stanislaus River at Orange Blossom Bridge for each alternative plan. A predicted change of at least 0.9°F in the 90th percentile monthly water temperature was used to differentiate among alternatives for purposes of comparing alternatives in the PFR. Recirculation had only a minimal effect on temperature in the Stanislaus River, with only a few occurrences when temperatures increased by greater than 0.9°F (**Table ES-6**).

DO was evaluated using the same methods described above for the evaluation of planning objectives. Recirculation increased DO in SDWSC and increased the frequency that the objective was met by 8.6% and 14.3% during recirculation periods.

In summary, recirculation would have an adverse effect on fisheries primarily because of the effects of entrainment at Jones and Banks. Adverse effects on salmonid straying and higher temperatures in the Stanislaus River at Orange Blossom Bridge would increase with increasing amounts of recirculation, with the most substantial effects occurring under Alternative D. The reduction of flow in the Stanislaus River with regard to fish habitat is not considered substantial. Increases in flow at Vernalis are not expected to provide substantial habitat improvements or be consistent through time.

[1] The mixing of Sacramento River water into the SJR during recirculation, combined with potential hydrodynamic changes in the Delta, could interfere with the ability of salmon and steelhead to home to their natal streams and could lead to an increase in straying in some runs.

Energy

Energy was evaluated by estimating how many gigawatt-hours of energy would be generated and consumed by CVP and SWP facilities under each alternative plan. Net energy generation was calculated as the sum of energy generation from hydropower facilities and the energy usage from pumping operations. Net energy generation was calculated for both long-term and drought conditions.

Long-term net energy generation would decrease as recirculation increased under Alternatives A1, A2, B1, B2, and C because of increased usage of Delta pumping plants. However, net energy generation would increase relative to the No-Action Alternative under Alternative D as a result of the reduction in CVP Delta export water deliveries, which would result in less energy usage to pump and store water in the SLR. During drought conditions, net energy generation would decrease relative to the No-Action Alternative under all alternative plans. Alternative B2 would result in the least net energy generation under both long-term and drought conditions.

Economics

Economic impacts on a national level were evaluated by calculating the net annual NED benefits for each alternative plan. Benefits reflect changes in economic values associated with physical effects on natural resource management, while costs are based on the monetary outlays required to implement the alternative.

On a regional level, the output from agricultural production in three areas of analysis—statewide, San Joaquin County, and combined Fresno and King counties—was assessed for each alternative plan. The Regional Economic Development analysis was focused on changes in agricultural production and related regional economic impacts attributable to changes in surface water deliveries under each alternative.

The changes in the national and regional economic parameters for each alternative plan compared to the No-Action Alternative are listed in **Tables ES-7 and ES-8,** respectively.

On a national level, economic losses relative to the No-Action Alternative tend to increase with recirculation, with Alternative D resulting in the greatest loss of net NED benefits for both average and dry water year conditions. Alternative A2 showed the least loss of NED benefits.

On a regional level (statewide, San Joaquin County, and Fresno and Kings Counties), output from agricultural production would remain the same as under the No-Action Alternative for Alternatives A1 and B1. In general, output from agricultural production statewide and in Fresno and Kings Counties would be less than output under the No-Action Alternative, and the losses would increase with increased recirculation. Conversely, output from agricultural production in San Joaquin County would increase with recirculation because of increases in eastside CVP water supply. However, compared to the relative regional economic losses, these gains would not be substantial. It should be noted that the Central Valley Production Model did not vary groundwater use in response to the availability of surface water supply. Therefore, actual effects on agricultural production would be different depending on the local availability and cost of groundwater as a substitute for surface water supplies.

Table ES-7. Predicted Effect on Average Annual Net National Economic Development Benefits

No-Action Alternative / Alternative Plans		Net NED Benefits	
		Average Conditions[1]	Dry Conditions[2]
No-Action Alternative		$2.7B	$2.6B
Change Relative to the No-Action Alternative, by Alternative Plan	A1	–$200K	–$300K
	A2	–$60K	–$1.4M
	B1	–$290K	–$440K
	B2	–$420K	–$1.4M
	C	–$990K	–$4.1M
	D	–$1.1M	–$8.6M

Notes:

1 Average over Water Years 1922–2003

2 Average over Water Years 1929–1934, 1976–1977, and 1987–1992 (14 of 82 water years or 17% of total)

Key:

B = billion

CVPM = Central Valley Production Model

K = thousand

M = million

NED = National Economic Development

Table ES-8. Predicted Effect on Average Annual Regional Economic Development in Agricultural Production

		Central Valley		San Joaquin County, CVPM Region 8[1]		Fresno and King Counties, CVPM Region 14[2]	
		Average Conditions[3]	Dry Conditions[4]	Average Conditions[3]	Dry Conditions[4]	Average Conditions[3]	Dry Conditions[4]
No-Action Alternative		$22.5B	$21.6B	$1.2B	$1.2B	$1.5B	$771M
Change Relative to No-Action Alternative, by Alternative Plan	A1	0	0	0	0	0	0
	A2	$790K	–$8.1M	$140K	$210K	–$710K	–$7.7M
	B1	0	0	0	0	0	0
	B2	–$1.2M	–$6.9M	$220K	$290K	–$1.5M	–$7.7M
	C	–$13.1M	–$44.3M	$730K	$1.0M	–$14.0M	–$46.7M
	D	–$16.7M	–$96.5M	$740K	$1.3M	–$17.7M	–$100.5M

Notes:
1 Includes Sacramento County South of American River and San Joaquin County
2 Includes Westlands Water District
3 Average over Water Years 1922–2003
4 Average over Water Years 1929–1934, 1976–1977, and 1987–1992 (14 of 82 water years or 17% of total)

Key:
B = billion
CVPM = Central Valley Production Model
K = thousand
M = million

Principles and Guidelines

The principles and guidelines contained in *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*[1] (commonly referred to as P&Gs) provide a basis for comparison and selection of proposed alternative plans. The four acceptance criteria that are identified in the P&Gs are described below.

Completeness

Completeness is the extent to which an alternative plan provides and accounts for all necessary investments or actions by Reclamation, DWR, or others to ensure the realization of the planning objectives.

Effectiveness

Comparison of the effectiveness of each alternative plan is presented in the analysis of how well the planning objectives are achieved.

[1] U.S. Water Resources Council, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (1983).

Efficiency

Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the planning objectives. Analysis of NED benefits and resource area impacts provides an indication of the efficiency of the alternative plans.

Acceptability

Acceptability is the extent to which the alternative plans meet the requirements of applicable laws, regulations, and public policies. This criterion also requires an assessment of the degree of acceptance by State and local entities and the public.

Impacts to resource areas are different for each alternative plan, with some alternatives having greater potential impacts on fisheries and others on economics. Because of differences in the geographic areas that would benefit from or be affected by the alternative plans, local entities from different areas will not likely be in favor of the same alternative plans. As a result, overall acceptability of any one alternative is difficult to generalize.

Ranking of Alternative Plans

For each unit in the ranking analysis, (e.g., change in releases for New Melones Reservoir), a threshold was developed to indicate the degree to which an alternative plan deviates from the No-Action Alternative and the other alternative plans. A score was assigned to the alternative plan for each unit. After ranking each unit within a resource area, an overall ranking for a resource area was determined by calculating a weighted average. The overall rankings for the alternative plans in terms of achieving planning objectives are listed in **Table ES-9**.[1]

Table ES-9. Overall Weighted Ranking of Alternative Plans for Achieving Planning Objectives

Alternative Plan	Overall Weighted Ranking
A1	0.5
A2	0.7
B1	0.5
B2	0.7
C	1.5
D	1.6

[1] Alternatives C and D are carried forward at the request of certain stakeholders and is consistent with the 2nd definition of excess capacity.

Resource Areas

The overall rankings for the resource areas (water supply, water quality, fisheries, energy, and economics) are listed in **Table ES-10**. The change in water supply would be the most adverse under Alternatives C and D with minor effects under the other alternative plans. The change in water quality would be adverse under all alternatives, but the most adverse would occur under Alternatives B2, C, and D. Fisheries would also experience adverse changes under all alternatives, with the most adverse occurring under Alternative B2. Energy would be adversely affected under Alternatives A2, B1, and B2. Economics would be adversely affected under Alternatives A2, B2, C, and D, with D resulting in the greatest changes compared to the No-Action Alternative.

Each resource area was weighted equally in determining the overall ranking for each alternative plan. Contrary to the overall ranking based on planning objectives, the overall ranking based on resources would decrease as recirculation increased, with Alternative A1 being the least detrimental and Alternative D the most detrimental.

Table ES-10. Overall Weighted Ranking of Alternative Plans for Predicted Effect on Resource Areas[1]

Alternative Plan	Resource Area					Overall Ranking Value for Resource Areas
	Water Supply	Water Quality	Fisheries	Energy	Economics	
A1	0.0	–0.1	–0.2	0.0	0.0	–0.07
A2	0.0	–0.1	–0.3	–0.2	–0.1	–0.15
B1	0.0	–0.4	–0.5	–0.2	0.0	–0.22
B2	0.0	–0.5	–0.6	–1.2	–0.1	–0.47
C	–1.0	–0.5	–0.5	–0.2	–0.6	–0.56
D	–1.0	–0.5	–0.5	0.0	–1.0	–0.61
Weight	0.20	0.20	0.20	0.20	0.20	—

[1] Alternatives C and D carried forward at the request of certain stakeholders and is consistent with the 2nd definition of excess capacity.

Findings

P&Gs define an NED Alternative as an alternative that reasonably maximizes net national economic development benefits and that is consistent with the planning objectives. Net NED benefits for all six alternative plans are negative, indicating that none of the alternatives would provide a positive contribution to the economy. Alternative A1 has the least reduction in NED during dry-water years, and Alternative A2 has the least reduction in NED over the 82-year evaluation period. Alternatives C and D have the most negative NED benefits and the lowest ranking for environmental resources. Alternatives B1 and B2 rank in the middle for meeting project goals, NED benefits and environmental resources.

Because less water would be recirculated in Alternatives A1 and A2, these alternative plans have the best ranking for environmental resources but are the least effective in meeting the planning objectives.

All six alternative plans would increase Delta pumping, which could adversely affect Delta fisheries. Several programs currently under development are designed to mitigate the environmental impacts of the CVP and SWP in the Delta (e.g., Bay Delta Habitat Conservation Plan, Delta Habitat Conservation and Conveyance Program, reoperation of CVP/SWP to comply with Biological Opinions for the long-term coordination of the CVP and SWP). Other programs currently under development (e.g., Real-Time Water Quality Management, San Joaquin River Restoration Program, and Westside Drainage Management Program) include methods aimed at achieving more consistent compliance with water quality and flow objectives in the SJR. If successful, these programs may reduce the need for and impacts of recirculation.

Next Steps

Although the findings indicate that the project is not feasible, if further work were to be conducted on the project, the next steps of the Feasibility Study could include:

- Guidance from the Regional Water Quality Control Board and State Water Resources Control Board on the acceptability of short-term (less than 30-day) excursions above the 30-day average Vernalis salinity standard should be sought. Modeling indicates additional opportunities for recirculation may exist if these actions are allowed.

- Changes in CVP/SWP operations as a result of the current Biological Opinions would be incorporated into the water operations modeling to update existing and future conditions without the project.
- The San Joaquin River Restoration Water Management Program and the Real-Time Water Quality Management and efforts under the Program to Meet Standards would be incorporated into the Study assumptions.
- The potential for fish entrainment at the Delta pumping facilities would be re-evaluated based on the outcome of the Bay Delta Habitat Conservation Plan (and related activities). If a dual conveyance or isolated conveyance facility is implemented, recirculation opportunities and impacts would change.
- Recirculation could be more fully evaluated as a tool to assist in meeting minimum flow targets at Vernalis during the irrigation season, especially during periods when entrainment impacts at Delta pumping facilities are likely to be minimal.

The above actions would not be expected to significantly increase the net NED benefits; rather, they would serve to clarify the effects of recirculation activities on the system.

Contents

Tables

Figures

Photographs

Appendices

Abbreviations and Acronyms

ºF	degree(s) Fahrenheit
cfs	cubic feet per second
µmhos/cm	micromhos per centimeter
mmhos/cm	millimhos per centimeter
µg/L	microgram(s) per liter
gpm	gallon(s) per minute
mg/L	milligram(s) per liter
AF	acre-foot (feet)
APE	area of potential effect
Authority	San Luis & Delta-Mendota Water Authority
Basin Plan	Water Quality Control Plan for the Sacramento and San Joaquin River Basins (CVRWQCB 2007a)
Banks	Harvey O. Banks Pumping Plant
Banks Pumping Plant	Harvey O. Banks Pumping Plant
Bay-Delta	San Francisco Bay and Sacramento–San Joaquin River Delta
Bay/Delta Plan	Water Quality Control Plan for San Francisco Bay/Sacramento–San Joaquin Delta Estuary
BDCP	Bay Delta Habitat Conservation Plan
bgs	below ground surface
BO	Biological Opinion
BOD	biological oxygen demand
CACMP	Common Assumptions Common Model Package
CALFED	California Federal Bay-Delta Program
CalSim II	California Simulation Model II
CCWD	Contra Costa Water District
CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CIT	Collaborative Interagency Team
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
Corps	U.S. Army Corps of Engineers

CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
CVRWQCB	Central Valley Regional Water Quality Control Board
D-XXXX	State Water Resources Control Board Water Right Decision XXXX
Delta	Sacramento–San Joaquin River Delta
DMC	Delta-Mendota Canal
DO	dissolved oxygen
DRMS	Delta Risk Management Strategy
DSM2	Delta Simulation Model 2
DWR	California Department of Water Resources
DWSC	Port of Stockton Deep Water Ship Channel
E/I	export/import (ratio)
EC	electrical conductivity
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EQ	environmental quality (account)
ESA	Endangered Species Act
Exchange Contractors	San Joaquin River Exchange Contractors Water Authority
EWA	Environmental Water Account
FERC	Federal Energy Regulatory Commission
GDA	Grassland Drainage Area
GWH	gigawatt-hour(s)
HORB	Head of Old River Barrier
IAIR	Initial Alternatives Information Report (Reclamation 2008a)
ID	irrigation district
Interior	U.S. Department of the Interior
IPO	Interim Plan of Operations
Jones	C.W. “Bill” Jones Pumping Plant
Jones Pumping Plant	C.W. “Bill” Jones Pumping Plant

LOD	level of development
Low Point Project	San Luis Reservoir Low Point Improvement Project
LVE	Los Vaqueros Enlargement
M&I	municipal and industrial
MPN	most probable number
MWH	megawatt-hour(s)
NED	national economic development (account)
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOD	Notice of Determination
NODOS	North-of-the-Delta Offstream Storage
NPDES	National Pollutant Discharge Elimination System
NRDC	Natural Resources Defense Council
NTU	nephelometric turbidity unit
OSE	other social effects (account)
P&Gs	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PFR	Plan Formulation Report
PMT	Project Management Team
POA	Plan of Action
POD	pelagic organism decline
Project	Delta-Mendota Canal Recirculation Project
P.L.	Public Law
RBDD	Red Bluff Diversion Dam
Reclamation	Bureau of Reclamation
RED	regional economic development (account)
ROD	Record of Decision
RPA	Reasonable and Prudent Alternatives
RWQCB	Regional Water Quality Control Board
SDIP	South Delta Improvements Program
Secretary	Secretary of the Interior
Service	U.S. Fish and Wildlife Service
Settlement	San Joaquin River Restoration Settlement

SJR	San Joaquin River
SJRA	San Joaquin River Agreement
SJRGA	San Joaquin River Group Authority
SJRHR	San Joaquin River Hydrologic Region
SJRIP	San Joaquin River Improvement Project
SJRRP	San Joaquin River Restoration Program
SJRWQMG	San Joaquin River Water Quality Management Group
SLR	San Luis Reservoir
SLU	San Luis Unit
SLWRI	Shasta Lake Water Resources Investigation
SOD	south of Delta
Study	DMC Recirculation Project Feasibility Study
SWAMP	Surface Water Ambient Monitoring Program
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TDS	total dissolved solids
TKN	total kjeldhal nitrogen
TMDL	total maximum daily load
TOC	total organic carbon
TOP	Transitional Operation Plan
TSS	total suspended solids
USGS	U.S. Geological Survey
U.S.C.	United States Code
USJRBSI	Upper San Joaquin River Basin Storage Investigation
VAMP	Vernalis Adaptive Management Plan
WAP	Water Acquisition Program
WDR	Waste Discharge Requirement
WQO	water quality objective
WRC	U.S. Water Resources Council

Chapter 1
Introduction

The U.S. Department of the Interior (Interior), Bureau of Reclamation (Reclamation) is evaluating the feasibility of using recirculation strategies to improve water quality and flows in the lower San Joaquin River (SJR). Specifically, Reclamation is evaluating the feasibility of the Delta-Mendota Canal (DMC) Recirculation Project (Project), in which water from the Sacramento–San Joaquin River Delta (Delta) would be recirculated through the Central Valley Project (CVP) pumping and conveyance facilities to the SJR upstream from Vernalis.

The DMC, which is part of the CVP, would be the major conveyance facility. The DMC is a 120-mile canal that begins at the C.W. "Bill" Jones (Jones Pumping Plant) near Tracy and ends at Mendota Pool, near the town of Mendota. The Jones Pumping Plant pumps water from the Delta into the canal. Water would be released from the canal into either Newman Wasteway or Westley Wasteway and would flow back into SJR from the wasteway near its confluence with the Merced River (Newman Wasteway) or with the Tuolumne River (Westley Wasteway). The water would re-enter the Delta near the town of Vernalis (**Figure 1-1)**.

In 2004, Reclamation initiated the DMC Recirculation Project Feasibility Study (Study). As a Federal water resources investigation, the Study must follow the plan formulation process, which is defined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC 1983), commonly referred to as P&Gs. The plan formulation process is a six-step approach to problem solving (see **Chapter 3** for more information on the process). The six steps are:

Step 1: Define water resources problems and needs to be addressed.

Step 2: Identify existing resource conditions and project future conditions without implementation of a project.

Step 3: Develop planning objectives, constraints, and criteria.

Step 4: Identify resource management measures and formulate alternative plans for meeting the objectives.

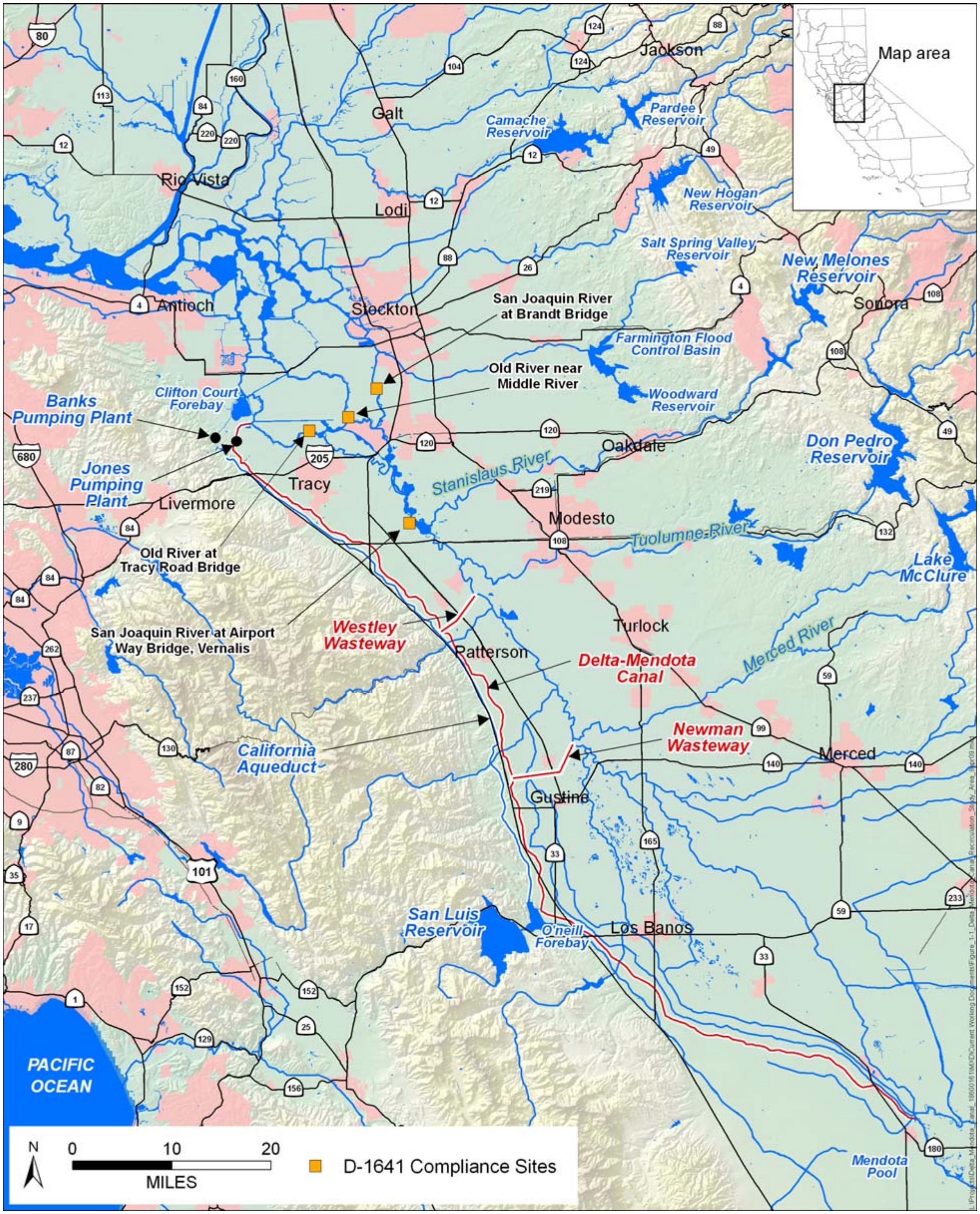


Figure 1-1. Delta-Mendota Canal Recirculation Project Vicinity

Step 5: Evaluate and compare the alternative plans

Step 6: Recommend a plan for implementation.

A number of reports are prepared during the Study, and some of the steps overlap in these reports. Technical and pilot studies and an Initial Alternatives Information Report (IAIR)[1] (Reclamation 2008a) have already been completed. This Plan Formulation Report (PFR) builds on the IAIR. An Environmental Impact Statement / Environmental Impact Report (EIS/EIR) and a Feasibility Study Report would complete the Study.

The EIS/EIR and the Feasibility Study Report would both be made available to the public for review and comment. Reclamation would file a Record of Decision (ROD), and DWR would file a Notice of Determination (NOD) before the project could be implemented.

For the Study, Reclamation is the lead Federal agency for compliance with the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. §§ 4321-4347 [2006]), and the California Department of Water Resources (DWR) is the lead State agency for compliance with the California Environmental Quality Act of 1970 (CEQA) (California Public Resources Code §§ 21000 et seq.).

1.1 Purpose of the DMC Recirculation Project Feasibility Study

The purpose of the Study is to evaluate the feasibility of implementing DMC recirculation as a means of accomplishing the objectives defined in the authorization for the Study (see **Section 1.2** and **Chapter 3**). The Study, which is identified in the authorizing legislation as part of Reclamation's overall Program to Meet Standards (PTMS) (see **Section 1.8.1**), is intended to determine whether Reclamation can, through the use of excess capacity in export pumping and conveyance facilities, provide greater flexibility in meeting the existing water quality objectives (WQOs) and flow objectives for which the CVP has responsibility, reduce the demand on water (for use to improve water quality and flow) from New Melones Reservoir, and assist the Secretary of the Interior (Secretary) in meeting obligations to CVP water contractors using New Melones Reservoir.

[1] All references to the Initial Alternatives Information Report (IAIR) in this document are to Reclamation (2008a).

1.2 Authorization for the DMC Recirculation Project Feasibility Study

The Study is authorized by the CALFED [California Federal Bay-Delta Program] Bay-Delta Authorization Act of 2004 (118 Stat. §§ 1681-1702.; Public Law 108-361).

Section 103(d)(2)(D)(i) of the Act directs the Secretary to:

> … develop and initiate implementation of a program to meet all existing water quality standards and objectives for which the Central Valley Project has responsibility

Section 103(d)(2)(D)(ii) states:

> In developing and implementing the program, the Secretary shall include, to the maximum extent feasible, the measures described in clauses (iii) through (vii).

Section 103(d)(2)(D)(iii) states:

> The Secretary shall incorporate into the program a recirculation program to provide flow, reduce salinity concentrations in the San Joaquin River, and reduce the reliance on the New Melones Reservoir for meeting water quality and fishery flow objectives through the use of excess capacity in export pumping and conveyance facilities.

Section 103(d)(2)(D)(vi) states:

> The purpose of the authority and direction provided to the Secretary under this subparagraph is to provide greater flexibility in meeting the existing water quality standards and objectives for which the Central Valley Project has responsibility so as to reduce the demand on water from New Melones Reservoir used for that purpose and to assist the Secretary in meeting any obligation to CVP contractors from the New Melones Project.

Section 103(f)(1)(G) provides funding authorization for the Study:

> Funds may be used to conduct feasibility studies, evaluate, and, if feasible, implement the recirculation of export water to reduce salinity and improve dissolved oxygen (DO) in the San Joaquin River.

Water Right Decision 1641 (Revised) (D-1641) (SWRCB 2000) amended Reclamation's water-right permits to allow CVP water to be diverted at the

Harvey O. Banks Pumping Plant (Banks Pumping Plant), subject to DWR's permission, as part of the joint operations of Federal and State export facilities. The joint operation of the CVP and State Water Project (SWP) is commonly referred to as the "Joint Point of Diversion."

As part of D-1641, the State Water Resources Control Board (SWRCB) required Reclamation to conduct a feasibility study for recirculation and prepare a Plan of Action (POA) for the evaluation of the potential impacts of recirculating water from the DMC through the Newman Wasteway and back to the Delta via the SJR. The SWRCB has directed Reclamation to address the following issues in the POA:

- The potential impacts of changes in water composition on Delta native fish and on the imprinting of juvenile fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) in the SJR basin
- The potential effects of increased exports on in-Delta hydrodynamics and fish entrainment at the CVP and SWP export facilities
- The potential effects of salt and contaminant loading in the SJR basin due to the recirculation of water through Newman Wasteway
- The impacts on water deliveries to the San Joaquin River Exchange Contractors Water Authority (Exchange Contractors) and other contractors receiving water from the DMC, the California Aqueduct, and the San Luis Reservoir (SLR)
- The capacity of the physical facilities to implement recirculation, including a description of any needed structural/channel modifications, a cost estimate, and a determination of the potential of the conserved water (compared to other alternatives) to meet Delta flow and Vernalis Adaptive Management Plan (VAMP) requirements
- The potential for improvements in water quality in the SJR as a result of recirculation

Reclamation submitted the POA (Reclamation 2000) to the SWRCB on December 15, 2000. The SWRCB approved the POA in a letter dated March 21, 2001 (SWRCB 2001). In April 2006, Reclamation submitted a revised POA to the SWRCB (Reclamation 2006a); the revised POA included a revised schedule and incorporated the Feasibility Study authorized by P.L. 108-361.

1.3 Purpose and Scope of the Plan Formulation Report

The PFR represents an interim milestone in the Study. It is a progress report, not a decision document.

The purposes of the PFR are (1) to provide information on the existing and potential resources that may be affected by the Project and (2) to present the results of the evaluation of the alternative plans that were carried forward from the IAIR. The evaluation includes a comparison and ranking of the alternative plans. The next steps in the Study are also presented.

The PFR will be used to help prepare the EIS/EIR and the Feasibility Study Report, the final parts of the Study.

1.4 Organization of the Plan Formulation Report

The PFR is organized as follows:

- **Chapter 1** describes the purpose and scope of the PFR; authorization for the Study; water resources and related problems and needs in the Study area warranting Federal and State consideration; planning objectives to address problems, needs, and opportunities; the Study Area; highlights of relevant studies, projects, and programs; and the organization of the PFR.
- **Chapter 2** describes the existing and potential water resources and related conditions in the potentially affected environment of the Study area.
- **Chapter 3** describes the plan formulation process; the alternative evaluation process; planning constraints, guiding principles, and acceptance criteria for the Study, and agency and public outreach.
- **Chapter 4** describes the development and features of the alternative plans, features common to the alternatives, costs, and implementation considerations.
- **Chapter 5** provides a comparative analysis of the alternative plans and identifies and describes implementation considerations for the project.
- **Chapter 6** summarizes the findings of the PFR, identifies recommended plans and strategies for future phases of the Study.
- **Chapter 7** is a list of the references that are cited in the PFR.
- **Chapter 8** is a list of contributors to the PFR.

Supporting data and other relevant information is provided in the following appendices:

- **Appendix A**: Water Operations Analysis
- **Appendix B**: DSM2 Model Methods and Results
- **Appendix C**: Water Temperature Model and Analysis
- **Appendix D**: Suspended Sediments Model Methods and Results
- **Appendix E**: Selenium and Boron Model
- **Appendix F**: Water Resources Evaluation
- **Appendix G**: Drinking Water Evaluation
- **Appendix H**: Fisheries Evaluation
- **Appendix I**: Energy Resources Evaluation
- **Appendix J**: Economic Analysis
- **Appendix K**: Land Use
- **Appendix L**: Water Rights
- **Appendix M**: 2008 Pilot Study Report

1.5 Problems, Needs, and Opportunities

Significant elements of any water resources investigation are identification of the scope and magnitude of the problems and needs to be addressed, and discovery of opportunities for improving all affected resources. Identification of the problems, needs, and opportunities provides a foundation for formulating alternative plans that address these issues.

This section contains a description of the problems, needs, and opportunities that serve as the basis for the Study. The following concerns have been identified to date in the Study:

- San Joaquin River flow objectives
- San Joaquin River water quality objectives
- Water supply reliability
- Other opportunities and issues, as follows:
  - Fishery effects in the Delta, San Joaquin River, and Stanislaus River
  - Effects of increased pumping on Delta aquatic resources
  - South Delta water level

- South Delta water quality (e.g., EC and DO)
- Groundwater overdraft

DMC recirculation is only one strategy that may be used to help alleviate the problems and satisfy the needs. Other potential strategies include the new and ongoing programs and projects that are described in **Section 1.8**.

1.5.1 San Joaquin River Flow Objectives

To protect beneficial uses in the lower SJR and south Delta, the SWRCB has established flow requirements for the Delta that the CVP and SWP must meet as a condition of operating the C.W. "Bill" Jones (Jones Pumping Plant) and Banks Pumping Plant, respectively. The flow requirements were established as WQOs, which are set forth in D-1641 and the *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay/Delta Plan) (SWRCB 2006).[1] The Bay/Delta Plan includes a prescribed spring pulse flow at Vernalis (the point at which the SJR enters the Delta) that is scheduled to coincide with fish migration in the SJR tributaries and the Delta. SJR flow objectives were developed to provide attraction and transport flows and suitable habitat for various life stages of aquatic organisms, including Delta smelt (*Hypomesus transpacificus*) and Chinook salmon.

The Bay/Delta Plan flow requirements at Airport Way Bridge, Vernalis, that are intended to benefit fish and wildlife are listed in **Table 1-1**.

As a condition for operating Jones Pumping Plant, Reclamation has historically operated New Melones Dam and Reservoir to assist in meeting the flow requirements at Vernalis.

During the evidentiary and public input portions of the SWRCB process leading to adoption of both the Bay/Delta Plan and D-1641, interested parties suggested DMC recirculation as an alternative method for meeting flow obligations that could be more efficient and provide potential water supply benefits to water users of the Stanislaus River. Alternative methods are needed to reliably meet flow objectives at Vernalis.

[1] All references to the Bay/Delta Plan in this document are to SWRCB 2006.

Table 1-1. Minimum Average Monthly Water Quality Objectives for Flow for San Joaquin River at Airport Way Bridge, Vernalis (Interagency Station C-10)

Water Year Type[1,2]	Period	Flow (cfs) [3]
Wet, Above Normal	February 1 to April 14 and May 16 to June 30	2,130 or 3,420
Dry, Below Normal		1,420 or 2,280
Critical		710 or 1,140
Wet	April 15 to May 15	7,330 or 8,620
Above Normal		5,730 or 7,020
Below Normal		4,620 or 5,480
Dry		4,020 or 4,880
Critical		3,110 or 3,540
All	October	1,000[4]

Source: SWRCB (2006)

Notes:

[1] Based on San Joaquin Basin Index.

[2] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

3 Higher flow objective applies when the 2 ppt isohaline, measured as 2.64 mmhos/cm surface salinity (X2,) is required to be at or west of Chipps Island.

[4] Includes up to an additional 28,000 AF pulse/attraction flow during all water year types. The amount of water is limited to the amount necessary to provide a monthly average flow of 2,000 cfs. The additional 28,000 AF is not required in a critical year following a critical year.

Key:

AF = acre-foot (feet)
cfs = cubic foot (feet) per second
mmhos/cm = millimhos per centimeter
ppt = parts per thousand
SJR = San Joaquin River

1.5.2 San Joaquin River Water Quality Objectives

The Delta provides drinking water for two thirds of California's residents and water for other beneficial uses, such as other urban uses, agriculture, and the environment. To protect the beneficial uses, WQOs have been developed and are set forth in D-1641, the Bay/Delta Plan, and the *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* (Basin Plan) (CVRWQCB 2007a).[1] The WQOs were established to protect municipal and industrial (M&I), agricultural, and fish and wildlife beneficial uses. Of particular interest

[1] All references to the Basin Plan in this document are to CVRWQCB (2007a).

to the Study are the salt (EC) WQOs for the SJR downstream from its confluence with the Stanislaus River at Vernalis (near Modesto), which have the potential to be affected by recirculation.

Water quality in the lower SJR has been the subject of several studies, and regulatory actions related to the water quality are pending. Low flows and discharges from agricultural areas, wildlife refuges, and M&I treatment plants all affect water quality negatively. The lower SJR has been listed as an impaired water body by the SWRCB and the U.S. Environmental Protection Agency (EPA) (SWRCB 2007b), making it essential to find new ways to meet the WQOs. The portion of the SJR from Mendota Pool to Vernalis is listed as a water quality limited segment under Section 303(d) of the Clean Water Act of 1972 (33 U.S.C. § 1313 [2008]).

The SWRCB approved the *Amendment for the Control of Salt and Boron Discharges into the Lower San Joaquin River* (CVRWQCB 2007a) in November 2005, and final approval was received from EPA on February 8, 2007. The WQOs for salinity, the same as those in D-1641, are listed in **Table 1-2**. The table also lists WQOs for interior south Delta stations, which are discussed in **Section 1.5.4**. WQOs for boron are discussed in **Section 2.2.3**.

1.5.3 Water Supply Reliability

For this Study, water supply reliability is defined as delivering a specific quantity of water with a certain quality and determined frequency to a particular location at a particular time. Water supply reliability integrates water supply (storage), water quality, and the system capacity to convey water when and where it is needed. Water supply reliability in the lower SJR is complicated by flow and quality requirements at Vernalis and by the requirements of environmental, agricultural, and urban uses. As competition among water uses increases, the complexity of managing a highly constrained and regulated water system such as the SJR also increases.

In the San Joaquin River Hydrologic Region (SJRHR) Report, which is contained in the *California Water Plan Update 2005: Framework for Action* (DWR 2005a), water balances in the SJR basin were determined for Water Years 1998, 2000, and 2001. The water balances for the SJR basin were calculated as the difference between water entering the region and water leaving the region. Water Year 1998 had 174% of normal precipitation, Water Year 2000 had 113% of normal precipitation, and dry Water Year 2001 had 79% of normal precipitation. The report indicated that water demand exceeds water supply at just above normal to low precipitation conditions. Water supply reliability is therefore a significant challenge in the region.

Table 1-2. D-1641 Water Quality Objectives for Salinity

Objective	Location	Period	Water Year Type	EC in mmhos/cm (µmhos/cm)[1]
EC objective for agricultural beneficial uses	SJR at Airport Way Bridge, Vernalis	April to August	All	0.7 (700)
		September to March	All	1.0 (1,000)
EC objective for agricultural beneficial uses	Interior south Delta Stations SJR at Brandt Bridge, Old River near Middle River, Old River at Tracy Road Bridge	April to August[2]	All	0.7 (700)
		September to March	All	1.0 (1,000)

Notes:

[1] WQOs are evaluated as the 30-day running average of the mean daily EC.

[2] In D-1641, Footnote 5 of Table 2 indicates the interim objective of 1.0 mmhos/cm (1,000 µmhos/cm) expired April 1, 2005. The current objective is 0.7 mmhos/cm (700 µmhos/cm) because of the lack of construction of permanent barriers or equivalent measures. The EC objective is currently undergoing review through a State Water Resources Control Board process.

Key:

µmhos/cm = micromhos per centimeter
mmhos/cm = millimhos per centimeter
D-1641 = SWRCB Water Right Decision 1641
DWR = California Department of Water Resources
EC = electrical conductivity
Reclamation = Bureau of Reclamation
SJR = San Joaquin River
SWRCB = State Water Resources Control Board
WQO = water quality objective

Meeting Vernalis flow and salinity WQOs through recirculation could allow the releases from New Melones for flow and salinity purposes to be reduced, and the reliability of contract water service for CVP contractors along the Stanislaus River with water supplies derived from New Melones storage could increase in the long term. However, implementation of recirculation to increase CVP deliveries to Stanislaus contractors may reduce reliability for the CVP Delta export contractors.

1.5.4 Other Opportunities and Issues

In developing alternative plans that address SJR and Delta flow requirements and WQOs, the Study investigators have explored ways to improve other needs not explicitly addressed in the authorizing legislation, to the extent possible, and have also addressed the effects of recirculation on potentially affected resources such as fisheries in the Delta, SJR, and Stanislaus River; south Delta water quality and water level; and groundwater overdraft. These resources and issues may or may not be the direct responsibility of either lead agency but could be affected by recirculation.

Fisheries in the Delta, San Joaquin River, and Stanislaus River

The SJR system supports anadromous fish of fall-run Chinook salmon, steelhead, and white sturgeon (*Acipenser transmontanus*), and introduced species such as striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*). Loss of access to spawning habitat, altered hydrology, water supply operations, agricultural return flows, polluted runoff, reduction in riparian habitat, changes in geomorphology, and the introduction of exotic predatory species and competitors have negatively affected anadromous salmon and steelhead and other aquatic species in the SJR system.

Poor water quality in portions of the SJR has created problems in sustaining healthy fish populations. One of the problems is low DO, which can create a barrier in the Stockton Port of Stockton Deep Water Ship Channel (DWSC) to upstream migrating adult Chinook salmon in the fall. The portion of the SJR from Mendota Pool to Vernalis is listed as a water quality limited segment under the Section 303(d) of the Clean Water Act of 1972 (33 U.S.C. § 1313 [2008]). During late summer and fall, recirculation could be used to improve DO levels in the Stockton area, potentially aiding the upstream migration of adult salmonids.

Improved flow in sections of the SJR might provide some benefit to outmigrating juvenile anadromous fish. Recirculation presents some risk of straying[1]. In D-1641, the SWRCB requires an evaluation of the potential imprinting[2] impacts on outmigrant juvenile fall-run Chinook salmon and steelhead in the SJR basin from the DMC Recirculation Project.

Effects of Increased Pumping on Delta Aquatic Resources. Delta smelt, longfin smelt (*Spirinchus thaleichthys*), juvenile salmonids, other fish species, and other pelagic organisms are entrained at both the Jones and Banks pumping plants during operations to move water into the DMC and the California Aqueduct. Changed hydrodynamics in the Delta resulting from the operation of State and Federal water projects affect habitat condition indicators for fish and other aquatic organisms in the Delta. Alternative plans that increase the amount of pumping for the purpose of recirculation would tend to have more impact on Delta aquatic resources by further altering the already changed hydrodynamic conditions.

Effects of Recirculation on Salmonid Habitat in the Stanislaus River. The Stanislaus River supports both anadromous runs of Central Valley fall-run Chinook salmon and Central Valley steelhead. The amount of year-round rearing habitat in the river is a function of flow as it influences temperatures and the downstream limit of habitat that supports salmonids. Chinook salmon juveniles use the river from February into June. Juvenile steelhead rear year-round. Use of recirculated water to meet flow or salinity objectives at Vernalis could alter flows released from Goodwin Dam into the Stanislaus River. Change in river temperature was examined by looking at the timing of recirculation events and the use of Stanislaus River or recirculated water to meet Vernalis objectives relative to no recirculation during the same periods.

South Delta Water Level

The SJR splits at the head of Old River in the south Delta, and under natural conditions, approximately half of the water in SJR flows down Old River. However, operations of the CVP and SWP can change Delta flow patterns and during periods when low SJR flows combine with high export rates and low tides, south Delta water levels can become so low as to constrain diversions for irrigation. The problem of south Delta low water levels is multifaceted; it may be addressed, in full or in part, by the South Delta Improvements Program (SDIP) and DMC recirculation during late summer. The SDIP involves installing permanent operable barriers at key locations in the Delta, carefully focused channel dredging, and other actions to improve water quality and water

[1] The mixing of Sacramento River water into the SJR during recirculation, combined with potential hydrodynamic changes in the Delta, could interfere with the ability of salmon and steelhead to home to their natal streams and could lead to an increase in straying in some runs.

[2] Juvenile salmonids learn (or imprint to) the odors associated with their natal stream; these retained odor memories are later used to guide the final phases of home-stream migration.

levels. The DMC Recirculation Project (Project) could improve the likelihood of the SDIP being successful in addressing low water levels.

In response to stakeholder requests at scoping and outreach meetings, the Study includes an examination of whether, and to what extent, the DMC recirculation alternative plans would enhance or maintain desired water levels in the south Delta during critical irrigation periods.

South Delta Water Quality

Delta WQOs for the operation of CVP and SWP facilities were established by the SWRCB and are set forth in the Bay/Delta Plan and D-1641. The EC objectives in D-1641 are listed in **Table 1-2**. The Bay/Delta Plan WQOs for three interior south Delta locations (SJR at Brandt Bridge, Old River at Middle River, and Old River at Tracy Road Bridge) are expressed as a maximum 30-day running average of daily average EC for the protection of agricultural beneficial uses. Meeting these WQOs is the joint responsibility of DWR and Reclamation. Reclamation meets its share of the joint responsibility through meeting WQOs at Vernalis.

The water quality in the south Delta is also influenced by diversions of water by the SWP and CVP, diversions by local users, tidal action, operation of gates and barriers, irrigation drainage, return flows, urban runoff, wastewater discharges, and channel capacity. Other ongoing projects (e.g., SDIP) described in **Section 1.8** are more directly designed to address improvements needed to increase compliance.

The Study includes an examination of whether, and to what extent, DMC recirculation alternative plans would enhance water quality in the south Delta and in the DWSC.

Groundwater Overdraft

The SJR basin, also known as the SJR Hydrologic Region (SJRHR) in terms of groundwater, covers approximately 9.7 million acres and contains two entire groundwater basins, the Yosemite Valley basin and the Los Banos Creek Valley basin, and a portion of the San Joaquin Valley basin. SJRHR depends heavily on groundwater for agricultural and urban use, especially during droughts, and portions of Merced County and eastern San Joaquin County are entirely dependent on groundwater. According to *California's Groundwater Update 2003* (DWR 2003), groundwater in the region accounts for about 30% of the average annual supply for agricultural and urban use.

Irrigation Districts (IDs) and cities pump groundwater from the Merced, Modesto, and Eastern San Joaquin subbasins to help meet water demands, particularly during drought conditions. All three of these subbasins are in a state of overdraft. In Bulletin 160-93 (DWR 1994), DWR reported that the overdraft in the Merced groundwater basin is occurring at a rate of 28,000 acre-feet (AF) per year, based on the 1990 Level of Demand.

Overdraft conditions can contribute to subsidence, groundwater quality degradation, and declines in agricultural productivity. Under some conditions, subsidence can lead to the irreversible loss of storage capacity in an aquifer. Subsidence from hydrocompaction has occurred in two particular areas: lands west of Mendota (USGS 1999) and most of the area north of Tracy. Overdraft conditions in the western portion of the SJR basin contribute to the deterioration of groundwater quality by promoting the recharge of stream flow from marine sediments in the Coast Range with high total dissolved solids (TDS) levels.

Recirculation may reduce the existing groundwater overdraft to the extent that it increases water supply availability from New Melones for uses other than meeting the flow and water quality objectives in the SJR and south Delta established in the Bay/Delta Plan and D-1641. Conversely, alternative plans that result in reduction in water availability, particularly for Delta export contractors, could result in increased groundwater pumping to replace lost surface-water supplies.

1.5.5 Summary of Problems, Needs, and Opportunities

The primary problems and needs that must be considered in the Study are compliance with flow and water quality requirements in the SJR at Vernalis and improving water supply reliability for Stanislaus River water users. Opportunities that are being considered are improving fisheries, improving water quality and raising water levels in the interior south Delta, and preventing further groundwater overdraft. **Table 1-3** is a summary of the problems, needs, and opportunities for the DMC Recirculation Project.

1.6 Planning Objectives

Planning objectives for the Project were developed based on the problems, needs, and opportunities that were identified in the Study area and on legislative and regulatory directives. The objectives have been used to guide the formulation of alternative plans. The alternatives were formulated to address the primary planning objectives and the other potential benefits listed below.

Table 1-3. Problems, Needs, and Opportunities

Problems, Needs, and Opportunities		**Description**
Problems and Needs	San Joaquin River Flow Objectives	Provide flow for meeting fishery flow objectives at Vernalis. Provide operational flexibility to improve the reliability of meeting the flow requirements at the Vernalis gauging station.
	San Joaquin River Water Quality Objectives	The lower SJR has been listed as an impaired water body by the SWRCB and EPA (Alex Strauss, Director, EPA Water Division, pers. comm., November 30, 2006) because of its high concentrations of salts, boron, and selenium, as well as toxicity. Reclamation has been successful in meeting the Vernalis EC objective but relies on releases from New Melones. Also, when several dry water years occur sequentially, water from New Melones may not be available to help meet the objective. Recirculation will be evaluated for its ability to help meet Vernalis EC objectives.
	Water Supply Reliability	Improve water supply reliability for Stanislaus River users. Recirculation to improve water quality and flows may have the potential to improve water supply reliability for CVP contractors in the Stanislaus River.
Opportunities	Fisheries in the Delta, San Joaquin River, and Stanislaus River	Augment flow to improve anadromous fish survivability. D-1641 requires an evaluation of potential imprinting impacts from recirculation on juvenile fall-run Chinook salmon and steelhead in the SJR basin. Determine whether improving the flow in the SJR through recirculation would be a benefit or liability for anadromous fish.
	South Delta Water Level	Improve south Delta water levels. Low SJR flows combined with high export rates and low tides can cause south Delta water levels to become so low as to constrain diversions for irrigation.
	South Delta Water Quality[1]	As of April 1, 2005, D-1641 requires DWR and Reclamation (1) to meet an EC objective of 0.7 mmhos/cm (700 µmhos/cm) from April through August or (2) to have completed construction of permanent operable barriers (or equivalent measures) in the south Delta (i.e., SDIP) and an operations plan to protect south Delta agriculture. Water quality routinely fails to meet the April through August EC objective of 0.7 mmhos/cm (700 µmhos/cm) for agricultural water use in the interior south Delta locations and implementation of the SDIP has been delayed. Recirculation will be evaluated for its ability to improve south Delta water quality. The effect of recirculation on DO conditions in the DWSC will also be evaluated.

Table 1-3. Problems, Needs, and Opportunities

Problems, Needs, and Opportunities		Description
Opportunities (cont.)	Groundwater Overdraft	Reduce groundwater overdraft. Merced and Oakdale IDs pump groundwater from the Merced, Modesto, and Eastern San Joaquin groundwater subbasins to help meet demand during drought conditions, and some basins are in a state of overdraft. Westside water users rely on deep groundwater pumping and saline surface supplies to supplement inadequate CVP contract deliveries.

Note:

1 The SWRCB is currently reviewing the south Delta salinity WQOs for agriculture. Any changes in the WQOs will affect the need for, or implementation of, the DMC Recirculation Project.

Key:

μmhos/cm = micromhos per centimeter
mmhos/cm = millimhos per centimeter
CVP = Central Valley Project
D-1641 = SWRCB Water Right Decision 1641
Delta = Sacramento–San Joaquin River Delta
DMC = Delta-Mendota Canal
DO = dissolved oxygen
DWR = California Department of Water Resources
DWSC = Port of Stockton Deep Water Ship Channel
EC = electrical conductivity
EPA = U.S. Environmental Protection Agency
ID = Irrigation District
Reclamation = Bureau of Reclamation
SDIP = South Delta Improvements Program
SJR = San Joaquin River
SWRCB = State Water Resources Control Board

The primary planning objectives are:

- **Objective A**: Provide supplemental flow in the lower SJR for meeting fishery flow objectives through the use of excess capacity[1] in export pumping and conveyance facilities.
- **Objective B**: Provide lower salinity water to the SJR for meeting WQOs at Vernalis through the use of excess capacity in export pumping and conveyance facilities.
- **Objective C**: Provide greater flexibility in meeting the existing water quality standards and objectives for which the CVP has responsibility to reduce the demand on water from New Melones Reservoir used for that purpose and to assist the Secretary of the Interior in meeting any obligation to CVP contractors from the New Melones Project.

The other potential benefits are:

- Improve DO in the SJR.
- Improve water quality and water levels in the interior south Delta through the use of excess capacity in export pumping and conveyance facilities.

In the Study, water operations modeling using recirculation to achieve the primary objectives was conducted. Operations modeling results for the primary objectives were used to evaluate the effectiveness of recirculation in improving DO in the SJR and water quality and water levels in the interior south Delta. Also, water operations modeling sensitivity analysis was conducted on the ability to use recirculation to improve flow and water quality in the interior south Delta.

1.7 Study Area

The Study area includes all areas that have the potential to be affected by the DMC Recirculation Project. The areas for the PFR, in general, are the lower main stem of the SJR just above its confluence with the Merced River; the areas served by the Merced, Tuolumne, and Stanislaus rivers on the western side of the Sierra Nevada Mountains; and the areas served by the DMC, which includes approximately 30 water agencies. The Study area also includes the south Delta, which serves as a source of water supply for agricultural and urban uses in the Delta area.

[1] Two definitions of "excess capacity" were utilized to develop the PFR alternatives in response to request by various stakeholders: Capacity in CVP facilities in excess of that needed to meet (1) CVP authorized purposes; or, (2) CVP environmental requirements.

The Study area contains several IDs that are served by the SJR tributaries, including the Modesto and Turlock IDs on the Tuolumne River; the Merced ID on the Merced River; the South San Joaquin ID; and the Stockton East Water District, Central San Joaquin Water Conservation District, and Oakdale ID on the Stanislaus River.

Immediately downstream from the confluence with the Stanislaus River, the SJR becomes part of the Delta, which serves as a source of water supply for agricultural and urban uses within the Delta area. The south Delta is therefore considered part of the Study area.

The DMC is on the western side of California's San Joaquin Valley. It runs for approximately 120 miles, beginning near Tracy at the southern edge of the Delta and terminating at the Mendota Pool on the SJR, at Mendota. The primary areas served by the DMC are agricultural lands on the western side of the San Joaquin Valley, from Tracy in the north to Kettleman City in the south, and urban uses in the San Felipe Unit of the CVP, in San Benito and Santa Clara counties, west of the Coast Range.

The DMC generally runs parallel to the California Aqueduct, a State-owned conveyance facility providing primarily agricultural water to southern portions of the San Joaquin Valley and primarily urban water to southern California. The DMC is part of the Federal CVP Delta export facilities, which also include the Jones Pumping Plant (formerly known as the Tracy Pumping Plant), the Westley and Newman wasteways, the O'Neill Pumping Plant, the O'Neill Forebay, and the SLR joint-use facility.

The facilities and features that may be used directly for recirculation include, but may not be limited to, Jones Pumping Plant, DMC, Westley or Newman Wasteway, and the SJR just above its confluence with the Merced River. Recirculation may also affect the operations of other CVP or joint-use facilities, either directly or indirectly, including the SLR which is a joint CVP/SWP facility, and the New Melones Reservoir on the Stanislaus River, which is a CVP facility (see **Figure 1-1**). SWP facilities that may be used for recirculation include Banks Pumping Plant and the California Aqueduct.

1.8 Related Studies, Projects, and Programs

Related studies, projects, and programs that have the potential to affect or be affected by the DMC Recirculation Project are described in this section. How these studies will be incorporated into the baseline and the No-Action/No-Project Alternative conditions is discussed in **Chapter 2**.

1.8.1 Program to Meet Standards

The CALFED Bay-Delta Authorization Act of 2004 requires Reclamation to develop a program to meet all existing WQOs for which the CVP has responsibility. Three actions, in addition to the DMC Recirculation Project, have been identified for consideration relative to achieving this goal on the SJR: Best Management Practices for wetlands discharges, water acquisitions from willing sellers, and an updated New Melones Reservoir Plan of Operations. The status of these projects and their potential to affect the Project are described in this section. The results of earlier DMC recirculation studies are incorporated later in this report when the results relate to alternative plan development and evaluation.

Best Management Practices Plan for Wetlands Discharges

The Grassland Water District is developing a comprehensive flow and salinity monitoring system and using a decision support system to improve the management of seasonal wetlands in the San Joaquin Valley and the releases of high-salinity water. The models that are used for the decision support system generate salinity balances at regional and local scales. The regional scale is focused on deliveries to and exports from Grassland Water District, and the local scale, where more intensive monitoring is conducted, is focused on the individual wetland unit (Harris 2001).

The U.S. Fish and Wildlife Service (Service) is also developing Best Management Practices for wildlife management areas that receive Federal water to reduce potential impacts to the SJR when the areas are drained for habitat management.

Water Acquisition Program

The Central Valley Project Improvement Act of 1992 (CVPIA) (P.L. 102-575) requires the acquisition of water for protecting, restoring, and enhancing fish and wildlife populations. To meet water acquisition needs under the CVPIA, Interior has developed a Water Acquisition Program (WAP), which is a joint effort by Reclamation and the Service (Interior 2003).

The WAP acquires water to meet two purposes: Level 4 refuge water supplies and instream flows. Since the Project involves both augmentation of instream flows in the SJR and the use of Jones Pumping Plant capacity, which also may be used to convey Level 4 refuge water, the WAP has the potential to affect or be affected by the Project.

As a part of CVPIA long-range planning efforts to increase stream flows, the Service is conducting ongoing studies related to three key issues: biological needs of anadromous fish, hydrological characteristics of targeted streams (including reservoir operations), and economic considerations. Information from these studies will be used to establish which streams have the highest priority need for additional flows and how much water is needed in each of those streams.

To date, the WAP has acquired water primarily from the San Joaquin River Group Authority (SJRGA) and its member agencies. These acquisitions provide additional spring and fall fishery flows on the Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers.

New Melones Interim Plan of Operations

Reclamation is updating the operating plan for New Melones Dam and Reservoir that will establish how available water supplies are managed in and outside the Stanislaus River basin. New Melones operations may affect or be affected by the Project, depending on the operations priorities in the alternative plans.

New Melones Dam is about 0.75 mile downstream of the original Melones Dam, built by the Oakdale and South San Joaquin IDs in 1926. Construction of the dam began in July 1966, and the reservoir was filled in 1983. Current water availability from the New Melones Project is significantly lower than the amount that was expected when the dam was constructed.

Original estimates anticipated that approximately 200,000 AF of water per year would be available after pre-existing obligations were met. From those estimates, contracts were negotiated with Stockton East Water District and the Central San Joaquin Water Conservation District for up to 155,000 AF per year. During the drought of 1987 to 1992, pre-existing obligations were not always met, and there were periods when water was not available to service those contracts (Reclamation n.d.).

The operating criteria for New Melones Reservoir are governed by the New Melones authorization statutes (Flood Control Acts of December 1944 [P.L. 78-534] and October 1962 [P.L. 87-874]), Stanislaus River water rights, instream fish and wildlife flow requirements, temperature and DO requirements, Vernalis water quality and flow requirements from D-1641, CVP contracts, and flood control requirements. The Stanislaus River subsection of **Section 2.2.2** provides details about the flow requirements.

Water released from New Melones Dam and power plant is re-regulated at Tulloch Reservoir and either diverted at Goodwin Dam or released from Goodwin Dam to the lower Stanislaus River. Releases into the lower Stanislaus River provide water for riparian water rights and help meet instream fishery flow, water temperature, and instream DO objectives. Stanislaus River water that is released into the SJR generally improves the flow and water quality conditions at Vernalis.

The *New Melones Project Water Right Decision 1422* (D-1422) (SWRCB 1973), issued in 1973, provided the primary operational criteria for New Melones Reservoir. The decision permits Reclamation to appropriate water from the Stanislaus River for irrigation and M&I uses, but it requires the operation of New Melones Reservoir to include releases for existing water rights, fish and wildlife enhancement, and the maintenance of water quality conditions on the Stanislaus River and lower SJR.

In June 1987, Reclamation and the California Department of Fish and Game (CDFG) executed an agreement that specified interim releases from New Melones Dam to maintain instream flows that would be beneficial to fishery resources and habitat downstream of the dam. The agreement also increased the annual water for fisheries release by changing 98,300 AF from the maximum to the minimum required, and it allowed for releases as high as 302,100 AF in wetter years.

The 1987 agreement also established a program of studies intended to identify long-term instream flow and to determine measures to improve the survival of Chinook salmon freshwater life stages. The program is conducted jointly by Reclamation, CDFG, and the Service.

The Interim Plan of Operations (IPO) was developed as a joint effort between Reclamation and the Service, in conjunction with the Stanislaus River Basin Stakeholders. The process of revising an operations plan began in 1995, with the goal of developing a long-term management plan, but the focus shifted in 1996 to developing an interim operations plan. The IPO was meant to be a short-term plan for 1997 and 1998. It is currently used as guidance for annual allocations. The IPO defines categories of water supply based on storage and projected inflow and then allocates annual water releases for fisheries, water rights settlement, water quality, Vernalis flow objectives, and use by CVP contractors.

Reclamation is currently developing a Revised Plan of Operations for New Melones Reservoir to replace the IPO. The end result of the process will be a report that describes the revised plan development and defines how New Melones Reservoir will be operated to meet regulatory commitments and demands for use of CVP supplies from the Stanislaus River.

Development of a long-term plan of operations for New Melones Reservoir will require balancing the competing needs in the SJR basin. In addition to existing demands, ongoing and newly authorized projects and programs are underway that may change the regulatory requirements of the CVP and resulting demands on New Melones Reservoir.

Because many of these activities will require several years to develop meaningful results, a near-term revision process will be initiated simultaneously to develop a Transitional Operation Plan (TOP). Development of the TOP will incorporate updated hydrologic and water quality information and will be based on a specified level of risk for drought occurrence during the life of the TOP (Reclamation 2005b). The TOP was expected to be implemented in 2007 and be in place for 8 to 10 years, but the TOP has not been completed at the time of this report.

1.8.2 CALFED Bay-Delta Program

The California Federal Bay-Delta Program (CALFED) was established in 1995. CALFED is a consortium of five State and ten Federal agencies with management and regulatory responsibilities in the San Francisco Bay and the Sacramento–San Joaquin River Delta (Bay-Delta). The State and Federal agencies have pledged to (1) coordinate their implementation of WQOs to protect the Bay-Delta, (2) coordinate the operation of the SWP and CVP, which both involve transporting fresh water through the Delta to points south, and (3) develop a process to establish a long-term Bay-Delta solution that will address four categories of problems—ecosystem quality, water quality, water supply reliability, and levee system vulnerability (CALFED 2000a). For water quality, concerns have focused primarily on the effects of elevated salts, organic carbon, and bromide on drinking water and agricultural supplies coming from the Bay-Delta. The *CALFED Bay-Delta Program Final Environmental Impact Statement/Environmental Impact Report* was released in 2000 (CALFED 2000a).

1.8.3 CALFED Bay-Delta Conveyance

CALFED identified several conveyance improvements as part of its multiprogram solution. The major conveyance improvement programs with the potential to affect the need and use of the DMC Recirculation Project are described in this section.

South Delta Improvements Program

One element of the preferred CALFED alternative is the SDIP, which was identified in the CALFED ROD (CALFED 2000b) as a part of the programmatic method of achieving the goals of water supply reliability, water quality, ecosystem restoration, and levee system integrity. The SDIP is proposed to be implemented in two stages. Stage 1 would include installing and operating permanent gates and dredging south Delta channels to protect SJR salmon and improve water levels and circulation in south Delta waterways. Stage 2 would increase the flexibility of the diversion operations in the south Delta for the SWP by increasing exports from 6,680 cubic feet per second (cfs) to 8,500 cfs. DWR is currently proposing to move forward with Stage 1, to install permanent gates, to replace temporary structures installed and removed each year. Any activity regarding Stage 2 would require further study and public input and is currently not proposed.

The SDIP Final EIS/EIR contains an evaluation of the alternatives for the proposed Stage 1 action to construct four permanent operable gates on Middle River, Grant Line Canal, and Old River near the DMC and the Head of Old River in the south Delta. The gates would protect salmon in the SJR in the spring and fall and improve water levels and circulation for local agricultural water supplies. The proposed project also includes dredging portions of Middle River and Old River to improve flows in south Delta channels and the extension of up to 24 agricultural intakes.

In December 2006, DWR certified the SDIP Final EIR. Release of the report certifies environmental assessments, but until a Biological Opinion is rendered under the Federal Endangered Species Act (ESA) and permits are obtained, no action will be taken to construct the facilities. Progress is being made on a supplemental environmental document and the acquisition of permits, but major delays have occurred because operation of SDIP is described in the CVP/SWP operations biological assessment, and USFWS and NMFS needs to include SDIP operations in their CVP/SWP operations Biological Opinions. A separate ESA consultation is proposed for the construction-related impacts.

A final decision on Stage 1, documented in a NOD, will be made in conjunction with the Federal ROD. The NOD will identify the recommended action to be implemented and include the environmental commitments and mitigation measures to be applied to the action.

SDIP actions and decisions are important to the DMC Recirculation Project because meeting south interior Delta salinity objectives is a potential benefit of the Project (see **Section 1.6**). Implementation of the SDIP will affect the need for recirculation. In addition, assumptions regarding future implementation of the SDIP are implicit in the common assumptions of the California Simulation Model II (CalSim II) modeling used to analyze future “with” and “without” alternative plans.

North/Central Delta Water Quality and Fisheries Improvement Study

Franks Tract is a 3,300-acre flooded island in the central Delta, north of the community of Bethel Island. The land was historically reclaimed for agricultural use through the construction of levees. In 1936 and 1938, the levees surrounding Franks Tract failed, resulting in flooding of the island. Franks Tract includes the Franks Tract State Recreation Area, owned and managed by the California Department of Parks and Recreation. The recreation area is popular with recreational fishermen and boaters.

Given its location in the central Delta and its relatively deep bathymetry, Franks Tract plays a key role in determining the quality of south Delta water that is available for in-Delta use and for export by the CVP and SWP. Franks Tract is one component of several conveyance improvements intended to increase the quality and reliability of water supply and water transport through the Delta.

In addition to its role in influencing water quality in the south Delta, however, Franks Tract is thought to contribute to the colonization and spread of invasive species, such as the aquatic plant *Egeria densa* and clam *Corbicula fulminea*.

In 2004, Congress passed the CALFED Bay-Delta Authorization Act, which authorized Reclamation to conduct a feasibility study and to implement actions at Franks Tract to improve water quality in the Delta. In 2007, Reclamation and DWR initiated the feasibility study to further develop alternatives and evaluate their environmental impacts and effectiveness in meeting water supply reliability and water quality improvement goals of the project.

Actions at Franks Tract could affect the need for the DMC Recirculation Project to meet WQOs in the SJR below Vernalis and in the interior south Delta. Depending on which alternative is selected and implemented, water quality at the CVP and SWP pumping facilities may be improved, increasing the quality of DMC water and thereby reducing the volume of water needed to meet the Vernalis WQOs.

1.8.4 CALFED Bay-Delta Storage Investigations

The CALFED Surface Storage Program, which is included in the CALFED ROD (CALFED 2000b), identified 52 potential reservoir sites for screening.

The subsections of **Section 1.8** contain a discussion of four of the surface-storage sites that were identified in the CALFED screening process and that are in various stages of feasibility studies: Shasta Lake Water Resources Investigation (SLWRI), Los Vaqueros Enlargement (LVE), the North-of-the-Delta Offstream Storage (NODOS) Investigation, and the Upper San Joaquin River Basin Storage Investigation (USJRBSI).

The surface-storage projects all have the potential either to affect water quality in the SJR and south Delta or the availability of pumping capacity at Jones and Banks pumping plants.

Shasta Lake Water Resources Investigation

Through the SLWRI, Reclamation is evaluating the enlargement of Shasta Dam and Reservoir. The investigation is being conducted as directed by Congress and supports other Federal interests in the SLWRI study area, which includes Shasta Dam and Reservoir, in-flowing tributaries, and the Sacramento River downstream to Red Bluff Diversion Dam (RBDD).

The primary objectives of the SLWRI are to increase the survival of anadromous fish populations in the upper Sacramento River, primarily upstream from the RBDD, and increase water supplies and supply reliability for agricultural, M&I, and environmental purposes to help meet future water demands, with a focus on enlarging Shasta Dam and Reservoir.

Secondary objectives include, to the extent possible, preserving, restoring, and enhancing ecosystem resources in the Shasta Lake area and along the upper Sacramento River; reducing flood damages and improving public safety along the Sacramento River; developing additional hydropower capabilities at Shasta Dam; and preserving and increasing recreational opportunities at Shasta Lake.

The SLWRI completed an IAIR (Reclamation and DWR 2004a) and published a Notice of Intent in preparation of an EIS (Reclamation 2005a).

Los Vaqueros Enlargement

Contra Costa Water District (CCWD), Reclamation, and DWR have jointly undertaken a series of studies to analyze the feasibility of expanding Los Vaqueros Reservoir while adhering to reservoir expansion principles established by CCWD. The project has two primary objectives and one secondary objective.

The primary objectives are:

- Use an expanded Los Vaqueros Reservoir to develop replacement water supplies for a fisheries protection program such as the long-term Environmental Water Account (EWA) program or an equivalent Delta fish protection and water for environmental purposes program if the cost of water provided from an expanded reservoir is found to be less than the cost of water from other sources for continued implementation of that program.

- Increase water supply reliability for water providers within portions of the San Francisco Bay Area including those served by the South Bay Aqueduct, principally to help meet M&I water demands during drought periods, with a focus on enlarging Los Vaqueros Reservoir.

The secondary objective is:

- To the extent possible through the pursuit of water supply reliability and environmental water objectives, improve the quality of water deliveries to M&I customers of the CCWD and San Francisco Bay Area.

North-of-the-Delta Offstream Storage Investigation

The NODOS Investigation is a feasibility study being conducted by DWR and Reclamation. The NODOS Investigation will include an evaluation of potential offstream surface storage projects in the upper Sacramento River basin that could improve water supply, water supply reliability, water management flexibility; enhance anadromous fish survival; and improve Delta water quality.

The NODOS Investigation will also include the exploration of opportunities for hydropower generation, recreation, and flood control storage. Congress provided NODOS feasibility study authority to Reclamation in the Omnibus Appropriations Act of 2003 (P.L. 108-7) and reaffirmed the authority in the Water Supply, Reliability, and Environmental Improvement Act of 2004.

A new reservoir, if constructed, has the potential to provide additional flows for Delta water quality, reduce Sacramento River diversions during critical fish migration periods, and provide additional water and storage to improve water supply reliability for Sacramento Valley and other CVP and SWP contractors. Project planning will culminate in an environmental document and Feasibility Report. The new reservoir, if constructed, has the potential to change the inflow into the Delta from the Sacramento Valley, potentially resulting in changes in Delta water deliveries and operations at both the Jones and Banks pumping plants.

Upper San Joaquin River Basin Storage Investigation

The USJRBSI is a feasibility study being conducted by Reclamation and DWR. The objectives of the investigation are to find ways to contribute to SJR restoration, improve SJR water quality, facilitate additional conjunctive management in the eastern San Joaquin Valley to reduce groundwater overdraft, and support exchanges that improve the quality of water delivered to urban areas. The USJRBSI study area encompasses the SJR watershed upstream from Friant Dam, the SJR from Friant Dam to the Delta, and the portions of the San Joaquin and Tulare Lake hydrologic regions that are served by the Friant-Kern and Madera canals.

To the maximum extent possible, the investigation will include an evaluation of opportunities to increase control of flood flows at Friant Dam, contribute to water supply for environmental protection, develop hydropower generation capacity, and develop additional recreation opportunities.

Federal authorization for the investigation was provided initially in the Omnibus Appropriations Act of 2003. Subsequent authorization was provided in the Water Supply, Reliability, and Environmental Improvement Act of 2004. Section 227 of the State of California Water Code authorizes DWR to participate in water resources investigations.

1.8.5 CALFED Record of Decision

Other projects listed in the CALFED ROD that have the potential to influence the DMC Recirculation Project are described in this section.

Water Quality Evaluation, Stage 1

The CALFED ROD requires CALFED agencies to implement several major elements of the Water Quality Program and to report on their status at the end of the first stage of implementation (Stage 1). The elements are in various stages of implementation and are as follows:

- Address drainage problems in the San Joaquin Valley to improve downstream water quality
- Implement source controls in the Delta and its tributaries
- Invest in treatment technology demonstration
- Control runoff into the California Aqueduct and other similar conveyances
- Address water quality problems at the North Bay Aqueduct
- Study recirculation of export water to reduce salinity and improve DO in the San Joaquin River

Ecosystem Restoration Program

As directed in the CALFED ROD, CALFED implemented a comprehensive Ecosystem Restoration Program. The goal of this program is to maintain, improve, and increase aquatic and terrestrial habitats and to improve ecological health and functions in the Delta. It is intended to support sustainable populations of diverse and valuable native plant and animal species.

The Ecosystem Restoration Program has proposed substantial actions to rehabilitate the natural processes in the Bay-Delta and its watershed to support, with minimal ongoing human intervention, natural aquatic and associated terrestrial biotic communities in ways that favor native members of those communities.

1.8.6 Other Reclamation Projects and Programs

Other programs have the potential to contribute to the DMC Recirculation planning objectives, independent of implementing recirculation. These programs are described below.

Operations Criteria and Plan

The long-term CVP Operations Criteria and Plan, prepared by Reclamation and DWR in 2004 (Reclamation and DWR 2004b), served as a baseline description of the facilities and operating environment of the CVP and SWP. The Operations Criteria and Plan identified the many factors influencing the physical and institutional conditions and decision-making process under which the projects currently operate. Regulatory and legal requirements were explained, and alternative operating models and strategies were described. The immediate objective was to provide operations information for the Federal Endangered Species Act (ESA), Section 7 consultation.

In 2005, the results of annual surveys designed to indicate population levels of several pelagic organisms, including the Delta smelt, were showing a precipitous decline. Reclamation reinitiated Federal ESA consultation on the Operations Criteria and Plan with the Service based on new information regarding the Delta smelt, including the apparent decline in the population.

The consultation process required the Service to determine whether the operation of the projects would jeopardize the continued existence of the Delta smelt and to identify reasonable and prudent measures for the appropriate agency to implement, thereby minimizing any adverse effects of the projects. During the consultation process, Reclamation implemented the remedial actions required by the 2007 decision in *Natural Resources Defense Council (NRDC) v. Kempthorne* (WL 4462395, Federal District Court, Eastern District of California, December 14, 2007).

The Service delivered its Biological Opinion (BO) for the long-term coordination of the CVP and SWP to Reclamation on Monday, December 15, 2008, on the effects of the continued operation of the CVP and the SWP on the Delta smelt and its designated critical habitat (Service 2008g).

The Service determined that the continued operation of these two water projects, as described in the Biological Assessment, would likely jeopardize the continued existence of the Delta smelt and adversely modify its critical habitat. The CVP/SWP operations BO is accompanied by a Reasonable and Prudent

Alternative (RPA) intended to protect each life-stage and critical habitat of this federally protected species.

Reclamation is currently reviewing the CVP/SWP operations BO, including the RPA, to determine whether the CVP/SWP operations BO can be implemented in a manner that is consistent with the intended purpose of the action, within the agency's legal authority and jurisdiction, and economically and technologically feasible.

Concurrent with the consultation with the Service, Reclamation reinitiated ESA consultation with NMFS regarding Delta issues affecting salmon, steelhead, and sturgeon. The NMFS issued a draft CVP/SWP operations BO on December 11, 2008, and a final BO was released on June 4, 2009 (NMFS 2009).

Revisions to the Operations Criteria and Plan have the potential to affect the availability of water for export at Jones and Banks pumping plants and subsequently for use in recirculation. As these CVP/SWP operations BOs are still being evaluated or developed, inclusion in the DMC Recirculation Project Feasibility Study is premature.

San Luis Drainage Feature Re-Evaluation Project

The purpose of the San Luis Drainage Feature Re-Evaluation Project is to develop and evaluate alternatives for providing long-term drainage service to the CVP San Luis Unit (SLU). Seven alternatives have been developed and evaluated and are presented in the San Luis Drainage Feature Re-Evaluation Project EIS (Reclamation 2006b). The study area is in the western San Joaquin Valley and consists primarily of lands that are within the boundaries of the SLU.

As defined by the authorized service area, the SLU encompasses the entire Westlands, Broadview, Panoche, and Pacheco water districts and the southern portion of San Luis Water District. Lands immediately adjacent to the SLU, in the Grassland Drainage Area (GDA), are also included. Potential actions include four alternatives for in-valley conveyance, treatment, and disposal of drainage that incorporate different levels of land retirement.

Three out-of-valley alternatives also were evaluated, including treatment and disposal to the Delta near Antioch, treatment and disposal to San Francisco Bay near Carquinez Strait near the town of Crockett, and disposal to the Pacific Ocean offshore from Point Estero, northwest of Morro Bay.

Reclamation issued a ROD on March 9, 2007, which documented the selection of the In-Valley/Water Needs Land Retirement Alternative as the alternative for implementation. With a total of 194,000 acres of land retirement (44,106 acres are already retired), this alternative was the closest to a “locally developed” alternative because it was consistent with the key elements of the proposed *West Side Regional Drainage Plan* (Exchange Contractors et al. 2003).

Reclamation is preparing a cost estimate, which is expected to confirm the need for new authorizing legislation to increase the appropriation ceiling beyond what was authorized by the San Luis Act (P.L. No. 86-488, 74 Stat. 156 [1960]).

Currently, agricultural drainage from lands in the northern part of the SLU is discharged into Mud Slough, a SJR tributary upstream from its confluence with the Merced River, in accordance with the National Pollutant Discharge Elimination System Permit (NPDES) for the Grassland Area Farmers.

Implementation of any of the alternatives would result in the elimination of this drainage (and associated salts and selenium) to the SJR, with a corresponding decrease in the salt concentrations at Vernalis. Required water quality dilution flow releases from New Melones Reservoir may also be reduced as a result of the cessation of Grassland Bypass drainage discharges (Reclamation 2006b).

Central Valley Project Improvement Act Land Retirement Program

The Central Valley Project Improvement Act of 1992 (CVPIA) (Title 34, Public Law 102-575)authorized the purchase of land, water, and other property interests from willing sellers who received CVP water. Land retirement (i.e., the removal of lands from irrigated agriculture) is proposed as one strategy to reduce drainage-related problems. In this approach, lands characterized by low productivity, poor drainage, shallow water tables, and high groundwater selenium concentrations would be retired from irrigated agriculture through a willing seller program. Retirement of such lands would help achieve the program goals of reducing drainage, enhancing fish and wildlife resources, and making water available for other CVPIA purposes.

A multiagency team consisting of representatives from Reclamation, the Service, and the Bureau of Land Management has been assembled to accomplish the goals of the program. The program targets lands in the entire San Joaquin Valley, including those that do not have a direct discharge to the SJR and would therefore not affect the DMC Recirculation Project. Lands that will have the largest effect on the water quality of the SJR are salt-impacted lands in the SLU along the western side of the San Joaquin Valley.

San Luis Reservoir Low-Point Improvement Project

Reclamation, in cooperation with the Santa Clara Valley Water District and San Luis & Delta-Mendota Water Authority (Authority), are currently conducting a feasibility study (Reclamation 2006c) to address the delivery-schedule and water-supply reliability problems associated with the SLR low point. The low-point issue arises when water levels fall below the functional low point, creating a water quality restriction that has the potential to interrupt a portion of the San Felipe Division's water supply. The objective of the San Luis Reservoir Low Point Improvement Project (Low Point Project) (Santa Clara Valley Water District 2008) is to optimize the water supply benefit of SLR while reducing additional risks to water users by:

- Avoiding supply interruptions when water is needed by increasing the certainty of meeting the requested delivery schedule throughout the year to south-of-Delta contractors dependent on SLR
- Increasing the reliability and quantity of yearly allocations to south-of-Delta contractors dependent on SLR
- Announcing higher allocations earlier in the season to south-of-Delta contractors dependent on SLR without sacrificing the accuracy of the allocation forecasts

In cooperation with DWR, Reclamation may consider modifying the operations of the SLR to improve water quality conditions for the San Felipe Division contractors and to provide ecosystem restoration opportunities.

Solutions may include physical modifications to existing facilities, construction of new facilities, changes to operations, or some combination of these solutions. Because the DMC Recirculation Project may affect reservoir levels and the use of SLR storage, the Study will take into consideration the effects of recirculation on the Low Point Project.

The Low Point Project study area includes the SLR and the service area of the Authority, which is also part of the DMC Recirculation Project Study area. The Authority includes CVP contractors in the West San Joaquin, San Felipe, and Delta Divisions of the CVP. These contractors either receive CVP deliveries from the SLR or have annual water deliveries that are likely to be influenced by SLR operations.

San Joaquin River Restoration Settlement

In 2006, a settlement reached in *NRDC v. Rodgers* (CIV-S-88-1658 LKK/GGH, Federal District Court, Eastern District of California, October 23, 2006) ended an 18-year dispute over the operation of Friant Dam and resolved longstanding claims brought by a coalition of conservation and fishing groups led by the NRDC. The settlement was agreed to by, among others, the NRDC, Friant Water Users Authority, Interior, and the U.S. Department of Commerce. The settlement is referred to as the San Joaquin River Restoration Settlement (Settlement).

The Settlement provides for substantial river channel improvements and sufficient water flow to sustain a salmon fishery upstream from the confluence of the Merced River tributary, while providing water supply certainty to Friant Division water contractors. The additional flows are likely to increase the quantity and quality of the water in the lower SJR and will therefore have the potential to affect either the need for the DMC Recirculation Project or the magnitude and timing of recirculation flows necessary to assist in meeting standards.

At the heart of the Settlement is a commitment to provide continuous flows in the SJR to sustain naturally reproducing Chinook salmon and other fish populations in the 153-mile stretch of the SJR between Friant Dam and the Merced River. Accomplishing this goal will require funding and extensive channel and structural improvements in many areas of the river, including some that have been without flows for decades, except for occasional flood releases.

Restoring continuous flows to the approximately 60 miles of dry river will occur in phases through the San Joaquin River Restoration Program (SJRRP). Planning, design work, and environmental reviews are underway, and interim flows for experimental purposes will start in 2009. The flows will be increased gradually over the next several years, with salmon being re-introduced by December 31, 2012. The Settlement continues in effect until 2026, with the U.S. District Court retaining jurisdiction to resolve disputes and enforce the Settlement. After 2026, the court, in conjunction with the SWRCB, will consider any requests by the parties for changes to the restoration program. Funding the Federal actions in the Settlement requires an appropriation by Congress.

1.8.7 Vernalis Adaptive Management Plan

The Bay/Delta Plan includes salinity standards and spring pulse flow requirements that are intended primarily to assist out-migrating salmon from all of the tributaries. In 1998, the parties affected by the Bay/Delta Plan, including Federal and State project operators, fishery agencies, water agency stakeholders, and environmental stakeholders, negotiated the San Joaquin River Agreement 1999–2010 (SJRA) (63 *Fed. Reg.* 50925 [Sept. 23, 1998]) which implemented the Vernalis Adaptive Management Plan (VAMP), a 12-year study program involving defined pulse flow levels, export pumping limits, installation of the Head of Old River Barrier (HORB), and water purchases from the water rights holders on the tributaries.

Initiated in 2000 as part of D-1641, the VAMP is a water supply program designed to protect juvenile Chinook salmon migrating from the SJR through the Delta. VAMP is also a scientific experiment that is intended to determine whether and to what extent salmon survival rates change as a result of alterations in SJR flows and CVP/SWP exports with the installation of the HORB. VAMP provides for a 31-day pulse flow (target flow) in the SJR at the Vernalis gage, along with a corresponding reduction in CVP/SWP exports. Details about VAMP water sources and flows are provided in **Section 2.2.2, San Joaquin River Agreement subsection**.

1.8.8 San Joaquin River Water Quality Management Group

The San Joaquin River Water Quality Management Group (SJRWQMG) is an informal group of stakeholders[1] who are working together to develop cooperative solutions to achieve the WQOs targeted by the TMDL. In 2005, the SJRWQMG published *Summary Recommendations of the San Joaquin River Water Quality Management Group for Meeting the Water Quality Objectives for Salinity Measured at Vernalis and Dissolved Oxygen in the Stockton Deep Water Ship Channel* (SJRWQMG 2005).

The document includes this statement: “Due to the highly modified nature of the SJR, complete solutions to both salinity/boron and DO problems are not readily available by approaching the problem through a load reduction strategy alone.” The primary objective of the group is listed as “Prepare and implement a plan to meet the WQOs for salt and boron at Vernalis and DO at the Port of Stockton Deep Water Ship Channel in coordination with CALFED Stage I objectives.”

The SJRWQMG recommendations for ways to achieve the salinity WQOs at Vernalis and to improve the ability to meet DO levels in the DWSC are summarized below (SJRWQMG 2005).

Salinity

- Fully implement the West Side Regional Drainage Plan
- Further evaluate and pursue managed wetland drainage management actions to mitigate impacts of February through April drainage releases
- Develop a real-time water quality management coordination group involving lower SJR operators, lower SJR dischargers, and the DWR to coordinate reservoir release and CVP/SWP operators (HORB and New

[1] SJRWQMG participants are Reclamation, DWR, Central California ID, Friant Water Users Authority, Grassland Water District, James ID, Merced ID, Modesto ID, Oakdale ID, San Luis Canal Company, Exchange Contractors, San Joaquin County and Delta Water Quality Coalition, San Joaquin County Resource Conservation District, San Joaquin Valley Drainage Authority, SJRGA, the Authority, South San Joaquin ID, south Delta Water Agency, State Water Contractors, Stockton East Water District, Tranquility ID, Turlock ID, Venice Island RD 2023, California Farm Bureau, and Western Growers.

Melones operations) to realize opportunities to improve water quality and increase the utility of stored water releases

Dissolved Oxygen

- Pursue additional use of the HORB to augment flows in the lower SJR and the DWSC, consistent with the need to maintain adequate in-Delta water quality, water level, and fishery protection
- Support continued implementation of the City of Stockton's ammonia removal project at the Stockton Wastewater Treatment Plant
- Install the demonstration aeration project in the DWSC and continue the newly implemented upstream monitoring efforts to understand DO load-producing discharges
- Evaluate additional actions necessary for DO compliance at the DWSC following implementation and analysis of all of these actions
- Establish a forum to evaluate ongoing changes in the water quality baseline and suggest further management actions to continue progress on water quality improvement

The San Joaquin River Water Quality Action Implementation Group[1] is a subset of the agencies that make up the SJRWQMG; the group includes additional regulatory agencies. The agencies coordinate individual actions of participating agencies that will collectively improve water quality on the lower SJR. These actions include, but are not limited to, the aforementioned SJRWQMG. The agencies also work to identify and assist in implementing actions that will achieve long-term water quality improvement and monitor baseline changes affecting water-quality improvement.

One of the actions overseen by the implementation group is the SJR Real-Time Water Quality Management Program. The program uses telemetered stream stage and salinity data and computer models to simulate and forecast water quality conditions along the lower SJR. Its primary goal is to increase the frequency of meeting SJR WQOs for salinity, thereby reducing the number and/or magnitude of high quality releases made specifically to meet SJR salinity objectives.

The SJR Real-Time Water Quality Management Program will also aid in determining the assimilative capacity of the SJR by using real-time load allocations. The assimilative capacity is the mass load of a pollutant that can be

[1] Participating agencies are CVRWQCB, DFG, California Department of Food and Agriculture, California Bay-Delta Authority, DWR, EPA, National Marine Fisheries Service, State Water Contractors, SWRCB, Exchange Contractors, the Authority, Stockton East, SJRGA, City of Stockton, City and Port of Stockton, Reclamation, and the Service.

safely discharged to a receiving water body without exceeding the WQO or standard for that pollutant (Quinn 2005).

EPA approved the TMDL for salt and boron on February 8, 2007. The Final Staff Report for the Basin Plan Amendment (CVRWQCB 2004) describes the real-time load allocations. Typically, fixed TMDL loads are established to meet WQOs during low-flow conditions. Historically, more salt has been added to the Central Valley basin than has been exported. To maintain a salt balance by exporting the maximum amount of salt while still meeting WQOs, the approved TMDL provides for additional real-time load allocations in lieu of base load allocations.

The Final Staff Report for the Basin Plan Amendment also includes the following statement about real-time load allocations:

> Real-time load allocations are based on real-time flow and water quality conditions and on a weekly or monthly forecast of assimilative capacity. Since real-time flow and water quality conditions are not known ahead of time, the real-time allocations must be formulaic. A coordinated effort is therefore needed to forecast assimilative capacity and allocate the available loading capacity (real-time loading allocation) to dischargers. Monitoring and modeling is needed to predict short-term assimilative capacity and to meter out discharges to the lower SJR in a manner that will not cause water quality exceedances (CVRWQCB 2004, p. 33).

1.8.9 Deep Water Ship Channel Demonstration Dissolved Oxygen Project

In September 2004, DWR approved a full-scale aeration demonstration project to study the effects of supplementing DO in the DWSC. The DWSC Demonstration Dissolved Oxygen Project is a multi-year study of the effectiveness of elevating DO concentrations in the channel. DO concentrations in the channel drop to as low as 2 to 3 milligrams per liter (mg/L) during warmer and lower water flow periods in the SJR. The objective of the study is to maintain DO levels above the minimum recommended levels specified in the Basin Plan. The Basin Plan water quality objectives for DO are 6.0 mg/L in the SJR between Turner Cut and Stockton, 1 September through 30 November, and 5.0 mg/L the rest of the year.

The project includes a full-scale aeration system designed to deliver approximately 10,000 pounds of oxygen per day into the DWSC. The aeration system is anticipated to be operated only when DWSC DO levels are below the Basin Plan DO WQOs, typically 100 days per year. The project includes an ongoing assessment of DO levels in the DWSC and vicinity and an investigation of other, possibly unintended consequences of large-scale aeration before the technology is used on a more permanent basis.

The project is currently on hold pending additional State funding. If funding is allocated, the goal is to complete the second year of the 2-year study by December 2009. At that time, the project will be evaluated to determine whether it should be recommended to continue as a long-term project. If that is recommended, an EIR/EIS would be required.

1.8.10 West Side Regional Drainage Plan

The West Side Regional Drainage Plan (Exchange Contractors 2003), an integrated plan adopted by the Authority, is designed to eliminate irrigated agricultural drainage water from, and enhance water supply reliability for, about 100,000 acres in the GDA. The plan began as an effort, which was successful, to reduce selenium discharges to the SJR. The plan has now been proposed to go beyond regulatory requirements and eliminate selenium and salt discharges to the SJR while maintaining the productivity of production agriculture in the region and enhancing water supplies to lands remaining in production. If the plan is successful, it will reduce salinity and could reduce the amount of water released from storage or recirculation that is necessary to maintain salinity WQOs. It also may reduce total flows in the SJR through the reduction of agricultural drainage.

The plan also includes strategies for reducing water demand, groundwater pumping and management, and water transfer elements to provide for drainage source control and improve water supply reliability for the partners executing the plan.

DWR and SWRCB have recommended funding of $25 million for the West Side Regional Drainage Plan under the Integrated Regional Water Management Program, which is funded by the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (California Proposition 50, Chapter 8). The funds have been approved, and work under the grant is expected to be completed by 2011 (SWRCB 2007a).

1.8.11 San Joaquin River Improvement Project

Panoche Drainage District obtained funding in 1998, based on California Proposition 13 (1978), to apply drainage water to pasture and alfalfa fields as part of the Grassland Area Farmers' efforts to meet selenium load targets. Phase 1 of the San Joaquin River Improvement Project (SJRIP) included purchasing about 4,000 acres of farmland and using drainwater to irrigate the salt-tolerant crops grown on this land. Additional funds have been obtained to continue the SJRIP, including Proposition 13 funds, to implement the Grassland Integrated Drainage Management Project to install subsurface drains and plant salt-tolerant crops. Funding has also been obtained from Reclamation and water districts to install drainage systems, construct an irrigation system, and plant halophytes[1] (Summers Engineering, Inc. 2004). Additional expansion and development of the SJRIP is planned to take place as funding becomes available.

1.8.12 State Water Resources Control Board and Regional Water Quality Control Board Programs and Requirements

The SWRCB was created by the California State Legislature in 1967. The SWRCB's mission is to "preserve, enhance, and restore the quality of California's water resources and ensure their proper allocation and efficient use for the benefit of present and future generations." The joint authority for water allocation and water quality protection enables the SWRCB to provide comprehensive protection for California's waters.

The SWRCB requirements that may affect or be affected by the DMC Recirculation Project are listed below. See **Section 2.2.3** for more information about these requirements.

- Applicable Water Quality Control Plans
- Water Quality Objectives and Criteria
- Total Maximum Daily Load Program
- Salinity Management Policy
- Agricultural Discharge Control Programs
- New Melones Interim Plan of Operations
- Vernalis Adaptive Management Plan
- Safe Drinking Water Act

1.8.13 California Department of Water Resources Programs

Because the Delta is the center of many statewide water-related issues, DWR is highly involved in Delta planning, including Delta initiatives such as the Delta Vision and the Delta Risk Management Strategy (DRMS).

[1] A halophyte is a plant adapted to living in a saline environment.

Delta Vision

Delta Vision broadens the focus of work formerly done through CALFED to address issues affecting natural resources, infrastructure, land use, and governance in the Delta. The intent of Delta Vision is to develop a strategy for a sustainable Delta ecosystem in support of the environmental and economics functions of the Delta. The Delta Vision Blue Ribbon Task Force, appointed by the Governor, has made recommendations for a sustainable Delta. The task force provided recommendations in *Our Vision for the California Delta* (DWR 2007) and issued the *Delta Vision Strategic Plan* in 2008 (DWR 2008a).

The 2007 report presents integrated recommendations regarding California water policies for both estuaries and exports. Ecosystem function and water supply reliability are recommended as co-equal goals. Conservation, efficiency, and sustainable use are recommended to drive water policies. Specific recommendations include increasing the efficiency of the water supply; modifying the patterns, timing, or quantity of exports; constructing new conveyance and storage facilities; strengthening selected levees; improving floodplain management; improving water circulation and quality; discouraging inappropriate urbanization of the Delta; and creating a new governance structure with the legal authority to achieve these goals. The 2008 strategic plan provides actions that would fulfill the goals set forth in the 2007 report.

Delta Risk Management Strategy

DRMS was included in the Preferred Program Alternative of the CALFED ROD to investigate the sustainability of the Delta. DRMS includes an assessment of the major risks to Delta resources from floods, seepage, subsidence, and earthquakes. Levees protect 700,000 acres in the Delta, and in the past 100 years, there have been 162 levee failures. At risk are drinking water for two thirds of California's residents, critical environmental and agricultural resources, homes and businesses, and infrastructure, including highways, rail lines, natural gas fields, and gas and fuel pipelines.

DRMS will also include an evaluation of the consequences of levee failures and recommendations for managing the risk in the Delta. In addition, Assembly Bill 1200 of 2005 requires that DWR evaluate the potential impacts on Delta water supply from subsidence, earthquakes, floods, climate change, and sea level rise, and a combination of these events.

The report for Phase I, which contains an evaluation of the risk and consequences of levee failures was published in February 2009 (DWR 2009). Phase 2, which will contain an evaluation of risk-reduction strategies, had not been completed as of March 2009. The Phase 2 final report will be submitted to the California State Legislature.

Proposition 84 – Water Quality, Safety and Supply, Flood Control, Natural Resource Protection, Park Improvements, Bonds, Initiative Statute

Proposition 84, passed in 2006, funds projects related to safe drinking water, water quality and supply, flood control, waterway and natural resource protection, water pollution and contamination control, State and local park improvements, public access to natural resources, and water conservation efforts. This proposition provides funding for emergency drinking water, and exempts such expenditures from public contract and procurement requirements to ensure immediate action for public safety. It authorizes $5.4 billion in general obligation bonds to fund projects and expenditures, to be repaid from the State's General Fund.

Chapter 2, Section 75029, of the proposition states that $130 million will be available to DWR for grants to implement Delta water quality improvement projects that protect drinking water supplies. Eligible projects are those that (a) reduce or eliminate discharges of salt, dissolved organic carbon, pesticides, pathogens and other pollutants to the SJR, (b) will reduce or eliminate discharges of bromide, dissolved organic carbon, salt, pesticides, and pathogens from discharges to the Sacramento River, (c) will reduce salinity or other pollutants at agricultural and drinking water intakes at Franks Tract and other locations in the Delta, and (d) are identified in the 2005 *Delta Region Drinking Water Quality Management Plan* (CALFED 2005), with a priority for design and construction of the relocation of drinking water intake facilities for in-Delta water users.

Section 75029(a) further states that eligible projects are those that:

> … reduce or eliminate discharges of salt, dissolved organic carbon, pesticides, pathogens and other pollutants to the San Joaquin River. Not less than $40 million shall be available to implement projects to reduce or eliminate discharges of subsurface agricultural drain water from the west side of the San Joaquin Valley for the purpose of improving water quality in the San Joaquin River and the Delta.

This funding may result in additional implementation of Westside drainage management projects to reduce salinity in the SJR and assist in meeting Vernalis WQOs.

1.8.14 Bay Delta Habitat Conservation Plan

A number of agencies known collectively as the Potentially Regulated Entities are preparing a habitat conservation plan for the Sacramento–San Joaquin River Delta (Bay-Delta Habitat Conservation Plan [BDCP]). The agencies are DWR, Reclamation, Metropolitan Water District of Southern California, Kern County Water Agency, Santa Clara Valley Water District, Alameda Flood Control and Water Conservation District (Zone 7), San Luis & Delta-Mendota Water Authority, Westlands Water District, and Mirant Delta.

The primary purposes of the BDCP are to:

- Improve the ecosystem of the Delta.
- Restore and protect the ability of the SWP and CVP to deliver up to full contract amounts of water when hydrologic conditions result in the availability of sufficient water, consistent with the requirements of Federal and State laws and the terms and conditions of water delivery contracts and other existing applicable agreements.

The BDCP will likely consist of three major elements: (1) actions to improve ecological productivity and sustainability in the Delta, (2) potential capital improvements to the water conveyance system, and (3) potential changes in Delta-wide operational parameters of the CVP and SWP associated with improved water conveyance facilities.

Three general alternatives are being considered as they relate to the potential changes in the water conveyance system and CVP and SWP operations. The alternatives are (1) through Delta, (2) dual conveyance, and (3) isolated facility. The dual-conveyance alternative may include use of existing points of diversion during some circumstances and potential new points of diversion at various locations in the north Delta, as well as facilities to move water from new points of diversion to the existing SWP and CVP pumping facilities in the south Delta. The isolated facility alternative may include new points of diversion at various locations in the north Delta and facilities to move water from these new points of diversion to the existing SWP and CVP pumping facilities in the south Delta. The through-Delta alternative may include new temporary or permanent barriers to modify existing hydraulics or fish movement within the Delta, armoring of levees along Delta waterways to ensure continued conveyance capacity, and/or actions to improve conveyance capacity in existing Delta waterways.

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Chapter 2
Existing and Future Conditions

In this chapter, the existing and likely future resources and conditions in the Study area are described and likely future conditions without DMC Recirculation are projected.

2.1 Environmental Setting

The SJR basin is in central California and encompasses all of the San Joaquin River drainage area, extending from the Delta in the north to Madera County in the south. The SJR basin includes all or portions of Alameda, Alpine, Amador, Calaveras, Contra Costa, El Dorado, Fresno, Madera, Mariposa, Merced, Sacramento, San Benito, San Joaquin, Stanislaus, and Tuolumne counties. The SJR basin is bordered by the Sierra Nevada on the east and the Diablo Range of the coastal mountains on the west. Most of the water for the SJR basin originates in the Sierra Nevada and the eastern side of the SJR basin. Most tributaries of the SJR are dammed and diverted to provide water for agriculture, M&I, and the environment.

The Study area is shown on **Figure 1-1**. The Study area for the PFR is defined as the lower main stem of the SJR just above its confluence with the Merced River, including the Merced, Tuolumne, and Stanislaus rivers on the western side of the Sierra Nevada Mountains and the area served by the DMC. Because of the influence of the SJR on the south Delta, the Study area also includes the south Delta. The Study area is defined as areas that can be affected directly by the Project.

2.2 Existing Conditions

Existing conditions are the conditions that existed at the time the Study was initiated. For a California Environmental Quality Act (CEQA) environmental analysis, initial conditions are those that exist at the time of the filing of the "Notice of Preparation (NOP) of a Draft Environmental Impact Statement / Environmental Impact Report (EIS/EIR) and Notification of Public Scoping Meetings for the Proposed Delta-Mendota Canal Recirculation Project" (March 28, 2007).

Existing conditions were developed for each resource area based on the availability of modeling tools and data. In general, existing conditions for water operations and resource analyses based on water operations (e.g., fishery entrainment, agricultural production) were based on model results for the current version of CalSim II. For other analyses, existing conditions were based on recent data. Existing conditions for hydrology and water quality from Water Year 2000 to Water Year 2007 (starting October 1, 1999, and ending September 30, 2007) are presented in this section. Instead of basing existing conditions on the current year, which would represent only one water year type, this 8-year period represents several water year types.

2.2.1 Physical Environment and Hydrology

The Study is focused primarily on the SJR's lower reaches between the confluences of the Merced River with the SJR downstream and where the SJR flows into the Delta. **Figure 1-1** shows the locations of the major facilities discussed in this section. Physical features and facilities required to recirculate water from the Delta to the SJR or that are potentially impacted by the DMC Recirculation Project are discussed below. Hydrology data representing existing conditions for each of these features are also summarized, with additional detail presented in **Appendix F, Attachment F1**.

Main Stem San Joaquin River

The following sections provide a detailed description of the upper SJR from below Friant Dam to Vernalis.

San Joaquin River Below Friant Dam. Flows in the SJR below Friant Dam are controlled by the operations at Friant Dam. Millerton Lake was formed by the completion of Friant Dam on the upper SJR in 1949. Millerton Lake has a gross pool capacity of 521,000 AF. The dam and reservoir provide flood control, conservation storage, diversions to the Madera and Friant-Kern Canals, and recreational uses. The dam and reservoir are 25 miles northeast of the City of Fresno.

Releases from Friant Dam to the SJR are currently made to meet downstream water rights and for flood-control purposes. Minimum required releases from Friant Dam for riparian and contractor uses are assumed to be a constant annual requirement, consistent with recent records of operations. **Table 2.2.1-1** provides the monthly and annual minimum required releases from Friant Dam.

Table 2.2.1-1. Minimum Required Release from Friant Dam to San Joaquin River

Minimum Required Release by Month (in TAF)												
Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
10.1	7.4	6.7	4.5	5.0	6.6	9.0	10.9	12.9	14.4	15.7	13.4	116.7

Key:
TAF = thousand acre-feet

The minimum required release volumes maintain flow in the SJR from Friant Dam to Gravelly Ford. Gravelly Ford, downstream of Friant Dam, is a sandy and gravelly section of the SJR that is subject to high losses of river flow. The section of the SJR between Gravelly Ford and Mendota Pool, a reach of approximately 17 miles, is generally dry except when releases are made from Friant Dam for flood-control purposes. Release patterns are expected to change as a result of a recent litigation settlement regarding operations of Friant Dam. The timing of such changes will depend on the completion of environmental and engineering studies for the SJRRP. The subsequent draft programmatic EIS/EIR is scheduled for release in early 2010.

Flood control operations for Millerton Lake and the SJR below the dam are based on the rain-flood space reservation requirements specified by the U.S. Army Corps of Engineers (Corps). The flood control operation during the snowmelt runoff period recognizes the competing objectives of water supply and flood control. The operation attempts to maximize water supply carry-over storage (into summer) while reducing the potential for downstream flooding. Flood control releases from Friant Dam can be significant volumes of water, but typically occur outside of the months of concern for water quality in SJR's lower reaches.

Mendota Pool (River Mile 204). Mendota Pool is an institutional and physical hub for water diversions and deliveries in the San Joaquin Valley. Prior to the Central Valley Project (CVP), long-established diversions (substantively by the Exchange Contractors) occurred at Mendota Pool and along the SJR from water originating from the upper SJR and occasional overflow from the Tulare Lake basin. As a condition of the diversion of SJR flow by the Friant Division, Reclamation provided a substitute supply for these diverters from the CVP via the DMC. Mendota Pool is a delivery point for CVP water to the Exchange Contractors. Currently, except during floods, the SJR above Mendota Pool is dry, beginning at Gravelly Ford.

During flood control operations, water that passes Gravelly Ford and exceeds demands at Mendota Pool (not being met from Fresno Slough flow) is diverted from the SJR to Chowchilla Bypass. When flow in Chowchilla Bypass reaches its capacity of 6,500 cubic feet per second (cfs), remaining water in the SJR flows into Mendota Pool. Chowchilla Bypass runs northwest, intercepts flows in the Fresno River, and discharges to the Chowchilla River.

Eastside Bypass begins at the Chowchilla River and runs northwesterly to rejoin the SJR above Fremont Ford. Together, Chowchilla and Eastside bypasses intercept flows of the San Joaquin, Fresno, and Chowchilla Rivers, and other lesser eastside SJR tributaries, to provide flood protection for downstream communities and agricultural lands. These bypasses are in highly permeable soils, and much of the floodwater recharges groundwater.

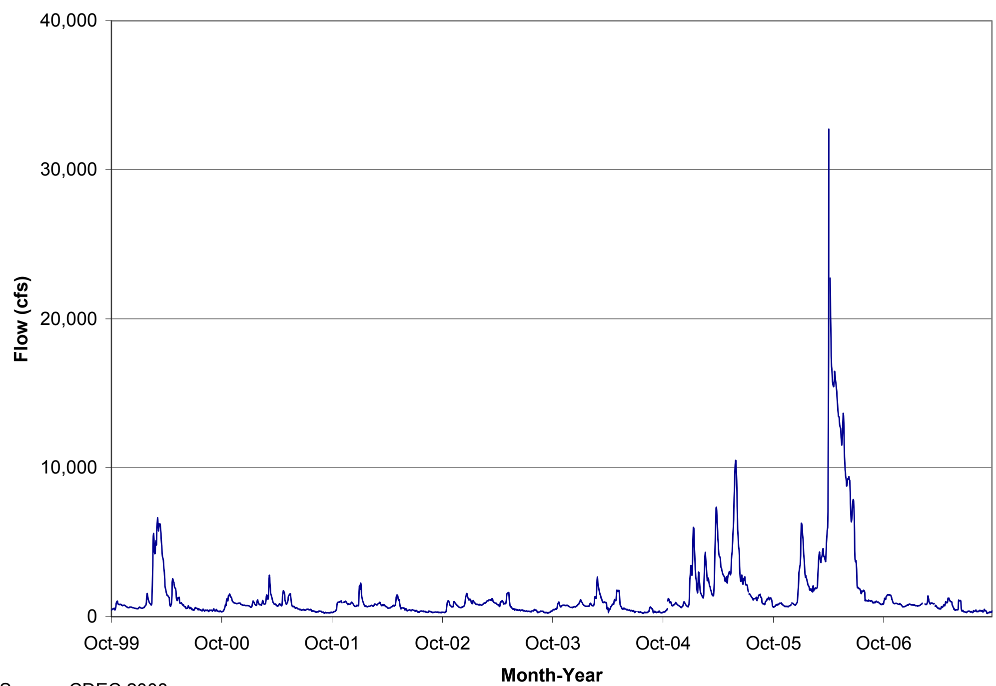
Flows in the SJR that are not diverted to Chowchilla Bypass enter Mendota Pool. Mendota Pool was formed in 1871 by the construction of Mendota Dam on the SJR by water rights holders, and is the point at which the SJR turns northward. Mendota Pool has a storage capacity of approximately 50,000 AF and serves as a forebay for diversions. The DMC, which conveys CVP water from the Delta to the Exchange Contractors and other entities, terminates at the Mendota Pool. Water also occasionally enters Mendota Pool from the south via Fresno Slough (sometimes referred to as James Bypass), which conveys overflows from the Kings River in the Tulare Lake basin to the SJR. Reclamation uses a portion of the flow in Fresno Slough to supply water to Mendota Wildlife Management Area.

Mendota Pool to Sack Dam (River Miles 204 to 182). This portion of the SJR is sand-bedded and meandering, and contains perennial flows of up to 600 cfs, due to water deliveries from the DMC, through the SJR channel, and to the Sack Dam diversion into Arroyo Canal. Agriculture is the primary land use in this reach, and the river is confined by local dikes and canals on both banks.

Sack Dam to Sand Slough (River Miles 182 to 168). This reach extends from Sack Dam (River Mile 182) downstream to the Sand Slough Control Structure (River Mile 168). It is sand-bedded and meandering, and is usually dewatered due to the diversion at Sack Dam. It is bounded on the western bank by the Poso and Riverside Canals and on the eastern bank by local dikes. Flows in this reach are usually negligible due to the Sack Dam diversion, but flood control flows are periodically conveyed.

Sand Slough to Merced River Confluence (River Miles 168 to 118). Portions of this section of the SJR have not had any river flows since the construction of the Sand Slough Control Structure, and have a maximum capacity of approximately 150 cfs. Flows in the SJR are diverted at Sand Slough to the Mariposa and Eastside bypasses. Water returns to the main channel from Mariposa and Eastside bypasses on the east, and Mud and Salt Sloughs on the west. The river flows through San Luis National Wildlife Refuge in the lower part of this reach where water is diverted and returned for refuge operations. Discharges from the Newman Wasteway are returned to this reach of the SJR.

Merced River Confluence to Tuolumne River Confluence (River Miles 118 to 86). In this reach, water is diverted for agricultural use from small riparian areas on both the eastern and western banks of the SJR. Return flows enter the SJR between the town of Newman, and Maze Boulevard. Flows at two locations in this reach of the SJR are reported by the California Data Exchange Center (CDEC) (CDEC 2008). Average flows for San Joaquin River near Newman are shown in **Figure 2.2.1-1** and **Table 2.2.1-2**, and for San Joaquin River near Crows Landing in **Figure 2.2.1-2** and **Table 2.2.1-3**.



Source: CDEC 2008.

Figure 2.2.1-1. Average Daily Flow in the San Joaquin River Near Newman (CDEC Station NEW)

Table 2.2.1-2. Average Monthly Flow in the San Joaquin River near Newman (CDEC Station NEW)

Water Year	Water Year Type[1]	Average Flow by Month (in cfs)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	776	747	541	692	3,212	4,199	1,487	1,168	628	545	459	405
2001	Dry	924	960	755	860	955	1,357	1,052	1,019	479	415	366	291
2002	Dry	656	975	886	1,121	815	869	709	912	460	355	341	299
2003	Below Normal	566	726	957	901	802	1,022	860	945	423	366	356	282
2004	Dry	581	703	668	906	1,138	1,297	770	1,019	374	317	416	301
2005	Wet	643	792	815	3,325	2,304	2,894	3,609	4,299	4,734	1,636	1,137	1,105
2006	Wet	842	766	1,318	3,921	1,663	3,985	16,610	13,350	8,852	1,992	1,159	1,078
2007	Critical	1,513	1,012	798	805	897	1,004	681	934	642	328	288	287

Source: USGS 11274000 San Joaquin River near Newman, CA (USGS n.d.)

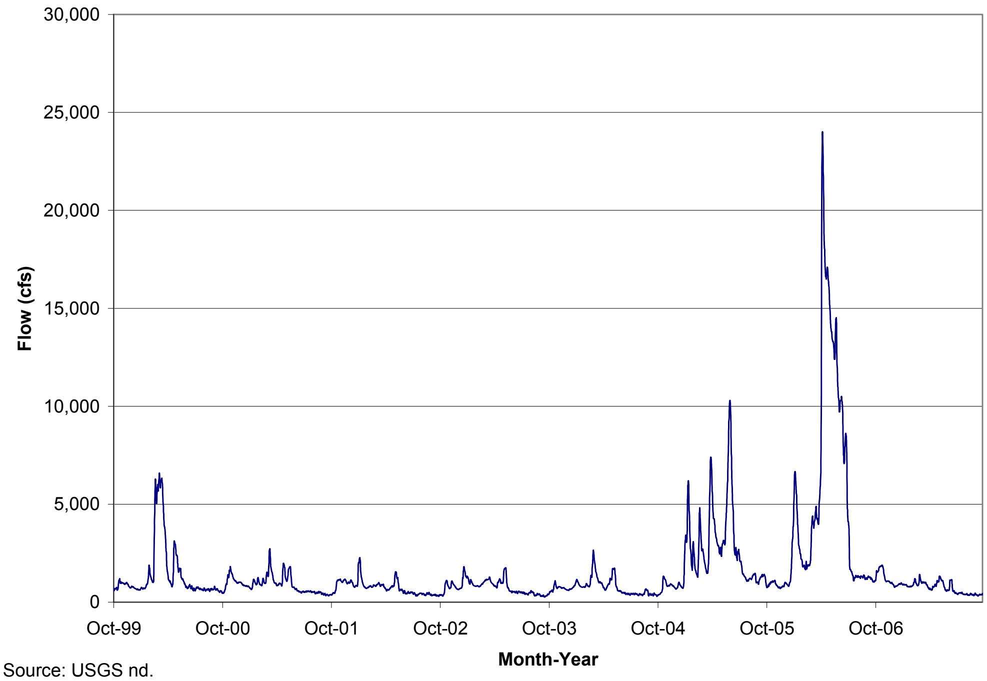
Note:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

Key:

cfs = cubic foot (feet) per second

D-1641 = State Water Resources Control Board Water Right Decision 1641



Source: USGS nd.

Figure 2.2.1-2. Average Daily Flow in the San Joaquin River Near Crows Landing (CDEC Station SCL)

Table 2.2.1-3. Average Monthly Flow in the San Joaquin River Near Crows Landing (CDEC Station SCL)

Water Year	Water Year Type[1]	Average Flow by Month (in cfs)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	844	878	687	961	3,507	4,470	1,681	1,364	730	677	631	608
2001	Dry	1,063	1,106	853	940	1,045	1,497	1,179	1,201	568	536	485	381
2002	Dry	744	1,059	952	1,196	804	870	706	937	483	413	408	348
2003	Below Normal	631	817	1,067	993	878	1,088	941	1,017	509	451	431	326
2004	Dry	664	731	702	888	1,121	1,369	847	1,054	454	403	477	376
2005	Wet	723	843	831	3,428	2,519	2,984	3,904	4,290	4,952	1,663	1,237	1,217
2006	Wet	953	813	1,280	4,076	1,850	4,127	16,350	13,680	9,240	2,285	1,294	1,195
2007	Critical	1,583	1,107	873	853	923	1,017	766	998	736	444	387	375

Source: USGS 11274550 San Joaquin River Near Crows Landing, CA (USGS n.d.)

Note:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

Key:

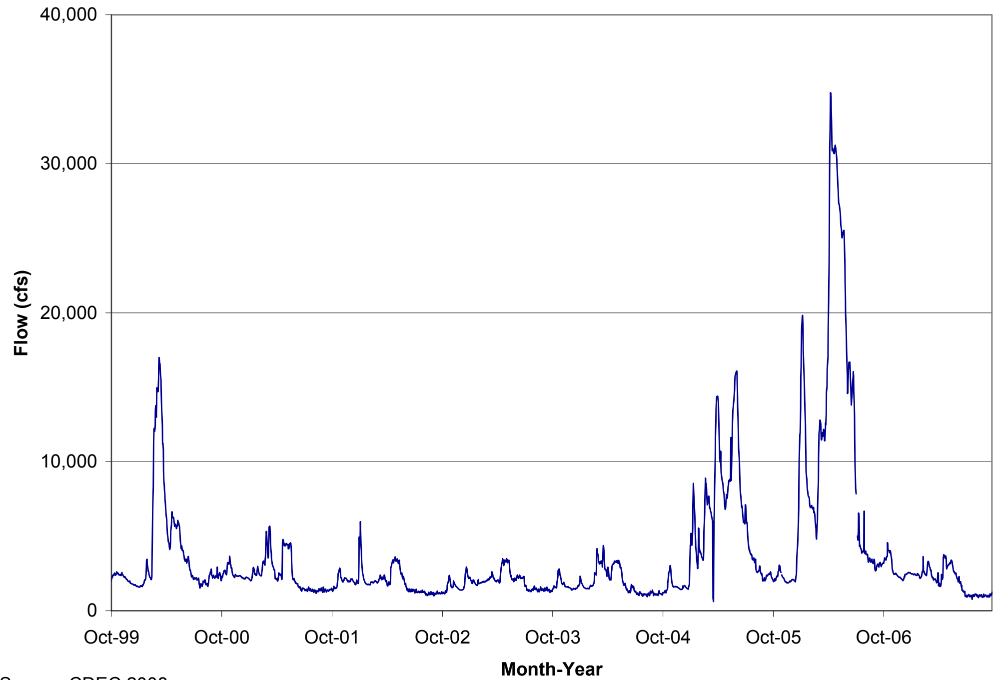
cfs = cubic foot (feet) per second

D-1641 = State Water Resources Control Board Water Right Decision 1641

Tuolumne River Confluence to Stanislaus River Confluence (River Miles 86 to 80). In this reach, water is diverted for agricultural use from small riparian areas on both the eastern and western banks of the SJR. Return flows go back to the SJR between Maze and Vernalis.

Stanislaus River Confluence to Old River (River Miles 80 to 54). In this reach, additional diversions for agricultural use occur on both of the SJR's banks. Return flows go back to the SJR as it flows into the south Delta. Average daily flows at Vernalis are reported by the CDEC (2008) and are shown on **Figure 2.2.1-3**. Monthly average flows as reported by USGS (2008) are shown in **Table 2.2.1-4**.

At Vernalis, average flows between 2000 and 2006 ranged from about 1,100 to nearly 28,000 cfs (**Figure 2.2.1-3** (daily averages)**, Table 2.2.1-4** (monthly averages). The rating curve that is used to calibrate water level with the flow and shown in the figure is updated frequently but is not calibrated to high flows (Jacob McQuirk, Project Manager, California Department of Water Resources, January 21, 2009). Between 2001 and 2004 (drier years), flows were generally below 2,500 cfs during most of the year, with the exception of spring time. Spring runoff flows reached 3,500 cfs during these years. Average flows were greater than 5,000 cfs in 2000, 2005, and 2006 (above normal and wet water years) during winter and spring. In 2006, flows exceeded 25,000 cfs in April and May.



Source: CDEC 2008.

Figure 2.2.1-3. Average Daily Flow in the San Joaquin River Near Vernalis (CDEC Station VNS)

Table 2.2.1-4. Average Monthly Flow in the San Joaquin River Near Vernalis (CDEC Station VNS)

Water Year	Water Year Type[1]	Average Flow by Month (in cfs)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	2,532	2,158	1,688	2,136	7,559	12,100	5,013	4,814	2,772	1,898	2,171	2,330
2001	Dry	2,826	2,526	2,238	2,442	3,092	3,430	3,008	3,527	1,549	1,400	1,330	1,376
2002	Dry	2,003	2,096	2,064	2,662	1,898	2,134	2,598	2,739	1,407	1,227	1,116	1,175
2003	Below Normal	1,705	1,715	1,988	1,913	1,879	2,193	2,668	2,625	2,034	1,321	1,281	1,308
2004	Dry	1,999	1,647	1,503	1,792	2,201	3,361	2,751	2,647	1,404	1,147	1,125	1,121
2005	Wet	1,753	1,632	1,578	4,918	5,303	8,065	10,060	10,410	9,979	4,155	2,615	2,412
2006	Wet	2,619	2,038	3,521	13,170	6,458	11,700	27,940	26,050	15,690	5,547	3,697	3,316
2007	Critical	3,851	2,538	2,354	2,587	2,534	2,555	2,225	2,898	1,745	1,138	1,008	1,014

Source: USGS 11303500 San Joaquin River near Vernalis, CA (USGS n.d.)

Note:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

Key:

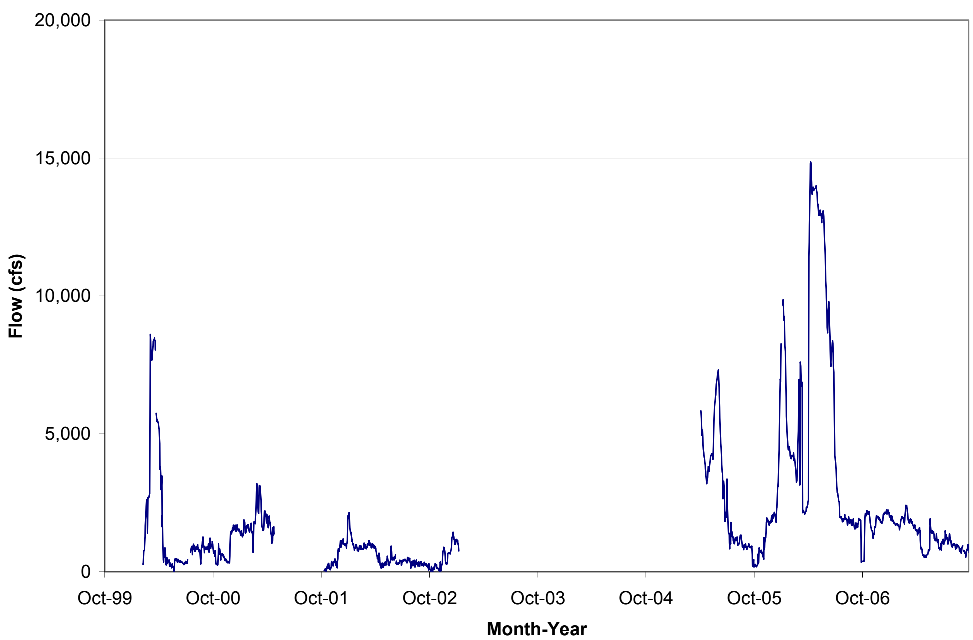
cfs = cubic feet per second

D-1641 = State Water Resources Control Board Water Right Decision 1641

Lower San Joaquin River and the South Delta

Major CVP facilities in the Delta include Delta Cross Channel, Contra Costa Canal, Jones Pumping Plant, and the DMC. Delta Cross Channel is a diversion channel between the Sacramento River and Snodgrass Slough near Walnut Grove. Delta Cross Channel is used to draw freshwater supplies from the Sacramento River to the interior of the Delta and the export facilities to improve water quality and lower salinity. Contra Costa Canal delivers water diverted from the lower SJR near Oakley to Contra Costa County and communities in the East Bay.

Flows and stage at various locations in the Delta are reported by the DWR via CDEC (2008) and the Water Data Library (DWR 2008b). Average flows for the SJR at the Head of Old River are shown in **Figure 2.2.1-4** (daily average) and **Table 2.2.1-5** (monthly average**)**. Stage data for SJR at Brandt Bridge and Old River at Tracy Road Bridge are shown in **Figures 2.2.1-5 and 2.2.1-6,** respectively**.** Flow and stage data for additional sites along the lower SJR (Rough and Ready Island, Rindge Pump, Mandeville Island, Antioch), Old River at Bacon Island, and Middle River East of Bacon Island are provided in **Appendix F, Attachment F1**.



Note: Data not available prior to February 2000.
Source: CDEC 2008.

Figure 2.2.1-4. Average Daily Flow in the San Joaquin River at Head of Old River (CDEC Station OH1)

Table 2.2.1-5. Average Monthly Flow in the San Joaquin River at Head of Old River (CDEC Station OH1)

Water Year	Water Year Type[1]	Average Flow by Month (in cfs)[2]											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	—	—	—	—	1,774	7,062	1,882	296	349	687	868	881
2001	Dry	580	530	1,545	1,530	1,790	2,188	1,584	—	—	—	—	—
2002	Dry	140	346	1,054	1,245	852	958	458	408	389	401	287	256
2003	Below Normal	136	371	899	1,065	—	—	—	—	—	—	—	—
2005	Wet	—	—	—	—	—	—	4,247	4,790	4,633	1,572	1,098	855
2006	Wet	435	1,378	2,709	7,022	4,008	4,234	10,983	13,111	9,006	3,096	1,856	1,754
2007	Critical	1,437	1,664	2,007	1,881	1,813	1,920	1,227	917	1,106	1,165	934	769

Source: CDEC 2008

Note:

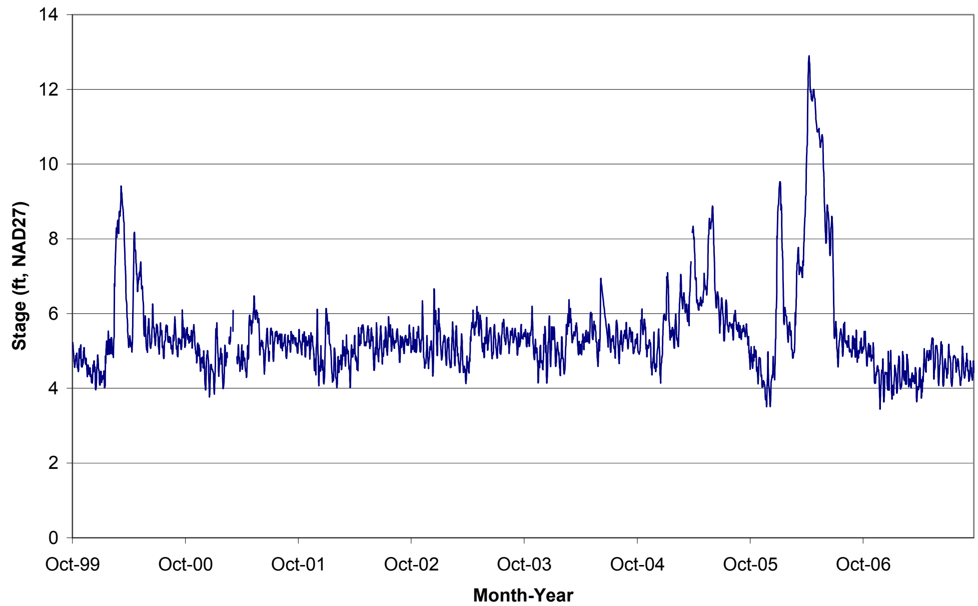
[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

[2] Data not available prior to February 2000, from May 2001 to September 2001, and from February 2003 to March 2005.

Key:

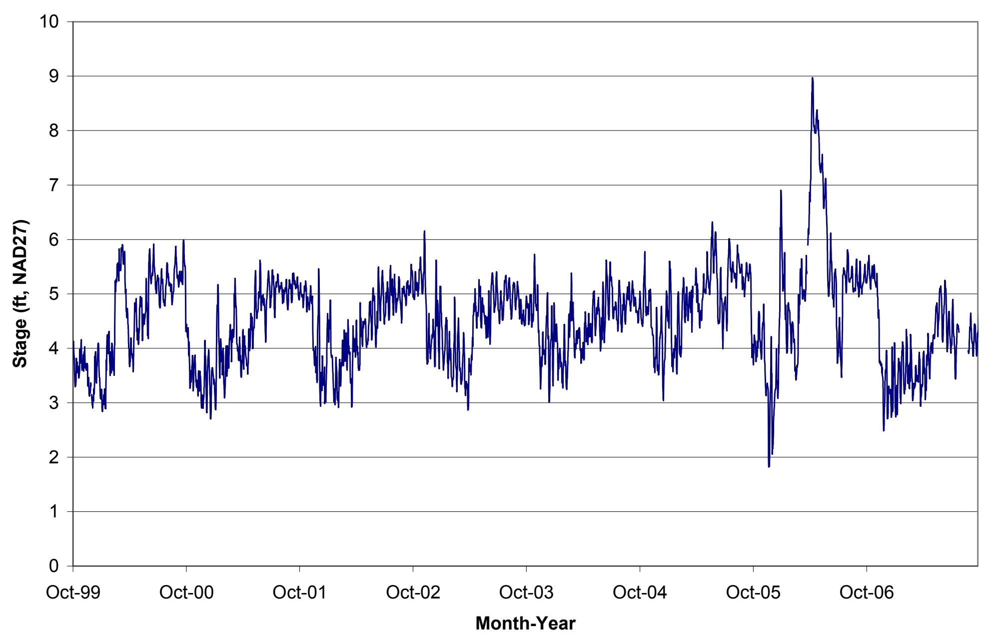
cfs = cubic foot (feet) per second

D-1641 = State Water Resources Control Board Water Right Decision 1641



Source: DWR 2008b.

Figure 2.2.1-5. Average Daily Stage in the San Joaquin River at Brandt Bridge (CDEC Station BDT)



Source: DWR 2008b.

Figure 2.2.1-6. Average Daily Stage in Old River at Tracy Road Bridge (CDEC Station OLD)

Delta Outflow. Delta outflow is an estimate of net downstream flow, calculated as the difference between inflow and the sum of estimated in-Delta consumptive uses and exports through the CVP and SWP pumps (defined in D-1641). Delta outflow is an important factor influencing fish habitat and fish populations, as it influences salinity gradients and other water quality parameters. The volume of the estuary's freshwater supply has been increasingly depleted each year due to upstream diversions, in-Delta use, and Delta exports.

D-1641 contains Delta outflow compliance criteria under the water quality objectives (WQOs) for fish and wildlife beneficial uses for net Delta outflow (see **Table 2.2.1-6**). Delta outflow requirements range from 3,000 to 8,000 cfs, depending on month and water year type. This requirement is based on a 3-day running average. Delta outflow is frequently greater than these requirements because of other operational requirements within the Delta, such as maintenance of X2 location or export/import (E/I) ratio.

Daily average net Delta outflow by month and water year type for Water Years 2000 and 2006 are presented in **Table 2.2.1-7**. This recent period of record was used to represent existing conditions because of the significant changes in Delta operations that have occurred in recent years. Delta outflow is highest during the late winter and early spring, and lowest in August and September. Monthly average flows ranged from 3,000 to 180,000 cfs between 2000 and 2006. Summer flows ranged from 3,000 to 12,000 cfs for all water years. In the wet months of drier years (2001 to 2004), average flows ranged from 12,000 to about 68,000 cfs.

Table 2.2.1-6. Delta Monthly Outflow Requirements Under D-1641

Water Year Type[1]	Average Flow by Month (in cfs)[2]											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet	4,500[3]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	8,000	4,000	3,000	4,000	4,500	4,500
Above Normal	4,500[3]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	8,000	4,000	3,000	4,000	4,500	4,500
Below Normal	4,500[3]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	6,500	4,000	3,000	4,000	4,500	4,500
Dry	4,500[3]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	5,000	3,500	3,000	4,000	4,500	4,500
Critical	4,500[3]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	7,100[4]	4,000	3,000	3,000	3,000	3,500	3,500

Notes:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

[2] Based on net Delta outflow index and calculated as a minimum monthly average.

[3] Increased to 6,000 cfs if the Eight Rivers Index for December exceeds 800,000 AF.

[4] Calculated as a 3-day running average. Requirement is also met if electrical conductivity at Collinsville is less than or equal to 2.64 mmhos/cm. Requirement may be further relaxed dependent on the Eight Rivers Index in January and February and the Sacramento River Index in May.

Key:

cfs = cubic foot (feet) per second
D-1641 = State Water Resources Control Board Water Right Decision 1641

Table 2.2.1-7. Average Monthly Delta Outflow

Water Year	Water Year Type[1]	Average Flow by Month (in cfs)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	4,258	6,803	10,467	21,541	94,092	87,828	27,233	22,057	8,823	9,123	6,024	4,622
2001	Dry	5,724	4,742	5,996	15,211	19,567	23,404	12,158	9,612	7,404	4,645	3,153	4,123
2002	Dry	4,259	8,205	24,733	38,734	12,029	16,964	11,892	13,483	7,374	5,662	3,768	4,108
2003	Below Normal	4,184	7,331	28,885	51,440	29,622	15,761	22,029	41,877	11,719	9,631	6,874	3,447
2004	Dry	4,288	6,626	23,820	32,104	68,091	56,256	21,948	12,354	5,651	7,317	5,204	4,676
2005	Wet	8,508	6,708	12,449	33,589	24,922	38,546	29,876	50,929	27,838	9,378	5,586	6,897
2006	Wet	4,451	5,006	42,828	145,920	51,805	115,393	179,387	80,754	34,332	9,300	7,227	6,982
2007	Critical	3,970	5,230	9,019	8,229	21,230	13,968	11,239	9,311	7,777	5,292	3,689	4,486

Source: Interagency Ecological Program (2007)

Note:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

Key:

cfs = cubic foot (feet) per second

Export/Import Ratio. D-1641 limits the ratio of the water exported by the combined CVP/SWP pumps to the total inflow to the Delta (E/I ratio) to be less than 65% from July through January, or 35% from February through June. Exceptions to the 35% requirement are allowed in February under some circumstances. Lower E/I ratios are presumed to be beneficial to fish (NMFS 2005a; Service 2004), in that a smaller proportion of the total flow is being diverted and, thus, presumably a smaller proportion of the fish is subjected to the adverse effects of the pumps.

Statistical relationships between E/I ratio and biological productivity or population indices have not been developed. Furthermore, substantially different conditions could be present in the Delta at the same E/I ratio (e.g., 1,000 cfs exports with 10,000 cfs inflow versus 10,000 cfs exports with 100,000 cfs inflow). Biologists with expertise in Delta operations have stated that no biologically meaningful thresholds or specific amount of change in E/I ratio could be identified as significance criteria (Victoria Poage, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, and Jim White, Staff Environmental Scientist, California Department of Fish and Game, pers. comm., August 24, 2007). For these reasons, changes in E/I ratios were not used in the evaluation of DMC Recirculation alternative plans.

Flexibility in the E/I standard is provided in the Bay/Delta Plan and pumping above the E/I standard is a tool for the EWA to obtain water. This tool has not been used in the most recent years, and will not be used in modeling runs for this Study.

Under baseline conditions, the E/I ratio rarely exceeds the regulatory limits and approaches them most closely in below normal and drier years (**Table 2.2.1-8**).

Table 2.2.1-8. Average Delta Export/Import Ratio by Water Year, 2000 to 2007

Water Year	Water Year Type[1]	Average Export/Import Ratio (as a percentage)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	59%	56%	34%	43%	15%	11%	17%	12%	36%	42%	51%	59%
2001	Dry	61%	61%	53%	36%	36%	29%	24%	10%	22%	45%	53%	53%
2002	Dry	42%	49%	32%	29%	42%	33%	22%	9%	29%	50%	59%	54%
2003	Below Normal	48%	50%	29%	17%	27%	41%	20%	6%	40%	43%	52%	63%
2004	Dry	53%	56%	29%	31%	23%	21%	14%	10%	30%	48%	56%	58%
2005	Wet	49%	57%	46%	30%	28%	18%	16%	6%	25%	45%	54%	54%
2006	Wet	62%	59%	38%	6%	17%	5%	2%	5%	16%	45%	51%	54%
2007	Critical	64%	61%	55%	46%	29%	34%	28%	10%	19%	52%	59%	58%

Source: Interagency Ecological Program (2007)

Note:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

X2 Location. Salinity is an important habitat factor in the estuary. Estuarine species characteristically have optimal salinity ranges, and their abundance may be affected by the amount of habitat available within the species' optimal salinity range (Kimmerer 2002). Because the salinity field in the estuary is largely controlled by freshwater outflows, the level of outflow may determine the available area of optimal salinity habitat for different species (Unger 1994 as cited in DWR and Reclamation 1996; DWR and Reclamation 2005; Kimmerer 2002). X2, the location of the 2-part-per-thousand isopleth, is an indicator of the salinity gradient in the Bay-Delta, and is measured in terms of river miles upstream of the Golden Gate Bridge. Lower values of X2 indicate that X2 is farther west, while higher values indicate X2 is farther east.

Under D-1641 Water Quality Objectives, X2 is to be west of the confluence of the Sacramento River and SJR at River Mile 50 in January, June and July, and west of Chipps Island (River Mile 46) during February through May. SWP and CVP operations are managed to comply with these criteria.

Average X2 location (**Table 2.2.1-9**) for Water Years 2000 through 2006 fell between River Miles 28 and 55, as measured upstream from the Golden Gate Bridge. X2 is generally furthest west in February through May and furthest east in August through November. X2 is generally farther west in wetter conditions and farther east in drier conditions.

Table 2.2.1-9. Estimated Average Location of X2

Water Year	Water Year Type[1]	Estimated Average Location of X2 (in River Mile)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	86	84	79	78	62	52	62	65	73	78	80	84
2001	Dry	87	85	84	80	74	68	74	76	79	83	88	88
2002	Dry	88	85	74	64	72	72	73	74	77	81	85	88
2003	Below Normal	87	84	80	63	62	69	71	63	69	77	79	86
2004	Dry	88	84	76	65	66	57	65	71	81	80	82	85
2005	Wet	84	81	81	70	68	64	62	62	61	72	80	82
2006	Wet	84	86	79	55	55	53	46	48	57	70	78	80
2007	Critical	83	86	83	79	75	71	75	76	79	82	87	86

Source: Interagency Ecological Program (2007)

Note:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

East San Joaquin Tributaries

Tributaries of the eastside SJR add significant volumes of water to the SJR as it heads north to the Delta. The major tributaries of the Merced, Tuolumne, and Stanislaus rivers are described in the following section. Additional small tributaries, mostly upstream of the confluence with the Merced River, include the Fresno and Chowchilla rivers and numerous smaller creeks. Some small creeks also empty into the SJR from the western side from just upstream of the Merced River confluence to the confluence with the Tuolumne River.

Merced River. The Merced River watershed covers approximately 883,000 acres and contributes approximately 15% of the flow in the lower SJR (CVRWQCB 2007b). Flows and stage in the Merced River near its confluence with the SJR are reported by the CDEC (2007, 2008) and are provided in **Appendix F, Attachment F1**.

Agricultural development in the Merced River watershed began in the 1850s, and significant development changes have occurred in the area since that time. The enlarged New Exchequer Dam forming Lake McClure was completed in 1967 and regulates releases to the lower Merced River. New Exchequer Dam is owned and operated by Merced ID for power production, irrigation, and flood control.

Lake McClure is operated to protect the Merced River and adjacent lands from flood damage, generate hydroelectric power, provide water supply for irrigation and downstream uses, and provide instream flow for the Merced River. The maximum storage is 1,024,600 AF, dead storage is 3,000 AF, and minimum pool from which the district can draw water supply is 115,000 AF.

Tuolumne River. The Tuolumne River watershed is approximately 1,200,000 acres and contributes approximately 27% of the flow in the lower SJR (CVRWQCB 2007b). Flows and stage in the Tuolumne River near its confluence with the SJR are reported by the CDEC (2007) and are provided in **Appendix F**.

Flows in the lower portion of the Tuolumne River are controlled primarily by the operation of New Don Pedro Dam, which was constructed in 1971 jointly by Turlock and Modesto IDs with participation by the City and County of San Francisco. The districts divert water to Modesto Main Canal and Turlock Main Canal, a short distance downstream from New Don Pedro Dam at La Grange Dam.

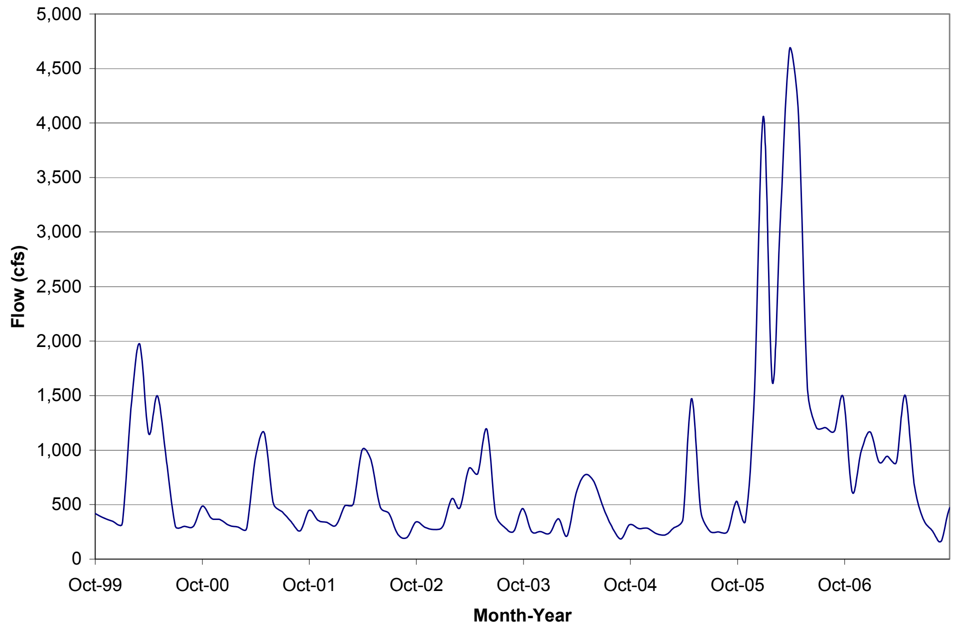
New Don Pedro Reservoir is due east of the City of Modesto on the Tuolumne River. The reservoir is 26 miles long and stores 2,030,000 AF of water at full capacity. Reservoir purposes include agricultural irrigation, hydroelectric power generation, fish and wildlife enhancement, recreation, and flood control.

Stanislaus River. The Stanislaus River watershed is approximately 737,000 acres and contributes approximately 18% of the flow in the lower SJR (CVRWQCB 2007b). Flows and stage in the Stanislaus River near its confluence with the SJR are reported by the CDEC (2007) and are provided in **Appendix F, Attachment F1**.

Agricultural water supply development in the Stanislaus River watershed began in the 1850s. Currently, the flow in the lower Stanislaus River is primarily controlled by New Melones Reservoir.

Other water storage facilities in the Stanislaus River watershed include the Tri-Dam Project, a hydroelectric generation project that consists of Donnells and Beardsley dams upstream of New Melones Reservoir on the middle fork of the Stanislaus River, and Tulloch Dam and power plant approximately 6 miles downstream of New Melones Dam on the main stem of the Stanislaus River. Releases from Donnells and Beardsley dams affect inflows to New Melones Reservoir. Under contractual agreements between Reclamation and Oakdale and South San Joaquin IDs, Tulloch Reservoir provides afterbay storage to re-regulate power releases from New Melones Power Plant.

The main water diversion point on the Stanislaus River is Goodwin Dam, approximately 1.9 miles downstream of Tulloch Dam. Goodwin Dam, which was constructed by Oakdale and South San Joaquin IDs in 1912, creates a re-regulating reservoir for releases from Tulloch Power Plant and provides for diversions to canals north and south of the Stanislaus River for delivery to Oakdale and South San Joaquin IDs. Water impounded behind Goodwin Dam may be pumped into Goodwin Tunnel for deliveries to Central San Joaquin Water Conservation District and Stockton East Water District. Monthly releases to the Stanislaus River below Goodwin Dam are reported by the CDEC (2008) and shown on **Figure 2.2.1-7**.



Note: Monthly volume converted to flow rate.
Source: CDEC 2008.

Figure 2.2.1-7. Average Monthly Flow in the Stanislaus River Below Goodwin Dam (CDEC Station SNS)

Below Goodwin Dam, monthly average flows ranged from around 180 to close to 4,500 cfs between 2000 and 2006 (**Table 2.2.1-10**). Average flows at this location exceeded 1,000 cfs at some time during spring runoff of most years of this period, as well as throughout most of 2006. Between 2001 and 2005, monthly average flows in the Stanislaus River below Goodwin Dam ranged between 200 and 500 cfs throughout most of the year, with the exception of spring runoff months.

Table 2.2.1-10. Average Monthly Flow at Stanislaus River Below Goodwin Dam (CDEC Station SNS)

Water Year	Water Year Type[1]	Average Flow by Month (in cfs)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	418	375	347	321	1,405	1,973	1,151	1,497	893	301	301	301
2001	Dry	486	375	362	308	293	277	925	1,157	512	434	342	260
2002	Dry	447	355	336	310	491	505	1,001	908	481	419	226	198
2003	Below Normal	339	286	270	298	553	471	831	785	1,189	410	291	256
2004	Dry	464	253	252	236	370	213	601	772	708	483	299	184
2005	Wet	316	280	281	232	223	287	364	1,472	441	259	249	256
2006	Wet	526	390	1,465	3,917	1,600	3,084	4,492	4,021	1,569	1,202	1,201	1,168
2007	Critical	1,493	635	967	1,161	880	917	866	1,448	664	363	265	182

Source: USGS 11302000 Stanislaus River below Goodwin Dam near Knights Ferry, CA (USGS n.d.)

Note:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

Key:

cfs = cubic foot (feet) per second

D-1641 = State Water Resources Control Board Water Right Decision 1641

New Melones Reservoir was completed by the Corps in 1978 and was approved for filling in 1983 with a storage capacity of about 2.4 million AF. The reservoir is approximately 60 miles upstream from the confluence of the Stanislaus River and SJR and is operated by Reclamation as part of the CVP. It is operated primarily for purposes of water supply, flood control, power generation, fishery enhancement, water quality improvement, and recreation. Reclamation operates New Melones Reservoir in accordance with the Interim Plan of Operations (IPO) for deliveries to water rights settlement holders, to CVP contractors, and to meet objectives for fish and water quality. Additional details on the operational requirements of the IPO are contained in the following section on regulations and agreements.

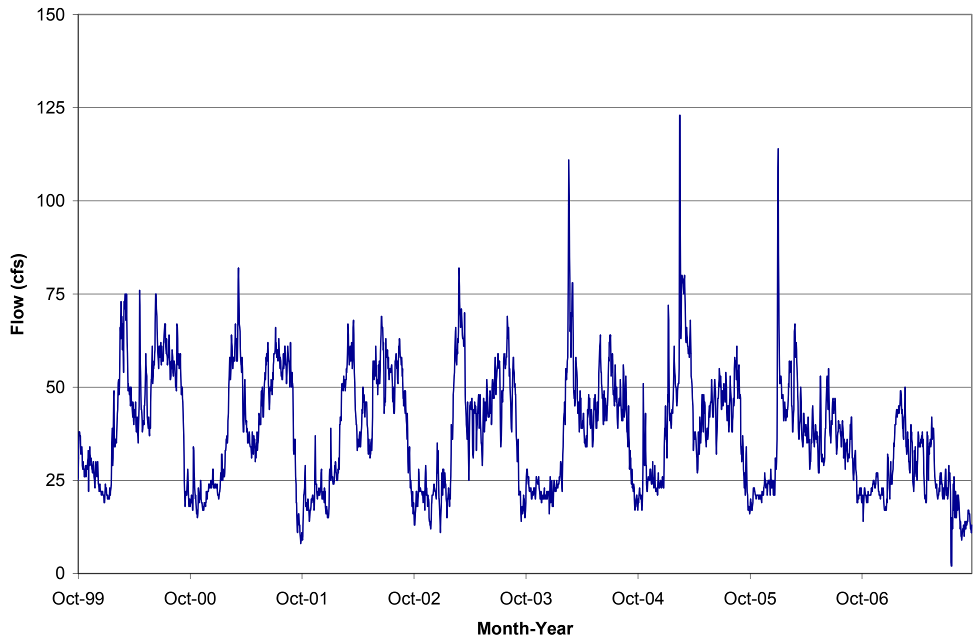
West San Joaquin River Tributaries

Grassland Drainage Area. The Grassland Drainage Area (GDA) is on the west side of the SJR roughly between Los Banos to the north and Mendota to the south. The GDA consists of CVP contractors Charleston Drainage District, Pacheco Water District, Panoche Drainage District, a portion of Central California ID known as Camp 13 drainage area, Firebaugh Canal Water District, Broadview Water District (acquired by Westlands Water District following retirement from irrigation), and Widren Water District. The GDA encompasses approximately 97,400 acres.

Salt Slough (Confluence with San Joaquin River at River Mile 129.7). Salt Slough, the other major westside tributary of the SJR, is on the easterly side of Kesterson National Wildlife Refuge. Since 1996, water in this channel comes only from wetland discharges, runoff from non-GDA farmland, and occasional flood flows. Flows and stage in Salt Slough near the confluences with the SJR are reported by the CDEC (2007) and are provided in **Appendix F, Attachment F1**.

Mud Slough (North) (Confluence with San Joaquin River at River Mile 121.1). Mud Slough (north), one of the two major westside tributaries of the SJR, is currently the major carrier of agricultural drainage to the SJR. Drainage originates from the GDA, travels via San Luis Drain, and is discharged directly into Mud Slough. Flow in Mud Slough (north) upstream of the discharge point consists of wetland releases from northern and southern Grassland Water District and additionally from Volta Wildlife Management Area, as well as operational spills from the DMC and Central California IDs Main Canal and flood flows from Los Banos Creek (Grassland Bypass Project Oversight Committee 1999). Mud Slough (north) downstream of the discharge point is often dominated by water originating from the GDA via the San Luis Drain.

Flows and stage data in Mud Slough near its confluence with the SJR are reported by the CDEC (2007) and are provided in **Appendix F, Attachment F1**. Flow data for San Luis Drain as reported by the San Francisco Estuary Institute (2007) are shown on **Figure 2.2.1-8** and in **Table 2.2.1-11.**



Source: San Francisco Estuary Institute 2007.

Figure 2.2.1-8. Average Daily Flow at the Terminus of the San Luis Drain (GBP Station B)

Table 2.2.1-11. Average Flow at the Terminus of the San Luis Drain (GBP Station B)

Water Year	Water Year Type[1]	Average Flow by Month (in cfs)											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	31	29	23	28	55	54	45	46	61	59	56	30
2001	Dry	21	20	24	28	56	57	36	40	53	58	56	22
2002	Dry	18	22	20	27	49	55	41	43	56	53	55	32
2003	Below Normal	20	19	22	23	55	55	41	42	48	52	54	23
2004	Dry	23	22	21	24	60	53	40	43	49	52	45	26
2005	Wet	25	25	25	46	66	64	36	42	46	47	50	30
2006	Wet	20	22	25	55	49	46	37	36	41	40	35	27
2007	Critical	20	24	21	32	43	31	32	32	23	20	16	13

Source: San Francisco Estuary Institute (2007).

Note:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

Key:

cfs = cubic foot (feet) per second

D-1641 = State Water Resources Control Board Water Right Decision 1641

Orestimba Creek (Confluence with San Joaquin River at River Mile 109). Orestimba Creek, another westside tributary of the SJR, joins the SJR downstream of Salt and Mud sloughs. It runs between Newman and Westley wasteways. Orestimba Creek carries both natural runoff and agricultural return flows. It is also likely that the deep entrenchment of the creek in its lower reaches near the SJR causes seepage of groundwater into the creek in several reaches. Flows and stage in Orestimba Creek near the confluence with the SJR are reported by the CDEC (2007) and are provided in **Appendix F, Attachment F1**.

Delta-Mendota Canal

The DMC extends from Jones Pumping Plant in the Delta 117 miles to Mendota Pool. In the context of this document, the DMC is discussed as "lower" and "upper" sections and described below. The "lower" DMC refers to the section of the canal that extends from O'Neill Forebay to Mendota Pool.

Water from the Delta would need to be pumped into conveyance facilities to allow release for recirculation at locations upstream of Vernalis on the SJR. Two potential Delta pumping facilities, Jones and Banks pumping plants, could be used for this purpose and are described in this section.

Lower DMC. This section of the DMC conveys water for Mendota Pool diversions (described in **Section 2.2.1, Mendota Pool [River Mile 204] subheading**) and for diversions prior to the Mendota Pool, including the Exchange Contractors and CVP agricultural and refuge users.

CVP Exchange Contractors. The Exchange Contractors are provided a substitute supply of 840,000 AF, and of this amount, 140,000 AF is diverted directly from the DMC prior to reaching Mendota Pool, subject to reduction in Shasta critical years. The majority of the return flows go to the SJR through Mud and Salt sloughs, and all return flows return upstream of Newman Wasteway.

CVP Agricultural Contractors. Total CVP agricultural contracts amount to 124,820 AF in the Lower DMC delivery area. CVP South-of-Delta agricultural allocations can be reduced up to 100% under certain hydrologic conditions.

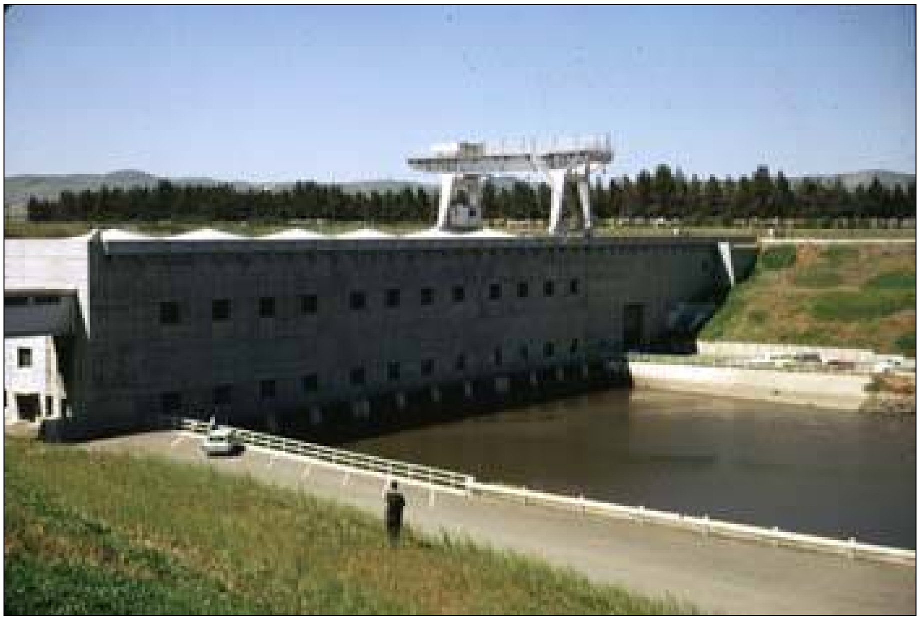
CVP Wildlife Management Areas. Wildlife management area contract demands in the Lower DMC service area total 182,698 AF annually. Deliveries are subject to a maximum reduction of 25% in Shasta critical years. In all other year-types, wildlife refuges are entitled to their full contract amounts. Most refuge return flows enter the SJR through Mud and Salt sloughs.

Upper DMC. As defined within the context of this document, "upper" DMC refers to the section of the DMC that extends from Jones Pumping Plant to O'Neill Forebay. Diversions along the upper DMC are made to CVP contractors and a water right holder. There are a total of 261,310 AF of agricultural contracts, a 10,000 AF M&I contract for the City of Tracy, and a 6,000-AF water right for Patterson Water District. The CVP contracts are subject to reductions based on CVP allocation procedures. A portion of the return flows from areas receiving water from the upper DMC reenters the SJR at Newman, the Tuolumne River confluence, and/or Vernalis.

Jones Pumping Plant. Formerly known as Tracy Pumping Plant, Jones Pumping Plant is a federally owned facility used to move water from the Delta for transfer into the DMC. Reclamation awarded the first contract related to construction of Jones Pumping Plant and appurtenant facilities on June 23, 1947. Reclamation completed the plant in 1951. It consists of an inlet channel, pumping plant, and discharge pipes (**Photograph 2.2.1-1**). Water in the Delta is lifted 197 feet into the DMC. Each of the six pumps at Tracy is powered by a 25,000-horsepower motor and is capable of pumping between 800 and 950 cfs, depending on the combination of units running at the time. Power is supplied by CVP power plants to operate the pumps. The water is pumped through three 15-foot-diameter discharge pipes and carried about 1 mile up to the DMC. The intake canal includes Tracy Fish Screen, which was built to intercept downstream migrant fish so they may be returned to the main channel to resume their journey to the ocean.

Constructed from 1950 to 1953, Jones Pumping Plant has a State water rights permit based on a "grandfathered" diversion permit issued by the Corps. The permit authorizes a maximum instantaneous pumping rate of 4,600 cfs all months of the year. In contrast, while the DMC's design conveyance capacity begins at 4,600 cfs at the Jones Pumping Plant discharge, it decreases to 4,200 cfs before reaching the inlet channel to O'Neill Forebay. In addition, three areas along the upper DMC have experienced subsidence such that the long-term average practical capacity is about 4,150 cfs.

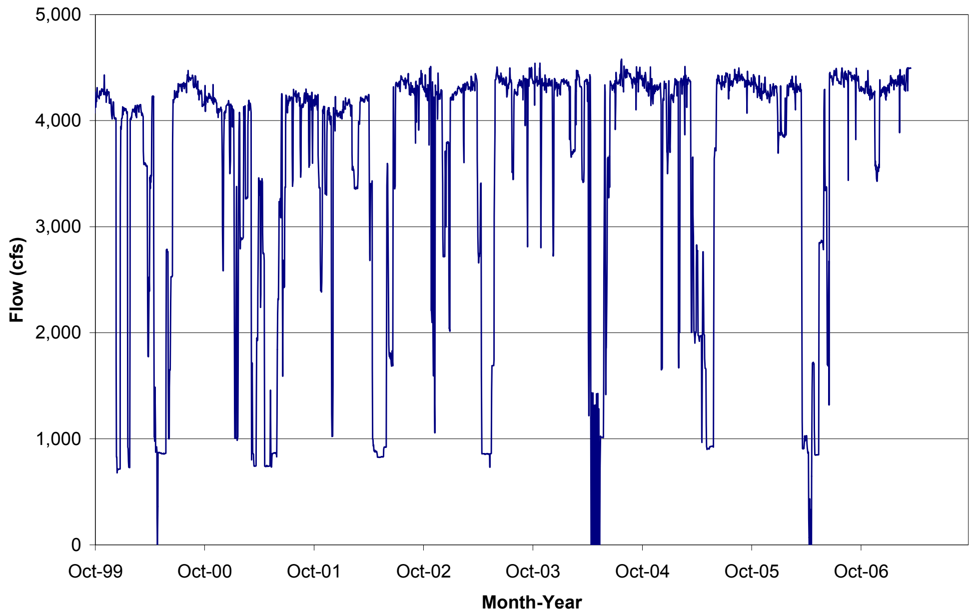
Operationally, during peak (summer) demand periods, deliveries along the upper DMC typically average 350 to 400 cfs such that Jones Pumping Plant can pump at or close to its permitted 4,600 cfs capacity. However, from early September through early spring upper DMC deliveries are minimal such that Jones Pumping Plant pumping is limited to about 4,150 cfs, the conveyance capacity of the DMC at O'Neill Forebay.



Photograph 2.2.1-1. C.W. “Bill” Jones Pumping Plant

The DMC transports water from Jones Pumping Plant 117 miles along westside San Joaquin Valley to Mendota Pool west of Fresno. The DMC also supplies water to O’Neill Forebay, where it is pumped into storage in the CVP portion of the San Luis Reservoir (SLR).

The CVP monitors flow at Jones Pumping Plant (DMC headworks). Daily average flow from 2000 to 2006 is presented on **Figure 2.2.1-9**. The daily average flow ranges from 0 to 4,581 cfs with an average of 3,597 cfs. Monthly average flows are shown in **Table 2.2.1-12**.



Note: Data not available after March 2007.
Source: Based on data provided by Chris Eacock, Soil Scientist/Natural Resources Specialist, Bureau of Reclamation, pers. comm., April 2, 2007.

Figure 2.2.1-9. Average Daily Flow at Jones Pumping Plant (DMC Headworks)

Table 2.2.1-12. Average Monthly Flow at Jones Pumping Plant (DMC Headworks)

Water Year	Water Year Type[1]	Average Flow by Month (in cfs)[2]											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	Above Normal	4,249	4,195	2,544	3,205	4,108	3,380	2,207	1,263	3,045	4,319	4,386	4,250
2001	Dry	4,208	4,061	3,910	2,737	3,520	1,883	2,177	857	2,997	4,135	4,130	4,081
2002	Dry	3,619	3,749	3,671	4,137	3,598	4,175	2,141	855	2,531	4,347	4,329	4,271
2003	Below Normal	4,080	3,664	3,328	4,254	4,266	4,347	1,896	1,462	4,405	4,192	4,300	4,259
2004	Dry	4,296	4,316	4,143	4,350	3,961	4,134	1,952	959	3,626	4,366	4,422	4,385
2005	Wet	4,356	4,290	3,794	4,217	3,889	3,376	2,117	1,071	4,167	4,374	4,408	4,361
2006	Wet	4,335	4,279	4,268	3,911	4,314	3,256	815	1,800	3,357	4,398	4,393	4,371
2007	Critical	4,308	4,027	4,133	4,345	4,361	4,427	—	—	—	—	—	—

Source: Based on data provided by Chris Eacock, Soil Scientist/Natural Resources Specialist, Bureau of Reclamation, pers. comm., April 2, 2007

Notes:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

[2] Data not available after March 2007.

Key:

cfs = cubic foot (feet) per second

D-1641 = State Water Resources Control Board Water Right Decision 1641

Banks Pumping Plant. The SWP also has significant infrastructure in the Delta, including Banks Pumping Plant and the California Aqueduct. Banks Pumping Plant is west of Jones Pumping Plant on a second canal off of Clifton Court Forebay. Banks Pumping Plant lifts water into the California Aqueduct for delivery to SWP contractors in the Central Valley and Southern California. Water is diverted directly from the California Aqueduct as well as delivered to O'Neill Forebay for storage in the State's portion of the SLR.

Banks Pumping Plant is 2.5 miles southwest of Clifton Court Forebay and 11.5 miles northeast of the City of Livermore. Banks Pumping Plant is the first pumping plant for the California Aqueduct and the South Bay Aqueduct. Banks Pumping Plant has a much larger capacity than Jones Pumping Plant, with a physical capacity of 10,670 cfs at the design head from 11 units. However, diversion constraints at Clifton Court Forebay limit the capacity to 6,680 cfs.

Conveyance Pathways

Water could be moved from the DMC to the SJR through Newman Wasteway, Westley Wasteway, Mendota Pool, or CVP refuges. Newman Wasteway would release water into the SJR just upstream of the confluence of the Merced River. Westley Wasteway's outlet would release water back into the SJR just upstream of the confluence of the Tuolumne River. Mendota Pool and refuges would release water upstream of Salt and Mud sloughs.

Newman Wasteway (DMC Milepost 54.38). Newman Wasteway is a CVP facility designed to convey emergency releases from the DMC. Newman Wasteway flows from west to east with its headgate on the DMC, just upstream of Check 10 at Milepost 54.38. Newman Wasteway is 8.2 miles long, of which the upper 1.5 miles are concrete lined and the remainder is unlined. The design capacity of the wasteway channel is 4,300 cfs, but the existing average flow is only 50 to 75 cfs from agricultural drainage. Occasional pulse flows are sent down the wasteway to clear accumulated sediment away from the headgates. The terminus of the wasteway is at the SJR, 1.24 miles upstream of the Merced River confluence (see **Photograph 2.2.1-2**).

Photograph 2.2.1-2. Newman Wasteway at DMC (left) and at San Joaquin River Terminus (right)

Westley Wasteway (DMC Milepost 34.32). Westley Wasteway is also a CVP facility designed to convey emergency releases from the DMC. The headgates of Westley Wasteway are at DMC Milepost 34.32 and the wasteway flows from west to east. Westley Wasteway is 3.8 miles long with the upper 2.3 miles concrete lined, an unlined section between Milepost 2.30, and another lined section below Milepost 2.98 to Milepost 3.82. Below Milepost 3.82 the channel is unlined and has been diverted via a bypass structure to supply drainage water to a privately owned managed wetland southeast of the previous channel (see **Photograph 2.2.1-3**).

Photograph 2.2.1-3. Westley Wasteway at DMC (left) and at Bypass to Private Refuge (right)

The design capacity of the wasteway channel is 4,300 cfs, but the existing average flow is only 50 to 75 cfs from agricultural drainage. An occasional pulse flow is sent down the wasteway to clear accumulated sediment away from the headgates. The SJR is not currently directly connected to the wasteway outlet as originally constructed. As shown on **Figure 2.2.1-10**, outflow from the end of the wasteway flows through a recently constructed bypass channel that discharges into a privately owned managed wetland, which then drains to the SJR. Additional analysis will be required to determine the feasibility of using Westley Wasteway to convey DMC water to the SJR.

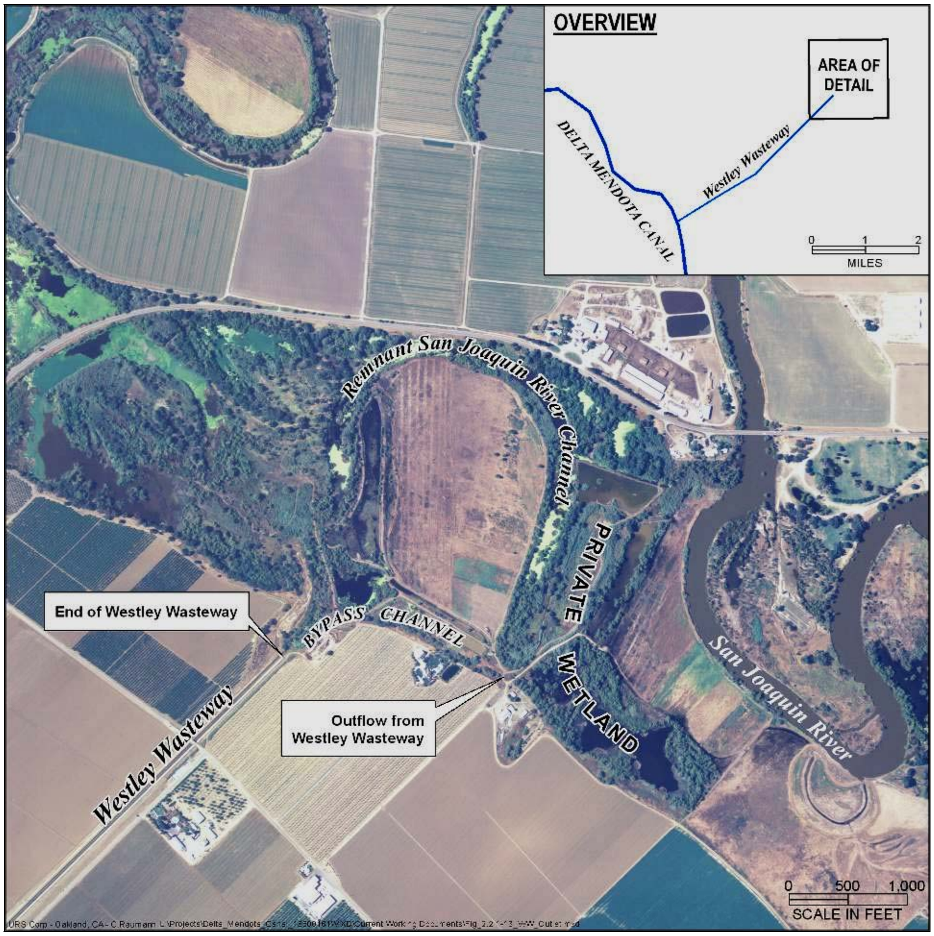


Figure 2.2.1-10. Westley Wasteway Outlet Relative to the San Joaquin River

Stage in Westley Wasteway is reported by the CDEC (2008) for January 2005 through February 2006 and provided in **Appendix F, Attachment F1**. Stage in the bypass channel was generally less than 2 feet.

Mendota Pool. The physical description of Mendota Pool is provided under the “Main Stem San Joaquin River” subheading above. Prior to new restoration flows expected to result from the SJRRP, recirculation through Mendota Pool would not be practical due to the dry reaches below Sack Dam.

CVP Wildlife Management Areas (Refuges). Recirculation through the refuges would likely have limited if any value due to water quality degradation as water passes through the refuges and mixes with return flows in Mud and Salt sloughs.

Storage Components

Use of existing south-of-Delta (SOD) storage facilities is an option that may be incorporated into one or more of the alternative plans. Significant storage is not needed for real-time operational alternatives, but the use of storage would increase flexibility in the ability to use Delta pumps to obtain recirculation water from the Delta or to replace water pumped from the Delta that was used for recirculation instead of being placed into storage. Construction of new storage facilities is not being considered for the DMC Recirculation Project. Existing SOD storage facilities that may be used in the project are discussed below.

O'Neill Dam and Forebay. These joint Federal/State facilities are on San Luis Creek, 2.5 miles downstream from B.F. Sisk Dam. O'Neill Dam is a zoned earthfill structure with a height of 87 feet and a crest length of 14,300 feet. Containing 2.8 million cubic yards of material, the dam was completed in 1967. The forebay holds 56,400 AF, the top 20,000 AF of which act as re-regulator storage necessary to permit off-peak pumping and on-peak generation by the main San Luis Pumping Plant.

O'Neill Forebay Inlet Channel extends 2,200 feet from the DMC to deliver water to O'Neill Forebay. Six pumping units of the O'Neill Pumping Plant lift water 45 to 53 feet into the forebay. The forebay is used as a hydraulic junction point for Federal/State waters. Recreation facilities are included at the forebay for picnicking, camping, swimming, boating, water skiing, and fishing.

B. F. Sisk Dam and San Luis Reservoir. These joint Federal/State facilities are on San Luis Creek near the City of Los Banos. Completed in 1967, B F. Sisk Dam is a zoned earthfill structure 382 feet high with a crest length of 18,600 feet. It contains 77.7 million cubic yards of material.

The SLR has a capacity of 2.0 million AF and is used to store water pumped from the Delta. Releases are made through the San Luis Pumping Plant, using its power generating capacity. The lake filled for the first time on May 31, 1969. The reservoir offers facilities for fishing, boating, water skiing, and camping. The SLR serves as the major storage reservoir for the CVP and SWP.

The California Aqueduct (a State feature) flows directly into O'Neill Forebay. The pumping-generating units lift the water from O'Neill Forebay and discharge it into the SLR. When not pumping, these units generate electric power by reversing flow through the turbines. Water for irrigation and urban uses is released into the San Luis Canal and flows by gravity to Dos Amigos Pumping Plant, where it is lifted more than 100 feet to permit gravity flow to the terminus of the joint-use facilities at Kettleman City. The State canal system continues to the southern San Joaquin Valley and southern coastal areas. Two detention reservoirs, Los Banos and Little Panoche, control cross drainage along the San Luis Canal. The reservoirs also provide recreation and flood control benefits.

The CVP portion of the SLR is 966,000 AF and the SWP portion is 1,062,000 million AF. The SLR is used to store water pumped from the Delta primarily during wet conditions in the winter months for delivery during the late summer and fall months. Water is released from the SLR back into the California Aqueduct and the lower DMC as well as diverted directly from the reservoir on the western side for delivery to Santa Clara County and other areas of the central coast.

Sacramento River

Although it is out of the Study area for the PFR, DMC recirculation has the potential to influence operations on the Sacramento River and, therefore, the Sacramento River warrants discussion in this section. The Sacramento Valley encompasses approximately 6.0 million acres of developed agriculture and urban areas and undeveloped native areas. The Sacramento River system includes the Sacramento River and its major tributaries including the Feather, Yuba, Bear, and American Rivers and their tributaries. The CVP also imports Trinity River water through facilities on the Trinity River and Clear Creek Tunnel. Most major streams and rivers in the Sacramento Valley are regulated by reservoirs of various sizes to provide flood control, water supply, hydropower, and other benefits.

Major reservoirs in the Sacramento Valley include the CVP's Shasta (4.6 million AF) and Folsom (975,000 AF) Reservoirs, and the SWP's Oroville Reservoir (3.6 million AF) on the Feather River. For the purpose of evaluating the effects of DMC recirculation in the PFR, changes in the Sacramento River system are not evaluated directly. Potential effects could occur under alternatives that affect South-of-Delta storage and deliveries as the system attempts to recover these lost supplies through additional Delta pumping if available. Potentially affected systems include CVP and joint-use reservoirs and systems (including affected species), with smaller effects that may ripple through the remainder of the upstream system due to changes in the Delta. However, operations in Sacramento basin would be compliant with existing laws and regulations governing operations of the CVP. Therefore additional analysis is not needed for the PFR.

2.2.2 Water System Operations Regulations and Agreements

The previously described system of natural rivers and human-made storage and conveyance facilities is governed by a myriad of Federal, State, and local regulations and agreements. These regulations and agreements constrain how the system can be operated. Regulations and agreements cover operations for flood control, water supply, water quality, and environmental objectives. The following sections describe the major regulations and agreements that govern and affect SJR hydrology and operations. A more limited description of Delta and upstream water requirements is included at the end of the section.

San Joaquin River Below Friant Dam

As discussed above, other than flood control releases, the releases from Friant Dam to the SJR are normally limited to that amount necessary to maintain diversions by riparian and contractor users below Friant Dam to a location near Gravelly Ford. Water diverted to the fish hatchery below Friant Dam and returned to the SJR partially serves that purpose. Review of historical operation records (Reclamation monthly reservoir operation reports) provided guidance in estimating the minimum downstream release in **Table 2.2.1-1**. From an analysis of the historical record (1990–1994) for periods when no flood control releases were made, an annual release of 116,700 AF was estimated to be the current minimum release necessary to meet downstream diversions (including seepage). Once the SJRRP is implemented, releases other than for flood control will be governed by the Settlement.

Merced River

Due to a water rights agreement known as the Cowell Agreement, Merced ID must make available below Crocker-Huffman Diversion Dam an amount of water that can then be diverted from the Merced River at a number of private ditches between Crocker-Huffman Diversion Dam and Shaffer Bridge. Two additional riparian diversions not covered under the Cowell Agreement exist off of the Merced Falls pool. The Merced River also has flow requirements as set forth by the Federal Energy Regulatory Commission (FERC) and the Davis-Grunsky contract between the State and Merced ID.

To satisfy the flow requirements and the Cowell Agreement, the district operates to a target flow below Crocker-Huffman Diversion Dam equal to the Cowell Agreement entitlement plus the FERC/Davis-Grunsky flow requirements.

Tuolumne River

Minimum flows for the Tuolumne River are required by the FERC license for the New Don Pedro Project. As listed in **Table 2.2.2-1**, the FERC license identifies 10-year type classifications for the Tuolumne River, of which only seven have distinctly different minimum flow schedules.

Table 2.2.2-1. Tuolumne River FERC Flow Requirement Classification

Year Type Classification[1]	San Joaquin Basin Index (in TAF)
Critical and Below	<1,500
Median Critical	1,500
Intermediate Critical/Dry	2,000
Median Dry	2,200
Intermediate Dry/Below Normal	2,400
Median Below Normal	2,700
Intermediate Below Normal/Above Normal	3,100
Median Above Normal	3,100
Intermediate Above Normal/Wet	3,100
Median Wet/Maximum	3,100

Note:

[1] For each year type classification, a basic schedule of flows is identified for the breakpoint for the year type. For example, if the San Joaquin Basin Index is 1,550,000 AF the year is classified as Median Critical and its basic schedule is a volume of 103,000 AF. The FERC license requires an interpolation of schedules within year type classifications.

Key:

FERC = Federal Energy Regulatory Commission
TAF = thousand acre-feet

Stanislaus River

The Stanislaus River is governed by several different regulations and agreements. Operations of New Melones Reservoir are guided by an attempt to balance numerous different objectives including fishery flow requirements, water supply, SJR water quality, and inflow to the Delta. The following paragraphs provide additional detail on the various regulations and agreements.

New Melones Interim Plan of Operations. The New Melones IPO provides water for four purposes: fishery, water quality, Bay-Delta flow, and water supply. In this discussion, fishery refers to flow requirements of the 1987 Reclamation–CDFG Agreement and prescriptive use of Central Valley Project

Improvement Act (CVPIA) 3406(b)(2); water quality refers to the State Water Resources Control Board's (SWRCB's) D-1641 salinity objectives at Vernalis; Bay-Delta flow refers to D-1641 flow requirements at Vernalis (not including pulse flows during the April 15–May 16 period, VAMP); and water supply refers to CVP contractors, Stockton East Water District, and Central San Joaquin Water Control District.

Allocations to various purposes are generally based on the value of the end-of-February New Melones storage, plus the March–September forecast of inflow to the reservoir. Water is provided to Oakdale and South San Joaquin IDs in accordance with their settlement with Reclamation (water year basis). Required releases to the Stanislaus River below Goodwin Dam are based on the following: (1) releases up to the amount of the fishery pattern are debited from the annual fishery allocation; (2) releases up to the amount of the D-1641 Bay-Delta flow requirement, excluding the amount of fishery release, are debited from the annual Bay-Delta flow allocation; and (3) releases up to the amount of the Vernalis water quality requirement, excluding the amount of fishery and Bay-Delta flow allocations, are debited from the annual Vernalis water quality allocation.

Oakdale and South San Joaquin IDs receive a full supply of 600,000 AF unless the water inflow to New Melones is less than 600,000 AF. In these dry conditions the IDs' supply is reduced as a function of the actual inflow.

1987 Reclamation–CDFG Agreement, and Service Discretionary Use of CVPIA 3406(b)(2). Depending on the fishery allocation (0–467,000 AF/year) under the New Melones IPO, the fishery release volume at Goodwin Dam is managed under the base and pulse flow schedules. Fishery releases are based on the 1987 Reclamation-CDFG agreement and the Service discretionary use of the CVPIA 3406(b)(2) account to support release goals established by the Anadromous Fish Restoration Program.

D-1422. Additional releases are made to the Stanislaus River below Goodwin Dam, if necessary, to meet the D-1422 dissolved oxygen (DO) content objective. D-1422 requires that water be released from New Melones to maintain the DO concentration in the Stanislaus River at a value of at least 7 milligrams per liter (mg/L) as measured near Ripon. Releases from Goodwin Dam to the Stanislaus River (except for flood control) do not exceed 1,500 cfs.

D-1641. Vernalis Water Quality and Flow The salinity objective near Vernalis was originally defined in D-1422, but D-1641 provisions revised this requirement. D-1641 requires salinity near Vernalis to be less than 700 micromhos per centimeter (µmhos/cm) for April–August and less than

1,000 µmhos/cm for September–March based on a 30-day running average. Releases are made from New Melones, as required, up to the allocation provided by the New Melones IPO, to meet this criterion.

D-1641 also requires the flow at Vernalis to be maintained during the February through June period. The flow requirement is based on the required location of X2 and the San Joaquin Basin Index according to **Table 2.2.2-2**. Releases are made from New Melones, as required.

Table 2.2.2-2. Minimum Average Monthly Water Quality Objectives for Flow for San Joaquin River at Airport Way Bridge, Vernalis (Interagency Station C-10)

Water Year Type[1,2]	Period	Flow (cfs) [3]
Wet, Above Normal	February 1 to April 14 and May 16 to June 30	2,130 or 3,420
Dry, Below Normal		1,420 or 2,280
Critical		710 or 1,140
Wet	April 15 to May 15	7,330 or 8,620
Above Normal		5,730 or 7,020
Below Normal		4,620 or 5,480
Dry		4,020 or 4,880
Critical		3,110 or 3,540
All	October	1,000[4]

Source: SWRCB 2006

Notes:

1 Based on San Joaquin Basin Index.

2 Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

3 Higher flow objective applies when the 2 ppt isohaline, measured as 2.64 mmhos/cm surface salinity (X2), is required to be at or west of Chipps Island.

4 Includes up to an additional 28,000 AF pulse/attraction flow during all water year types. The amount of water is limited to the amount necessary to provide a monthly average flow of 2,000 cfs. The additional 28,000 AF is not required in a critical year following a critical year.

Key:

AF = acre-foot (feet)
cfs = cubic foot (feet) per second
mmhos/cm = millimhos per centimeter
ppt = parts per thousand
SJR = San Joaquin River

San Joaquin River Agreement

The SJRA provides for the acquisition of water by Interior from certain SJRGA members for use as a pulse flow at Vernalis during April and May, and the acquisition of other water for use during other times of the year. The water is needed to support the VAMP during the pulse flow period and to assist the Interior in meeting the Anadromous Fish Restoration Plan, Bay-Delta flow objectives, and the Service Biological Opinion for Delta Smelt. As part of the VAMP, the CVP and SWP exports during the VAMP test period (April and May) will be managed to specified levels.

Four components of water are provided by certain SJRGA members: Merced, Turlock, Modesto, Oakdale, South San Joaquin IDs, and the Exchange Contractors.

- Up to 110,000 AF per year towards meeting the VAMP flow target. Water provided under this component is divided among the SJRGA members. This water is to only be used during the VAMP 31-day test flow period.
- Additional water from Merced ID (12,500 AF) during October of all years. This flow is provided above the "existing flow" in the Merced River during October.
- Additional water from Oakdale ID (15,000 AF) every year to be available to Reclamation. In addition to this water, any of the (up to) 11,000 AF of Oakdale ID VAMP water not provided towards meeting the VAMP flow target is also available to Reclamation.
- Additional water from willing SJRGA members above the 110,000 AF to achieve full "double-step" flow targets.

The VAMP flow target is determined by a series of procedures and conditions based on the flow at Vernalis, which would occur in the absence of the SJRA ("existing flow"), and the San Joaquin Valley Water Year Hydrologic Classification. The SJRA provides a VAMP flow target that will be incrementally larger than the existing flow at Vernalis consistent with **Table 2.2.2-3**.

The SJRA calculates a 60-20-20 Indicator that is a numeric adjunct to the San Joaquin Valley Water Year Hydrologic Classification:[1] a wet year is assigned the numeric value of 5, an above normal year is assigned the numeric value

[1] The 60-20-20 San Joaquin Valley Water Year Hydrologic Classification Index = 0.6 * current April - July runoff forecast (million AF) + 0.2 * current Oct-Mar runoff (million AF) + 0.2 * previous water year's Index. Index value is used to determine water year type. SJR runoff is the sum of Stanislaus River inflow to New Melones Lake, Tuolumne River inflow to New Don Pedro Reservoir, Merced River inflow to Lake McClure, and SJR inflow to Millerton Lake, in million AF.

of 4, a below normal year is assigned the numeric value of 3, a dry year is assigned the numeric value of 2, and a critical year is assigned the numeric value of 1. In any year when the sum of the current year's 60-20-20 Indicator and previous year's 60-20-20 Indicator is 7 or greater, the 31-day flow target will be the flow target one level higher than that established by **Table 2.2.2-3** (e.g., if the existing flow is 3,500 cfs, then the flow target will be 5,700 cfs). This condition is referred to as a "double-step."

Table 2.2.2-3. Vernalis Adaptive Management Plan Flow Targets

Existing Flow at Vernalis (in cfs)	VAMP Test Flow Target (in cfs)
0 – 1,999	2,000[1]
2,000 – 3,199	3,200
3,200 – 4,449	4,450
4,450 – 5,699	5,700
5,700 – 7,000	7,000

Note:
[1] For the purpose of determining water to be provided by the San Joaquin River Group Authority's members only. The VAMP Test Flow Target is 3,200 cfs.

Key:
cfs = cubic foot (feet) per second
VAMP = Vernalis Adaptive Management Plan

The SJRA also provides for relaxation of this obligation during sequential dry-year periods. During years when the sum of the current year's 60-20-20 Indicator and the previous 2 years' 60-20-20 Indicator is 4 or less (a sequence of dry and critical years), the SJRGA members will not be required to provide water above the existing flow.

The agreement assumes that the Stanislaus River is operated in accordance with the New Melones IPO and that releases under the plan are included in the "existing" flow at Vernalis.

The SJRGA has executed a "Division Agreement," which specifies the amount and order of the individual contributions of water by its members. The division of flow to provide up to 110,000 AF of water for VAMP is shown in **Table 2.2.2-4**.

Table 2.2.2-4. Division of Vernalis Adaptive Management Plan Pulse Flow Water

Entity (in order of providing flow)	In AF				
	First 50,000	Next 23,000	Next 17,000	Next 20,000	Total
Merced ID	25,000	11,500	8,500	10,000	55,000
Oakdale ID/ South San Joaquin ID	10,000	4,600	3,400	4,000	22,000
Exchange Contractors	5,000	2,300	1,700	2,000	11,000
Modesto ID/Turlock ID	10,000	4,600	3,400	4,000	22,000

Key:
AF = acre foot (feet)
ID = Irrigation District

An additional 12,500 AF of water above "existing" flow in the Merced River is provided by Merced ID in October of all years. Also, an additional 15,000 AF of water and up to 11,000 AF of any unused Oakdale ID VAMP water is made available to Reclamation by Oakdale ID. The additional 15,000 AF of water from Oakdale ID is released in October above any flow that is already occurring under the IPO. Oakdale ID VAMP water not used during the VAMP period is released to the Stanislaus River, evenly distributed between November and December.

Water Operation System Model Existing Conditions Assumptions

The water operations modeling was done in the current version of CalSim II. CalSim II is a hydrologic planning model of California's waterscape with an emphasis on the CVP and SWP systems. CalSim II was developed jointly by the DWR and Reclamation. CalSim II is a simulation-by-optimization model that uses a linear programming/mixed-integer linear programming solver to determine the optimal set of decisions based on a set of weights and constraints.

The current version of CalSim II has been expanded and refined through the Common Assumptions process for the CALFED surface storage investigations. **Appendix A** includes the common assumptions used as input to CalSim II. The Common Assumptions process has made significant improvements to the CalSim II model to provide a common representation of both the existing and the future conditions for use in all the surface storage investigations.

The Common Assumptions version of CalSim II covers both the Sacramento River and SJR valley floor drainage areas, the upper Trinity River, the San Joaquin Valley, and Southern California agricultural and urban areas served by the CVP and SWP.

CalSim II can be run to one or more different “steps” or levels of regulations (e.g., D-1641, CVPIA (b)(2)). This study included the operation of the system up to and including CVPIA Section 3406(b)(2).

Model Assumptions. Appendix A provides a summary of the assumptions used for existing and future conditions under the No-Project/No-Action Alternative for CalSim II. The appendix shows Version 8D of the Common Assumptions model package. Version 8D is an interim update to support the joint agency review process for Common Assumptions. These assumptions have been developed by the Common Assumptions Common Modeling Team and are completely described in **Appendix A**. When these assumptions are updated they will be incorporated into the CalSim II modeling as appropriate.

2.2.3 Water Resources and Quality

As discussed in **Section 2.2.1**, the primary sources of surface water to the SJR basin are rivers that drain the western slope of the Sierra Nevada Range (**Figure 1-1**). Each of these rivers, the San Joaquin, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes, drains large areas of high-elevation watershed that supply snowmelt runoff during the late spring and early summer months. The major reservoirs and lakes include Pardee, New Hogan, New Melones, New Don Pedro, McClure, and Millerton.

Drinking Water Resources

The primary drinking water sources in the San Joaquin Valley are deep aquifer wells. The cities of Merced, Turlock, Ceres, Mendota, and Los Banos receive all of their drinking water from groundwater. The City of Modesto obtains about 155.0 million gallons per day of water from the ground and 30.0 million gallons per day from the Modesto Reservoir in Stanislaus County, which is owned and operated by Modesto ID (City of Modesto 2002).

Project effects on drinking water quality derived from surface water sources are heightened because approximately two-thirds of California’s drinking water comes from the Delta region. Selenium, bromide, total organic carbon, and salts are constituents of major concern for drinking water, and salts are of importance to agricultural users of Delta water. In addition, high levels of TDS, salinity, and turbidity affect consumer acceptance of drinking water as well as treatment plant operations.

Water projects divert water from the Delta channels to meet the needs of approximately two-thirds of California’s population. CVP water is delivered through the Contra Costa Canal to the CCWD. The CCWD delivers water throughout eastern Contra Costa County providing for the municipal water needs of over 400,000 county residents. Water from the Delta is the primary source of water supply for 450,000 residents in central and eastern Contra Costa County. CCWD draws Delta water from Rock Slough, Old River near the town of Discovery Bay, and Mallard Slough. The water is transferred through the Contra Costa Canal to the CCWD's treatment plants and can also be stored in Los Vaqueros, Contra Loma, Mallard, and Martinez reservoirs. Los Vaqueros Reservoir becomes the major source during periods when use of Delta water is prohibited. Water taken from the reservoir is replaced at a relatively high expense incurred by pumping costs.

Canal water is also delivered to industrial users, public water supply retailers, and to CCWD's treatment facilities (Bollman and Randall-Bold water treatment plants). Treated water is distributed to about 230,000 residents in Clayton, Clyde, Concord, Pacheco, Port Costa, and parts of Pleasant Hill, Martinez, and Walnut Creek. Some treated water is also distributed to Antioch, Bay Point, and Brentwood. CCWD also sells raw water to the cities of Antioch, Martinez, and Pittsburg, California Cities Water Company (Bay Point), and Diablo Water District (Oakley).

Water Quality Regulatory Environment

Construction and operation of the alternative plans under consideration would be subject to a variety of water quality regulatory compliance actions that are in place to safeguard the environment. State and regional requirements that may affect or be affected by the DMC Recirculation Project are enacted by the SWRCB and Regional Water Quality Control Board (RWQCB), respectively. Specific responsibilities and procedures of the SWRCB and RWQCB are contained in the Porter-Cologne Water Quality Control Act. The SWRCB was created by the California Legislature in 1967. SWRCB's mission is to "preserve, enhance, and restore the quality of California's water resources and ensure their proper allocation and efficient use for the benefit of present and future generations." The joint authority for water allocation and water quality protection enables the SWRCB to provide comprehensive protection for California's waters.

The RWQCB's primary duty is to protect the quality of the waters within its region for all beneficial uses. This duty is implemented by formulating and adopting Water Quality Control Plans for specific groundwater or surface water basins and by prescribing and enforcing requirements on all agricultural, domestic, and industrial waste discharges. Of the nine RWQCBs in the State, the Central Valley RWQCB (CVRWQCB) presides over the DMC Recirculation Study area.

The following sections describe the State and regional regulatory compliance requirements of the SWRCB and CVRWQCB, as well as local and Federal requirements for surface water resources.

Applicable Water Quality Control Plans. The applicable Water Quality Control Plans for the DMC Recirculation Study area are the *Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin River Basins,* which was prepared by the CVRWQCB (2007b), and the *Water Quality Control Plan for San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay/Delta Plan), which was prepared by the SWRCB (2006).

The Basin Plan revisions most relevant to the DMC Recirculation Project include the following:

- The Adoption of WQOs and an Implementation Plan for the Regulation of Agricultural Subsurface Drainage in the Grassland Area (CVRWQCB 2007c; adopted May 3, 1996, but not yet approved by the SWRCB and Office of Administrative Law)
- The Amendment for the Control of Salt and Boron Discharges into the Lower San Joaquin River (CVRWQCB 2007a; in effect July 28, 2006, and approved by the EPA on February 8, 2007)
- The Amendment for the Control Program for Factors Contributing to the Dissolved Oxygen Impairment in the Stockton Deep Water Ship Channel (CVRWQCB 2007a; in effect August 23, 2006)

The Lower SJR has been divided into seven major geographic subareas. In some cases a subarea has been divided further into minor subareas to provide a greater level of detail. The CVRWQCB has apportioned salt and boron load allocations to each of the subareas. The amended Basin Plan is very specific in outlining priorities for implementing load allocations, time schedules for implementation, and the calculation of real-time salt load allocations. A supply water credit is provided to irrigators in the Grassland and Northwest Side subareas that receive water from the DMC (CVRWQCB 2007a).

The RWQCBs have the primary responsibility for formulating and adopting Basin Plans for their respective regions (Water Code Section 13240), but the SWRCB is also authorized (Water Code Section 13170) to adopt Water Quality Control Plans. When the SWRCB adopts a Water Quality Control Plan, it supersedes regional Basin Plans for the same waters to the extent of any conflict; however, historically, the SWRCB's Bay/Delta Plan established or amended primarily those objectives for which implementation includes the regulation of water diversion and use[1] (i.e., situations in which water supply activities affect water quality). Beneficial uses for potentially affected surface waters within the Study area are shown in **Table 2.2.3-1**.

The Bay/Delta Plan was adopted by the SWRCB on December 13, 2006 and approved by the Office of Administrative Law on June 27, 2007. The regulatory portions of the amended Bay/Delta Plan were submitted to the EPA for approval.

The December 13, 2006, revision states:

> At the time of this 2006 update to the Plan there are a number of emerging issues that this Plan either does not currently regulate or may not fully regulate because circumstances and scientific knowledge are changing … the State Water Board will immediately begin a process to evaluate and prioritize water quality control planning activities to address the following emerging issues:
>
> 1. Pelagic Organism Decline
> 2. Climate Change
> 3. Delta and Central Valley Salinity
> 4. San Joaquin River Flows

The SWRCB notes in the 2006 Bay/Delta Plan that information suggests that climate change could have an effect on water supply and water quality. The SWRCB plans to be responsive to water agencies submitting plans and applications for water projects, such as the SDIP, or potential future conveyance structures, such as a Delta peripheral canal.

Both the Basin Plan and the Bay/Delta Plan will be updated to reflect changes in salinity management in the Central Valley. The CVRWQCB and the SWRCB joined together in January 2006 with several other regulatory agencies to form the Central Valley Salinity Policy Group. Presentations given by the CVRWQCB and SWRCB on November 30, 2006, described the current salinity "crisis" in the Central Valley. SWRCB's Environmental Program Manager stated that if the salinity issue is not managed, beneficial use of waters could be lost.

[1] Some of the Bay-Delta objectives require water quality regulation as well as water supply regulation (SWRCB 2006).

Table 2.2.3-1. Beneficial Uses of Potentially Affected Surface Waters

Basin	Mun	Agr	Ind proc	Ind serv	Ind pow	Rec 1	Rec 2	Fresh W	Fresh C	Migr W	Migr C	Spwn W	Spwn C	Wild	Nav
Merced River	P	E	—	—	E	E	E	E	E	—	—	—	—	E	—
San Joaquin River, Mouth of Merced River to Vernalis	P	E	E	—	E	E	E	E	—	E	E	E	—	E	—
Tuolumne River	E	E	—	—	E	E	E	E	E	—	E	E	E	E	—
Stanislaus River	E	E	E	E	E	E	E	E	E	—	E	E	E	E	—
San Luis Reservoir	E	E	—	E	E	E	E	E	—	—	—	—	—	E	—
O'Neill Reservoir	E	E	—	—	—	E	E	E	—	—	—	—	—	—	—
Other lakes/rivers in the San Joaquin River Basin	E	—	—	—	E	E	E	E	E	—	—	—	E	E	—
California Aqueduct	E	E	E	E	E	E	E	—	—	—	—	—	—	E	—
Delta-Mendota Canal	E	E	—	—	—	E	E	E	—	—	—	—	—	E	—
Grassland Watershed	E	E	—	—	—	E	E	E	—	—	—	E	—	E	—
Sacramento–San Joaquin River Delta	E	E	E	E	—	E	E	E	E	E	E	E	—	E	E

Key:

— = No beneficial use
Agr = Agricultural supply
E = Existing use
Fresh C = Freshwater habitat cold
Fresh W = Freshwater habitat warm
Ind pow = Industrial power
Ind Proc = Industrial process
Ind serv = Industrial service supply
Migr C = Migration cold (salmon and steelhead)
Migr W = Migration warm (striped bass, sturgeon, shad)
Mun = Municipal and domestic supply
Nav = Navigation
P = Potential use
Rec 1 = Recreation 1 (contact, canoe, rafting)
Rec 2 = Recreation 2 (noncontact)
Spwn C = Spawning cold (salmon and steelhead)
Spwn W = Spawning warm (striped bass, sturgeon, shad)
Wild = Wildlife habitat

The Central Valley Salinity Policy Group will perform a technical assessment of data and modeling efforts, identify data gaps, and conduct comprehensive technical modeling. The group expects that after evaluating cost and effectiveness and selecting alternatives, it will be able to prepare draft Basin Plan amendments by the year 2013.

The 2006 Bay/Delta Plan references the Salinity Management Plan, noting that it will take 40 to 50 years to develop and fully implement the plan. The Salinity Management Plan is scheduled to be developed between 2010 and 2013. The SWRCB will continue to coordinate updates of the Bay/Delta Plan with ongoing development of the Salinity Management Plan.

The 2006 Bay/Delta Plan notes that, "The San Joaquin River flow objectives are not changed in the 2006 Revised Bay/Delta Plan due to lack of scientific information on which to base any changes."[1] The SWRCB has committed to evaluate this issue after the completion and review of CDFG's SJR salmon population model. In response to peer review, the SJR salmon population model was updated in September 2008 and additional refinements are anticipated in 2009.

Water Quality Objectives and Criteria. The Clean Water Act Section 303 requires EPA to develop and adopt water quality criteria to protect beneficial uses of receiving waters. The Porter-Cologne Water Quality Control Act also contains similar requirements. WQOs are promulgated and included in periodic updates to the Water Quality Control Plans. In California, EPA developed and adopted standards for certain toxic pollutants in the California Toxics Rule as required under Clean Water Act Section 303(c)(2) (B) (40 Code of Federal Regulations Part 131). Numeric water quality criteria contained in the California Toxics Rule have not currently been incorporated into the Basin Plan.

Table 2.2.3-2 shows the lowest applicable water quality criteria for the Sacramento and SJR basins and the Delta.

[1] The Program of Implementation for the Pulse Flow Objectives is amended in the 2006 Revised Bay/Delta Plan to allow for staged implementation of the objectives by conducting the VAMP until 2011. These changes are consistent with the current implementation of the objectives since 2000 pursuant to D-1641.

Table 2.2.3-2. Selected Water Quality Objectives and Criteria for Surface Waters in the Sacramento and San Joaquin River Basins and Delta

Constituent	Likely Receiving Water Objective / Criteria	Notes on Limits	Relevant Source of Limit
Arsenic	0.01 mg/L	—	Sacramento–San Joaquin Delta
Barium	0.1 mg/L	—	Sacramento–San Joaquin Delta
Boron	2.0 mg/L 0.8 mg/L 2.6 mg/L 1.0 mg/L 1.3 mg/L 0.8 mg/L	Maximum, Mar 15 to Sept 15 Monthly, Mar 15 to Sept 15 Maximum, Sept 16 to March 14 Monthly, Sept 16 to Mar 14 Monthly, critical years Monthly average, Sept 16 to Mar 14	SJR, mouth of Merced River to Vernalis and Sacramento–San Joaquin River Delta
Chlorpyrifos	0.025 µg/L	(acute) 1-hour average	SJR from Mendota Dam to Vernalis and Sacramento–San Joaquin River Delta
	0.015 µg/L	(chronic) 4-day average[1]	
Copper	0.01 mg/L	—	Sacramento–San Joaquin Delta
Cyanide	0.01 mg/L	—	Sacramento–San Joaquin Delta
Diazinon	0.16 µg/L	(acute) 1-hour average	SJR from Mendota Dam to Vernalis
	0.1 µg/L	(chronic) 4-day average[1]	
Dissolved oxygen	7.0 mg/L	—	Within legal Delta west of Antioch Bridge.
	6.0 mg/L	Sept 1 to Nov 30	SJR between Turner Cut and Stockton.
	5.0 mg/L	—	All other Delta waters except those constructed for special purposes and from which fish have been excluded or where fishery is not a beneficial use.
	5.0 mg/L	—	Outside legal Delta,[2] designated WARM[3] waters.
	7.0 mg/L	—	Outside legal Delta,[2] designated COLD[4] waters.
	7.0 mg/L	—	Outside legal Delta,[2] designated SPWN[5] waters.
Electrical conductivity	150 µmhos/cm	T 25°C (77°F), 90th percentile	SJR, Friant Dam to Mendota Pool[6]
Iron	0.3 mg/L	—	Sacramento–San Joaquin Delta

Table 2.2.3-2. Selected Water Quality Objectives and Criteria for Surface Waters in the Sacramento and San Joaquin River Basins and Delta

Constituent	Likely Receiving Water Objective / Criteria	Notes on Limits	Relevant Source of Limit
Manganese	0.05 mg/L	—	Sacramento–San Joaquin Delta
Molybdenum	0.015 mg/L 0.010 mg/L	Maximum Monthly average	SJR, mouth of the Merced River to Vernalis
	0.05 mg/L 0.019 mg/L	Maximum Monthly average	Salt Slough, Mud Slough (north), SJR from Sack Dam to the mouth of the Merced River
pH	Minimum 6.5 Maximum 8.5	Appropriate averaging periods may be applied providing beneficial uses are fully protected.	Entire basin, except Goose Lake
Selenium	0.012 mg/L 0.005 mg/L	Maximum 4-day average	SJR, mouth of the Merced River to Vernalis
	0.02 mg/L 0.005 mg/L	Maximum 4-day average	Mud Slough (north), SJR from Sack Dam to the mouth of the Merced River
	0.02 mg/L 0.002 mg/L	Maximum Monthly average	Salt Slough and constructed/reconstructed water supply channels in the Grassland Watershed listed in Basin Plan, Appendix 40
Silver	0.01 mg/L	—	Sacramento–San Joaquin Delta
Zinc	0.1 mg/L	—	Sacramento–San Joaquin Delta

Sources: SWRCB (2006); CVRWQCB (2007a)

Notes:

1 Not to be exceeded more than once in a 3-year period.

2 For surface water bodies outside the legal Delta, the monthly median of the daily average dissolved oxygen concentration should not fall below 85% of saturation in the main water mass, and the 95 percentile concentration should not fall below 75% of saturation.

3 COLD = Cold Freshwater Habitat. Uses of water that support cold-water ecosystems include, but are not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

4 WARM = Warm Freshwater Habitat. Uses of water that support warm-water ecosystems include, but are not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

Notes:

5 SPWN = Spawning, Reproduction, and/or Early Development. Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

6 Also see **Table 1-2**.

Key:

°C = degrees Celsius
°F = degrees Fahrenheit
mg/L = milligram(s) per liter
µg/L = microgram(s) per liter
µmhos/cm = micromhos per centimeter
SJR = San Joaquin River

Total Maximum Daily Load Program. Clean Water Act Section 303(d) requires each State to identify waters that will not achieve WQOs after application of effluent limits. For each water and pollutant, the State is required to propose a priority for development of a load-based (as opposed to concentration-based) limit for nonpoint source discharges, the Total Maximum Daily Load (TMDL). The TMDL determines how much of a given pollutant can be discharged from a particular nonpoint source without violating WQOs. **Table 2.2.3-3** is a complete listing of the constituents for TMDL implementation and their priority on the SJR and the Delta.

High-priority constituents for TMDL implementation in the SJR include boron, chlorpyrifos, diazinon, EC, and selenium. EC (a measure of salt concentrations) in the SJR is a concern for many water users. The CVRWQCB adopted a TMDL for salt and boron for the lower SJR designed to reduce the loading of salt to the SJR (and subsequently reduce the concentrations in the SJR), a TMDL for DO depletion in the Stockton DWSC on the SJR, and a TMDL for selenium in the SJR. The final TMDL for diazinon and chlorpyrifos in the lower SJR was adopted by the CVRWQCB and approved by the SWRCB and EPA.

Port of Stockton Deep Water Ship Channel Dissolved Oxygen TMDL. The SJR experiences regular periods of low DO concentrations in the DWSC from the City of Stockton downstream to Disappointment Slough. These conditions occur most often from June through October, though severe conditions have occurred in the winter months as well. Data also show that the frequency and severity of low DO concentrations are generally worse during drier water years. These conditions often violate the Basin Plan WQO for DO in the DWSC between the City of Stockton and Turner Cut. Constituents of concern for DO include nutrients and organic content.

In 2005, the CVRWQCB passed Resolution No. R5-2005-0005, approving *the Amendment for the Control Program for Factors Contributing to the Dissolved Oxygen Impairment in the Stockton Deep Water Ship Channel* (CVRWQCB 2007a).

Table 2.2.3-3. TMDL Priority List for Potentially Affected Waters

Constituent	Water Body	
	SJR	Delta
Boron	H	—
Chlordane	—	L
Chlorpyrifos	H	—
Copper	—	M
DDT	L	L
Diazinon	H	M
Dieldrin	—	L
Dioxin compounds	—	M
Dissolved oxygen	H	—
Electrical conductivity	H	H
Exotic species	—	H
Furan compounds	—	H
Group A pesticides	L	—
Mercury	L	H
Nickel	—	L
PCBs	—	M
PCBs (dioxin-like)	—	H
Pesticides	—	—
Selenium	H	L
Unknown toxicity	—	M

Key:

— = No total maximum daily load
Delta = Sacramento–San Joaquin River Delta
DDT = dichlorodiphenyltrichloroethane
H = high-priority constituent
L = low-priority constituent
M = medium-priority constituent
PCB = polychlorinated biphenyl
SJR = San Joaquin River
TMDL = total maximum daily load

A TMDL for the control of DO (CVRWQCB 2005) was adopted in 2006; it identifies three main factors that contribute to the low DO problem:

- Loads of oxygen-demanding substances from upstream sources
- Geometry of the DWSC that increases oxygen depletion
- Reduced flow through the DWSC

The TMDL allocates responsibility for excess net oxygen demand as follows:

- 30% as a waste load allocation for the City of Stockton Regional Wastewater Control Facility.
- 60% as a load allocation for nonpoint sources of algae and/or precursors in the SJR watershed.
- 10% as a reserve for unknown sources and impacts, and known or new sources that have no reasonable potential to impact DO concentrations.

The source area for loads of oxygen-demanding substances and their precursors being addressed by this TMDL includes the SJR watershed that drains downstream from Friant Dam and upstream from the confluence of the SJR and Disappointment Slough. The following exceptions to the general source area are as follows:

- The western slope of the Sierra Nevada foothills
- Above the major reservoirs of New Melones Reservoir on the Stanislaus River
- New Don Pedro Reservoir on the Tuolumne River
- Lake McClure on the Merced River
- New Hogan Reservoir on the Calaveras River
- Comanche Reservoir on the Mokelumne River
- Those portions of the SJR watershed that fall within Mariposa, Tuolumne, Calaveras, and Amador counties.

The TMDL required that entities responsible for point and nonpoint sources of oxygen-demanding substances and their precursors within the TMDL source area perform studies by December 2008 to identify and quantify the following:

- Sources of oxygen-demanding substances and their precursors in the DO TMDL source area.
- Growth or degradation mechanisms of these oxygen-demanding substances in transit through the source area to the DWSC.

- The impact of these oxygen-demanding substances on DO concentrations in the DWSC under a range of environmental conditions and considering the effects of chemical, biological, and physical mechanisms that add or remove DO from the water column in the DWSC.

This study was completed in 2008 through a grant obtained from CALFED by the San Joaquin Valley Drainage Authority.

Salinity Management Policy. Delta WQOs for the operation of CVP and SWP facilities were established by the SWRCB in the Bay/Delta Plan (2006) and D-1641. WQOs in the Bay/Delta Plan include objectives established to protect M&I, agricultural, and fish and wildlife beneficial uses. The Bay/Delta Plan specifies the south Delta salinity objective as a maximum 30-day running average of average daily EC in SJR at Airport Way Bridge, Vernalis, for the protection of agricultural beneficial uses. Additional salinity objectives are established for fish and wildlife beneficial uses in the SJR within the Delta.

The amendment to the Basin Plan for salinity and boron in the lower SJR was adopted by the CVRWQCB in 2004, and was approved by the SWRCB in 2006. The technical TMDL report was included as an appendix to the Basin Plan amendment. Under the implementation program, allowable discharges are to be based on the assimilative capacity (or flow rate). In addition to managing discharges of salinity and boron, the TMDL allows dischargers to increase the assimilative capacity by providing clean freshwater flows. Modeling conducted as part of previous investigations by Reclamation indicated that under some recirculation alternatives, such as the VAMP flow compliance, salinity might increase in some locations (such as Vernalis) and decrease in other locations (such as below Newman Wasteway) as a result of the substitution of Merced River releases for DMC releases (Reclamation 2003).

In January 2007, the SWRCB initiated a series of workshops to consider the south Delta salinity objectives for agriculture that are contained in the Bay/Delta Plan (2006). As a result of these workshops, the SWRCB will, if justification is adequate, develop and manage a thorough study or studies of the sources, concentrations, loads, and effects of salinity and methods for its control in the south Delta. The SWRCB presented a proposal that outlined a process for gathering additional data and reviewing the salinity objectives over the next several years. Any changes to the WQOs in the south Delta will affect the need for, or implementation of, the DMC Recirculation Project.

Waste Discharge Permitting Program Point source discharges to surface waters are generally controlled through Waste Discharge Requirements (WDRs) issued under Federal NPDES permits. Although the NPDES program was established by the Federal Clean Water Act, the permits are prepared and enforced by the various RWQCBs, per California's delegated authority for the act.

Issued in 5-year terms, an NPDES permit usually contains components such as discharge prohibitions, effluent limitations, and provisions and specifications necessary to ensure proper treatment, storage, and disposal of the waste. The permit often specifies a monitoring program that establishes monitoring stations at effluent outfall and receiving waters.

Under California's Porter-Cologne Water Quality Control Act, any person discharging or proposing to discharge waste within the region (except discharges into a community sewer system) that could affect the quality of the waters of the State is required to file a Report of Waste Discharge. The RWQCB reviews the nature of the proposed discharge and adopts WDRs to protect the beneficial uses of waters of the State. WDRs could be adopted for an individual discharge or for a specific type of discharge in the form of a general permit. The RWQCB may waive the requirements for filing a Report of Waste Discharge or issuing WDRs for a specific discharge where such a waiver is not against the public interest. NPDES requirements may not be waived.

Acceptable control measures for point source discharges must ensure compliance with NPDES permit conditions, including the discharge prohibitions and the effluent limitations provided by the Basin Plan. In addition, control measures must satisfy WQOs set forth in the Basin Plan, unless the RWQCB judges that related economic, environmental, or social considerations merit a modification after a public hearing process has been conducted. Control measures employed must be sufficiently flexible to accommodate future changes in technology, population growth, land development, and legal requirements.

Agricultural Discharge Control Programs. Discharges from nonpoint sources in California such as irrigated agriculture are becoming subject to increasing regulatory oversight. In July 2003, the CVRWQCB adopted a Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Resolution No. 2003-0105 passed by the CVRWQCB). This waiver requires discharges (including growers and IDs) to develop water quality monitoring programs to achieve the following objectives:

- Assess the impacts of waste discharges from agricultural and irrigation facilities to surface water
- Determine the degree of implementation of management practices to reduce discharges of specific wastes that impact water quality

- Determine the effectiveness of management practices and strategies to reduce discharges of wastes that impact water quality
- Determine concentration and load of waste discharges to surface waters
- Evaluate compliance with existing narrative and numeric WQOs to determine if additional implementation of management practices is necessary to improve and/or protect water quality

These programs are being implemented through coalitions of growers for specific geographic areas and by individual discharger groups (primarily IDs).

New Melones Interim Plan of Operations. The operating criteria for New Melones Reservoir are governed by the New Melones authorization statutes (Flood Control Acts of December 1944 [Public Law 78-534, December 22, 1944] and October 1962 [Public Law 87-874, October 23, 1962]), Stanislaus River water rights, instream fish and wildlife flow requirements, temperature and DO requirements, Vernalis water quality and flow requirements from SWRCB's D-1641, CVP contracts, and flood control requirements. The Stanislaus River section in **Section 2.2.2** provides specific details of these flow requirements.

D-1422. Additional releases are made to the Stanislaus River below Goodwin Dam, if necessary, to meet the D-1422 DO content objective. D-1422 requires that water be released from New Melones to maintain the DO concentration in the Stanislaus River at a value of at least 7 mg/L as measured near Ripon. Releases from Goodwin Dam to the Stanislaus River do not exceed 1,500 cfs (except for flood control).

D-1641. D-1641 requires salinity near Vernalis to be less than 700 µmhos/cm for April–August and less than 1,000 µmhos/cm for September–March based on a 30-day running average. Releases are made from New Melones, as required, up to the allocation provided by the New Melones IPO, to meet this criterion.

D-1641 also requires the flow at Vernalis to be maintained from February through June. The flow requirement is based on the required location of X2 and the San Joaquin Basin Index according to **Table 2.2.3-4**. VAMP's objectives become the flow objective during the period April 15 through May 16. Releases are made from New Melones, as required, but are limited by the Bay-Delta allocation determined by the New Melones IPO.

The 1997 New Melones IPO allocates water to serve four purposes: fishery, water quality, Bay-Delta flow, and water supply (**Table 2.2.3-5**).

Table 2.2.3-4. Minimum Average Monthly Water Quality Objectives for Flow for San Joaquin River at Airport Way Bridge, Vernalis (Interagency Station C-10)

Water Year Type[1,2]	Period	Flow (cfs) [3]
Wet, Above Normal	February 1 to April 14 and May 16 to June 30	2,130 or 3,420
Dry, Below Normal		1,420 or 2,280
Critical		710 or 1,140
Wet	April 15 to May 15	7,330 or 8,620
Above Normal		5,730 or 7,020
Below Normal		4,620 or 5,480
Dry		4,020 or 4,880
Critical		3,110 or 3,540
All	October	1,000[4]

Source: SWRCB 2006

Notes:

1 Based on San Joaquin Basin Index.

2 Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

3 Higher flow objective applies when the 2 ppt isohaline, measured as 2.64 mmhos/cm surface salinity (X2), is required to be at or west of Chipps Island.

4 Includes up to an additional 28,000 AF pulse/attraction flow during all water year types. The amount of water is limited to the amount necessary to provide a monthly average flow of 2,000 cfs. The additional 28,000 AF is not required in a critical year following a critical year.

Key:

AF = acre-foot (feet)
cfs = cubic foot (feet) per second
mmhos/cm = millimhos per centimeter
ppt = parts per thousand
SJR = San Joaquin River

Table 2.2.3-5. New Melones Interim Plan of Operation Allocations

New Melones Storage Plus Inflow (in TAF)		Fishery (in TAF)		Vernalis Water Quality (in TAF)		Bay-Delta (in TAF)		CVP Contractors (in TAF)	
From	To	From	To	From	To	From	To	From	To
0	1,400	0	98	0	70	0	0	0	0
1,400	2,000	98	125	70	80	0	0	0	0
2,000	2,500	125	345	80	175	0	0	0	59
2,500	3,000	345	467	175	250	75	75	90	90
3,000	6,000	467	467	250	250	75	75	90	90

Key:
TAF = thousand acre-feet

Required releases to the Stanislaus River below Goodwin Dam (a re-regulation dam, just downstream of New Melones) include the following in order of priority:

(1) Releases up to the total amount of the fishery account are debited from the annual fishery allocation.

(2) Releases up to the amount of the Vernalis water quality requirement, excluding the amount of fishery releases, are debited from the annual Vernalis water quality allocation.

(3) Releases up to the amount of the D-1641 Bay-Delta flow requirement, excluding the amount of fishery release, and Vernalis water quality are debited from the annual Bay-Delta flow allocation.

(4) Releases are made to the Stanislaus River below Goodwin Dam, if necessary, to meet SWRCB's D-1422 DO content objective. D-1422 requires that water be released from New Melones to maintain the DO concentration in the Stanislaus River at a value of at least 7 mg/L as measured near Ripon

Depending on the fishery allocation under the New Melones IPO, the fishery release volume at Goodwin Dam is managed by fisheries resource agencies based on the needs for a given period. For the purposes of modeling, CALSIM II assumes the following distribution of flows under the base and pulse flow schedules shown in **Table 2.2.3-6.**

Table 2.2.3-6. Stanislaus River Minimum and Pulse Flow Schedules

Flow	Period	Annual Fishery Allocation (in TAF)						
		0	98.4	243.3	253.8	310.3	410.2	466.8
		Average Monthly Flow (in cfs)						
Minimum	January	0	125	250	275	300	350	400
	February	0	125	250	275	300	350	400
	March	0	125	250	275	300	350	400
	April[1]	0	250	300	300	900	1,500	1,500
	May[1]	0	250	300	300	900	1,500	1,500
	June	0	0	200	200	250	800	1,500
	July	0	0	200	200	250	300	300
	August	0	0	200	200	250	300	300
	September	0	0	200	200	250	300	300
	October	0	110	200	250	250	350	350
	November	0	200	250	275	300	350	400
	December	0	200	250	275	300	350	400
Pulse	April 15 to May 16[1]	0	500	1,500	1,500	1,500	1,500	1,500

Note:
[1] Partial months are averaged for that period. For example, the flow rate for April 1 to 14 would be averaged over 14 days.
Key:
cfs = cubic foot (feet) per second
TAF = thousand acre-feet

Releases from Goodwin Dam to the Stanislaus River do not exceed 1,500 cfs (except for flood control).

Vernalis Adaptive Management Plan. The Basin Plan (CVRWQCB 2007a) included salinity standards and required spring pulse flows intended primarily to assist out migrating salmon from all of the tributaries. The affected parties, including State and Federal project operators, fishery agencies, water agency stakeholders, and environmental stakeholders, ultimately negotiated the SJRA, which implemented the VAMP, a 12-year study program involving defined pulseflow levels, export pumping limits, installation of the Head of Old River Barrier (HORB), and water purchases from the water rights holders on the tributaries.

DMC recirculation could be used to replace or supplement releases from eastside tributaries to achieve the pulse flow requirements. In addition, the proportion of eastside versus DMC water in the SJR may affect the straying potential of salmon returning to the river.

The VAMP, officially initiated in 2000 as part of D-1641, is a water supply program designed to protect juvenile Chinook salmon migrating from the SJR through the Delta. VAMP is also a scientific experiment to determine how salmon survival rates change in response to alterations in SJR flows and CVP/SWP exports with the installation of the HORB. VAMP provides for a 31-day pulse flow (target flow) in the SJR at the Vernalis gage, along with a corresponding reduction in CVP/SWP exports. Specific details regarding VAMP water sources and flows are provided in the SJRA section of **Chapter 2**.

Safe Drinking Water Act. This act (Public Law 99-339) became law in 1974 and was reauthorized in 1986 and again in August 1996. Through this act, the United States Congress gave the EPA the authority to set standards for contaminants in drinking water supplies. Amendments to this act provide more flexibility, more State responsibility, and additional preventative measures. The law changes the standard-setting procedure for drinking water and establishes a State Revolving Loan Fund to help public water systems improve their facilities, to ensure compliance with drinking water regulations, and to support State drinking water program activities.

Under provisions of this act, the California Department of Health and Safety has the primary enforcement responsibility. The California Health and Safety Code establishes this authority and stipulates drinking water quality and monitoring standards. To maintain primacy, a State's drinking water regulations cannot be less stringent than the Federal standards.

Surface Water Quality

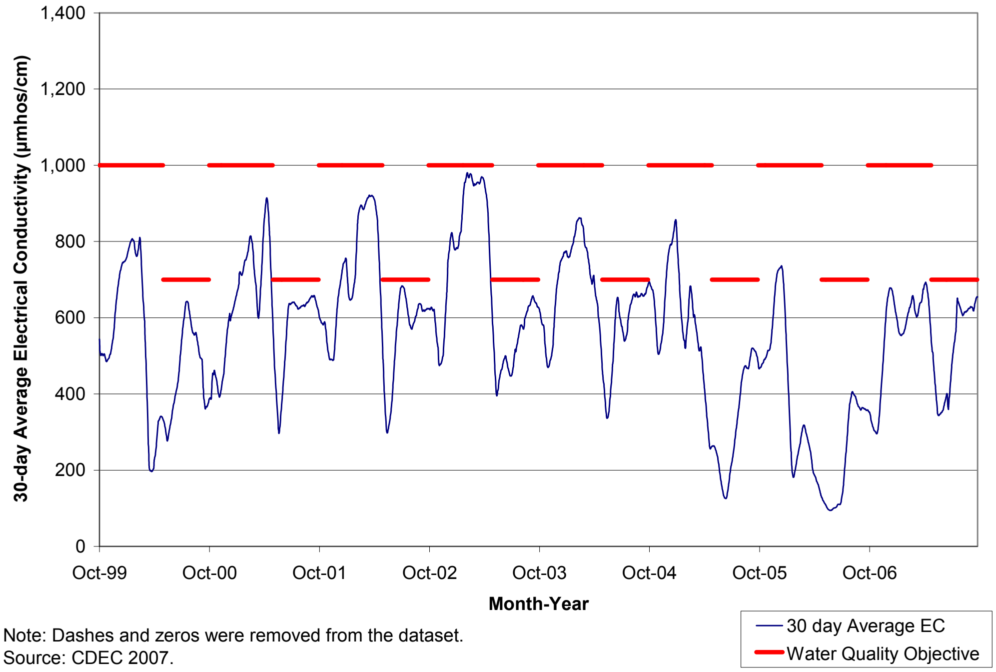
This section describes the existing water quality for different hydrological conditions for surface water resources in the Study area. The Study area for the PFR is defined as the SJR's lower main stem just above its confluence with the Merced River, the areas served by the Merced, Tuolumne, and Stanislaus rivers on the western side of the Sierra Nevada Mountains, and the areas served by the DMC, which include about 30 water agencies. The Study area also includes the south Delta, which serves as a source of water supply for agricultural and urban uses within the Delta area.

The facilities and features that may be used directly for recirculation are Jones Pumping Plant, DMC, Westley or Newman Wasteway, and the SJR just above its confluence with the Merced River. Recirculation may also impact the operations of other CVP or joint-use facilities, either directly or indirectly, including the SLR, which is a joint CVP/SWP facility, and New Melones

Reservoir on the Stanislaus River, which is a CVP facility (see **Figure 1-1**). SWP facilities that may be used for recirculation include the Banks Pumping Plant and the California Aqueduct.

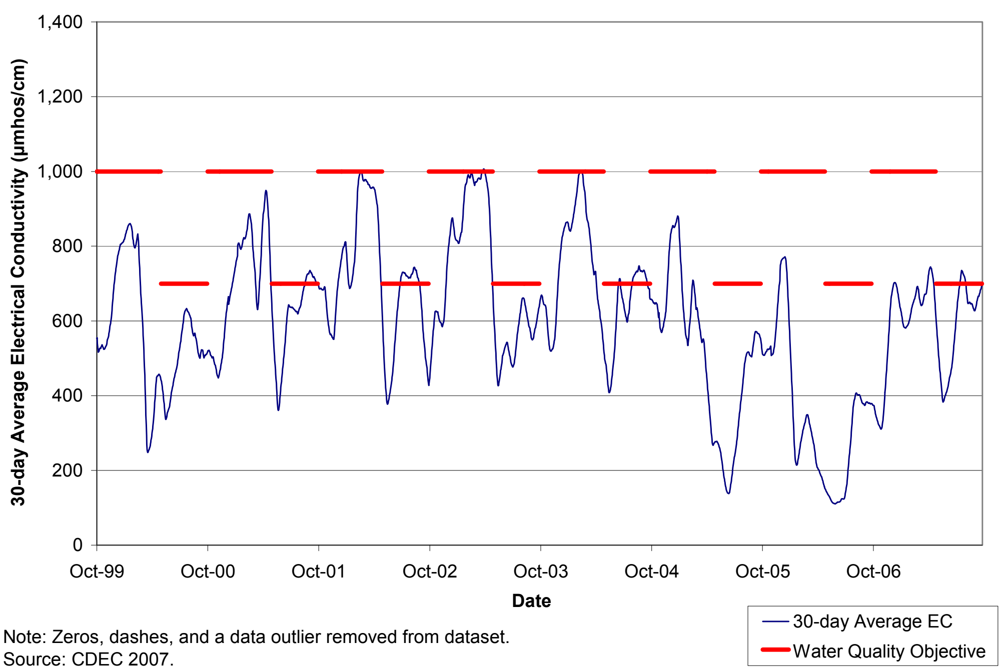
Lower San Joaquin River and the South Delta. Over 130 miles of the SJR's main stem downstream of Friant Dam, together with all other inputs in the watershed, contribute to water quality at Vernalis. Water quality at Vernalis is of concern because Vernalis is the current compliance point for EC objectives. The lower SJR has been listed as an impaired water body by the SWRCB and EPA because of its high concentrations of pesticides (chlorpyrifos and diazinon), salts, boron, and selenium, as well as toxicity, and low concentrations of DO in the Stockton DWSC (EPA 2006). As of April 1, 2005, D-1641 requires DWR and Reclamation either to meet an EC objective of 700 µmhos/cm from April through August or to have completed construction of permanent operable barriers (or equivalent measures) in the south Delta and an operations plan to protect south Delta agriculture. Implementation of the SDIP has been delayed, and a salinity objective of 700 µmhos/cm for agricultural water use in the interior south Delta locations is not always achieved.

The Basin Plan has established WQOs for four sites in the south Delta: SJR at Vernalis, SJR at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge. At each of these sites, the 30-day running average of daily average EC is not to exceed 700 µmhos/cm from April through August, and 1,000 µmhos/cm from September through March (CVRWQCB 2007a). **Figures 2.2.3-1 through 2.2.3-4** are derived from EC concentrations collected by Reclamation and DWR and reported through CDEC (2007) and the Water Data Library (DWR 2008) for locations at or near these four sites. The EC data presented on these figures are evaluated as 30-day running average concentrations. (The CDEC station for Union Island is at the head of Middle River. This station is assumed to have water quality equivalent to the D-1641 compliance site for the Old River near Middle River.)



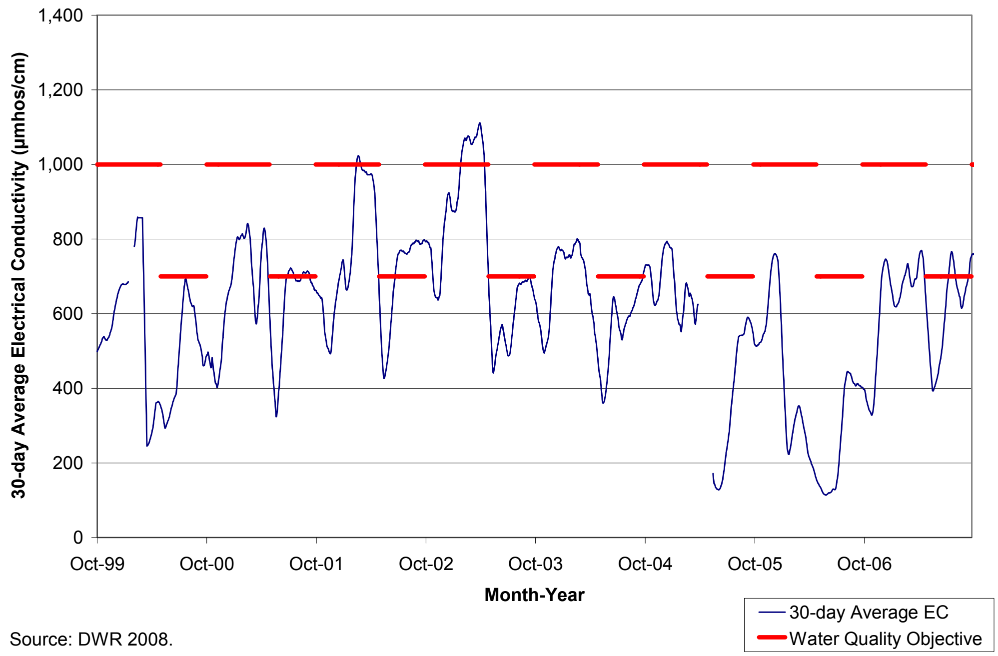
Note: Dashes and zeros were removed from the dataset.
Source: CDEC 2007.

Figure 2.2.3-1. Electrical Conductivity in the San Joaquin River at Airport Way Bridge, Vernalis (CDEC Station VER)



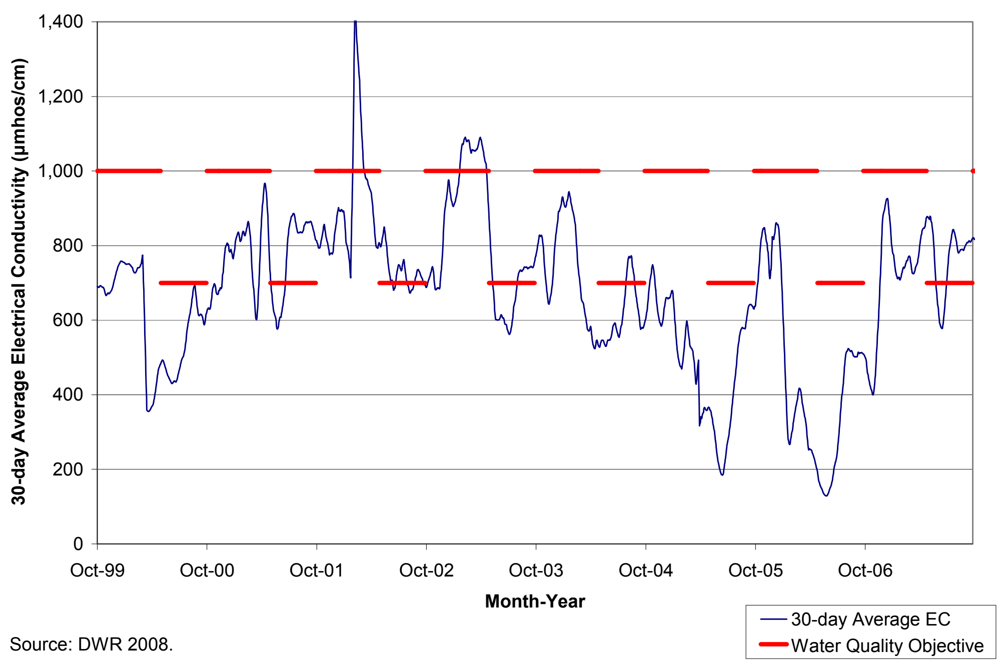
Note: Zeros, dashes, and a data outlier removed from dataset.
Source: CDEC 2007.

Figure 2.2.3-2. Electrical Conductivity at Union Island (CDEC Station UNI)



Source: DWR 2008.

Figure 2.2.3-3. Electrical Conductivity in the San Joaquin River at Brandt Bridge (CDEC Station BDT)



Source: DWR 2008.

Figure 2.2.3-4. Electrical Conductivity in Old River at Tracy Road Bridge (CDEC Station OLD)

Franks Tract is a 3,300-acre flooded island in the central Delta, north of the community of Bethel Island. Given its location in the central Delta and its relatively deep bathymetry, Franks Tract plays a key role in determining the quality of south Delta water that is available for in-Delta use and for export by the CVP and SWP. In addition to its role in influencing water quality in the south Delta, however, Franks Tract is thought to contribute to the colonization and spread of invasive species, such as the aquatic plant *Egeria densa* and clam *Corbicula fulminea*.

The DWSC of the SJR regularly experiences low DO concentration below the WQO from the City of Stockton downstream to Disappointment Slough (CVRWQCB 2007a). This portion of the SJR has been dredged to a depth of 35 feet to allow for navigation of cargo vessels between the San Francisco Bay and the Port of Stockton. DWR monitoring data for 1983 through 2001 show that the DO concentration in the DWSC most frequently violates the 5.0 mg/L WQO from June through October, although concentrations less than the WQO have occurred during all months. WQO violations tend to be more frequent in dry years and less frequent in wet years. Furthermore, a diurnal variation of about 1 mg/L occurs between peak DO concentrations during daylight hours and low DO concentrations during nighttime hours from June through September. Low DO concentrations in the DWSC occur most often from June through October, though severe conditions have occurred in the winter months, as well. Data also show that the frequency and severity of low DO concentrations are generally worse during drier water years.

These conditions often violate the Basin Plan WQO for DO in the DWSC between the city of Stockton and Turner Cut. Constituents of concern for DO include nutrients and organic content.

East San Joaquin River Tributaries. The Merced, Tuolumne, and Stanislaus rivers are the three largest tributaries to the SJR and compose the Eastside basin (CVRWQCB 2007a). Headwaters of the rivers originate in the Sierra-Nevada with downstream flows in each river regulated by major reservoirs. Below the reservoirs, the rivers receive varying discharges and withdrawals from municipalities and agriculture before flowing into the SJR and eventually to the Delta.

In recent years, the Eastside basin has experienced levels of organic carbon, total phosphorus, DO, and pH above or outside environmentally favorable conditions (CVRWQCB 2007a; SJRGA 2007). A specific DO WQO of 8.0 mg/L applies to upstream portions of both the Merced River (all year) and the Tuolumne River (October 15 through June 15) (CVRWQCB 2007a).

The southernmost tributary in the Eastside basin is the Merced River, followed by the Tuolumne River farther north, and then the Stanislaus River. The most recent RWQCB Surface Water Ambient Monitoring Program (SWAMP) data for each of the eastside tributaries at the confluences with the SJR are provided in **Appendix F, Attachment F1**.

As described in **Section 1.8.6**, the revised *Biological Opinion on Long-Term Central Valley Project and State Water Project for the Operations Criteria and Plan* was recently completed (NMFS 2009, unpublished). The previous CVP/SWP operations Biological Opinion (BO; NMFS 2004) includes the following terms and conditions relating to temperature on the Stanislaus River at Orange Blossom Bridge:

> 11. Reclamation shall manage the cold water supply within New Melones Reservoir and make cold water releases from New Melones Reservoir to optimize suitable rearing habitat for Central Valley steelhead in the Stanislaus River downstream of Goodwin Dam.
>
>   a. Reclamation shall manage cold water releases from New Melones Reservoir to maintain daily average water temperature in the Stanislaus River between Goodwin Dam and the Orange Blossom Road bridge at no more than 65°F during the period of June 1 through November 30 to protect rearing juvenile Central Valley steelhead.
>
>   b. Reclamation shall coordinate water temperature releases with CDFG and FWS to use fishery release water, to the extent possible, consistent with NM [New Melones] IPO, D-1641, and CVPIA.
>
>   c. If it becomes necessary to deviate from condition 7.a. above [11.a.], Reclamation shall consult with CDFG, FWS, and NOAA Fisheries to develop a plan using all means possible to maximize suitable rearing habitat for Central Valley steelhead juveniles within the Stanislaus River below Goodwin Dam prior to June 1 each year.

Available temperature data for Orange Blossom Bridge from 2001 through 2007 were downloaded from the CDEC to describe the temperature regime under existing conditions **(Table 2.2.3-7)**.

Table 2.2.3-7. Average Monthly Temperature at Stanislaus River at Orange Blossom Bridge

Water Year	Water Year Type[1]	Average Monthly Temperature (in °F)[2]											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2001	Dry	—	54	51	49	50	54	54	57	59	61	61	60
2002	Dry	58	55	52	50	51	52	54	55	59	61	62	61
2003	Below Normal	57	54	52	51	51	54	54	56	57	61	62	61
2004	Dry	58	53	52	50	51	56	56	57	59	61	62	62
2005	Wet	—	—	—	—	—	—	—	54	57	—	—	58
2006	Wet	56	53	51	50	50	50	51	52	55	57	57	56
2007	Critical	54	53	51	48	50	53	54	55	58	61	62	61

Source: CDEC Stanislaus River at Orange Blossom Bridge (OBB)

Notes:

[1] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

[2] Data not available during October 1999 through October 2000, October 2004 through April 2005, and July and August 2005.

Key:

— = data not available

°F = degrees Fahrenheit

In addition to the major tributaries in the Eastside basin, an area of about 305,000-acres drains directly to the lower SJR via a series of irrigation and drainage canals on the eastside San Joaquin Valley (CVRWQCB 2007a). These canals contain water from a variety of sources including agricultural surface returns, urban runoff, treated municipal wastewater, groundwater, and natural stream flows. The area draining directly to the SJR has three major sections. One large section lies between the Merced and Tuolumne watersheds, one smaller area in the north is between the Stanislaus and Tuolumne watersheds, and one to the south lies between the Merced River watershed and the Southeast basin. These laterals and drainage canals contribute approximately 4% of the flow in the lower SJR.

West San Joaquin River Tributaries. Tributaries that flow into the SJR from the west include Orestimba Creek and those in the Grassland Watershed, which include Salt Slough, Mud Slough (north), and San Luis Drain. The tributaries in the SJR Westside basin encompass a total area of approximately 386,000 acres and contribute 6% of the total SJR flow (CVRWQCB 2007a). Land use in the Westside basin is predominantly agriculture (e.g., confined animal facilities, row crops, orchards), though several small municipalities are also located here. Creeks in this area are naturally ephemeral, but valley floor sections are kept running for most of the year with irrigation supply and return water. Water in the Westside basin is of relatively poor quality and is high in salts. The water in this area comes from several different sources including the DMC, pumped groundwater, and diversions from the SJR.

Salt and Mud Sloughs. Salt and Mud sloughs are the primary westside drainage outlets to the SJR for the Grassland Watershed. Basin Plan WQOs applicable to these Grassland tributaries for selenium and molybdenum are shown in **Table 2.2.3-8** (CVRWQCB 2007a). In recent years, the San Luis Drain, Mud Slough, and the segment of the SJR between the Mud Slough and Merced River confluences have exhibited concentrations of selenium and boron that exceed the WQOs (Reclamation and Authority 2001; CVRWQCB 2007a). Selenium is particularly high in Mud Slough and is listed under Clean Water Act Section 303(d) as a high-priority constituent for Mud Slough. In addition, boron, EC, pesticides, and unknown toxicity are all listed as low-priority constituents in Mud Slough.

Like Mud Slough, Salt Slough is listed as being impaired by boron, EC, and unknown toxicity as well as chlorpyrifos and diazinon. Since January 1997, the Basin Plan prohibits the discharge of agricultural subsurface drainage to Salt Slough unless WQOs are met, and prohibits discharges in excess of 8,000 pounds of selenium per year. San Luis Drain has exhibited notably high salinity

Table 2.2.3-8. Water Quality Objectives for Salt Slough and Mud Slough

Water Body	Selenium	Molybdenum
Salt Slough and Wetland Water Supply Channels	2 µg/L monthly average, January 10, 1997	0.050 mg/L, maximum 0.019 mg/L, monthly average
Mud Slough (North) and the San Joaquin River from Sack Dam to the Merced River	5 µg/L, 4-day average, October 1, 2010	0.050 mg/L, maximum 0.019 mg/L, monthly average

Source: CVRWQCB (2007a)

Key:

µg/L = microgram(s) per liter
mg/L = milligram(s) per liter
ppb = part(s) per billion
ppm = part(s) per million

concentrations as well, though it is not specifically listed as being an impaired water body.

Various water quality parameters have been analyzed within the westside tributaries to the SJR under SWRCB's SWAMP. The most recent SWAMP data in Salt Slough, Mud Slough upstream of San Luis Drain, Mud Slough downstream of San Luis Drain, and Orestimba Creek are provided in **Appendix F, Attachment F1**. SWAMP data for San Luis Drain are shown in **Table 2.2.3-9**. Boron and selenium concentrations are highest in the San Luis Drain, ranging from 2.8 to 11 mg/L for boron and from 17.8 to 109 µg/L for selenium.

Delta-Mendota Canal. The DMC is on the western side of California's San Joaquin Valley. It runs for approximately 120 miles, beginning near Tracy at the southern edge of the Delta and terminating at the Mendota Pool on the SJR, at Mendota. The DMC is part of the Federal CVP Delta export facilities, which also include Jones Pumping Plant (formerly known as the Tracy Pumping Plant); Westley, Newman, Volta, and Firebaugh wasteways; O'Neill Pumping Plant; O'Neill Forebay; and the SLR joint-use facility.

The areas served by the DMC include primarily agricultural lands on the western side of the San Joaquin Valley, from Tracy in the north to Kettleman City in the south, and primarily urban uses in the San Felipe Unit of the CVP, in San Benito and Santa Clara counties, west of the Coast Range.

Jones Pumping Plant. Jones Pumping Plant lifts water from the Delta to the DMC. The CVP monitors EC at the DMC headworks. As shown on **Figure 2.2.3-5**, daily average EC measured from 2000 through 2006 ranged from 82 to 906 µmhos/cm with an average of 426 µmhos/cm. Note that WQOs for the SJR at Vernalis are shown on the figure for comparison and do not represent compliance evaluations.

Table 2.2.3-9. Existing Water Quality in San Luis Drain (Station MER535)

Parameter	Time Range (Water Years)	Unit	No. Samples	Min	Max	Average
Field EC	2000–2007	μmhos/cm	372	1940	5960	4445
pH	2000–2007	pH units	366	5.5	8.9	8.1
DO	2001–2007	mg/L	270	3.2	20.3	12.7
Boron	2000–2007	mg/L	359	2.8	11	7.2
Selenium	2000–2007	μg/L	366	17.8	109	51.8
TSS	2000–2007	mg/L	337	14	230	47
Turbidity	2002–2004	NTU	56	12.7	70.6	8.3
TOC	2002–2003, 2005–2007	mg/L	44	0.5	16	8.1
Total coliform	2002–2007	MPN/100 mL	42	272	>2400	2078
E. coli	2002–2007	MPN/100 mL	42	0.5	770	42
Chloride	2000–2003	mg/L	24	430	690	517
Sulfate	2000–2003	mg/L	26	1200	1900	1473
Hardness	2000–2003	mg/L	28	870	1400	1100
Calcium	2000–2003	mg/L	26	220	350	287
Magnesium	2000–2003	mg/L	26	78	120	93
TDS	2000–2002	mg/L	122	2200	4400	3338
Carbonate	2000–2002	mg/L	17	0.5	20	2.8
Bicarbonate	2000–2002	mg/L	16	51	260	177
Total Alkalinity	2000–2002	mg/L	15	96	210	158
Sodium	2000–2002	mg/L	17	560	860	671
Nitrate	2000–2004	mg/L	22	11	110	64
Nitrate-N	2004–2007	mg/L	43	5.3	33	15
TKN	2000–2007	mg/L	64	0.1	3.3	1.3
Ammonia-N	2000–2001, 2004–2004	mg/L	28	0.1	1.7	0.3
Phosphorus	2000–2007	mg/L	55	0.005	1.1	0.12
Orthophosphate-P	2000–2007	mg/L	55	0.005	0.5	0.2
Potassium	2000–2004	mg/L	26	5.4	13	9.1
BOD 5-Day	2001–2003	mg/L	22	0.9	5.8	3.2
BOD 10-Day	2001–2003	mg/L	22	1.6	10.9	5.6
Total Arsenic	2001–2003	μg/L	22	1	7.9	2.5

Table 2.2.3-9. Existing Water Quality in San Luis Drain (Station MER535)

Parameter	Time Range (Water Years)	Unit	No. Samples	Min	Max	Average
Dissolved Arsenic	2001–2003	µg/L	17	1	7.7	2.3
Total Cadmium	2001–2003	µg/L	21	0.05	0.5	0.2
Total Chromium	2000–2003	µg/L	48	0.5	14	5.3
Dissolved Chromium	2000–2003	µg/L	24	0.5	9.7	3.4
Total Copper	2000–2003	µg/L	47	0.5	4.6	2.5
Dissolved Copper	2001–2003	µg/L	23	0.5	2.1	0.9
Total Nickel	2000–2003	µg/L	48	2.5	6.9	3.6
Dissolved Nickel	2000–2003	µg/L	24	2.5	5	2.6
Total Zinc	2000–2003	µg/L	47	1	4.7	1.4

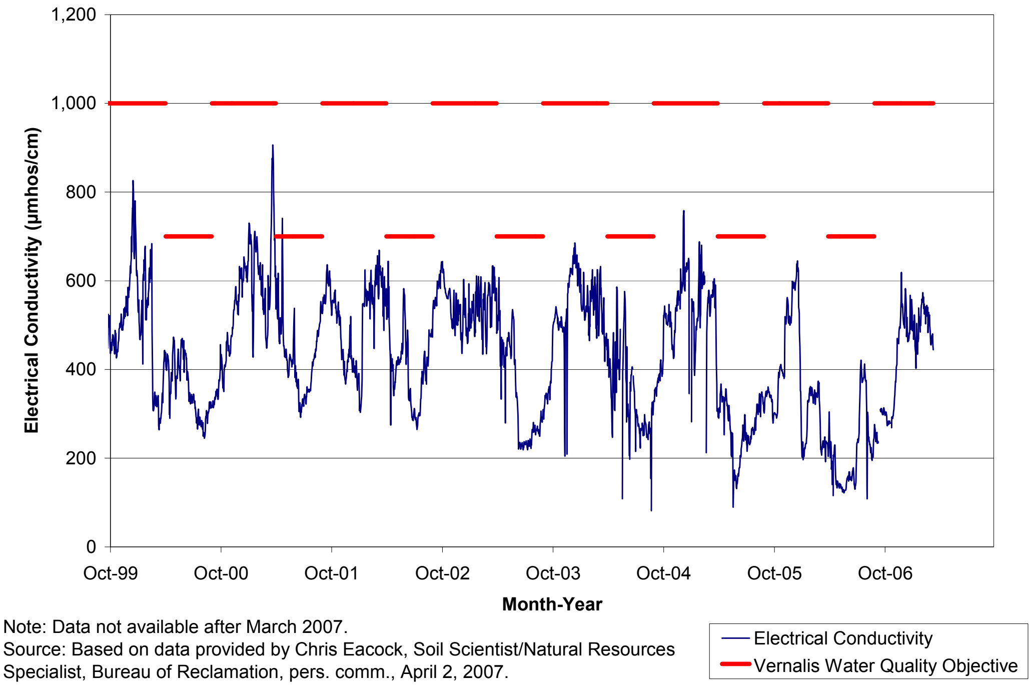
Source: CVRWQCB (2007b)

Note:

Analytes with at least one sample detected during Water Years 2000–2007 are shown above. For the purpose of data evaluation, nondetect data were assumed to equal half the reporting limit. Total coliform samples greater than the upper limit of quantitation, 2419.6 MPN/100 mL, are represented as >2420 MPN/100 mL.

Key:

µmhos/cm = micromhos per centimeter
µg/L = microgram(s) per liter
mg/L = milligram(s) per liter
BOD = biological oxygen demand
DO = dissolved oxygen
EC = electrical conductivity
MPN = most probable number
NTU = Nephelometric turbidity unit
TKN = total Kjeldhal nitrogen
TDS = total dissolved solids
TOC = total organic carbon
TSS = total suspended solids



Note: Data not available after March 2007.
Source: Based on data provided by Chris Eacock, Soil Scientist/Natural Resources Specialist, Bureau of Reclamation, pers. comm., April 2, 2007.

Figure 2.2.3-5. Electrical Conductivity at Jones Pumping Plant (DMC Headworks)

Conveyance Pathways. The four DMC wasteways (Westley, Newman, Volta, and Firebaugh) were created for maintenance and emergency water releases from the DMC. Because elevated concentrations of selenium and salt, constituents of concern in the SJR, also occur in shallow groundwater in the Firebaugh and Volta wasteway areas, the DMC Recirculation Project considers only Westley and Newman wasteways as possible recirculation conduits.

Westley Wasteway. Westley Wasteway is 3.8 miles long and is lined for approximately 3.1 miles of this length. Below the wasteway, an unlined bypass channel diverts drainage water to private wetlands. Wasteway drainage meanders through a small overgrown waterway and an agricultural field, eventually spilling into the SJR. Water flowing through the wasteway is primarily from agricultural tailwater that is pumped into the canal from surrounding fields but also comes from DMC maintenance releases.

The DWR and the Westside San Joaquin River Watershed Coalition have both collected water quality data within Westley Wasteway. DWR has monitored the wasteway for water quality parameters including temperature and EC and posts the data on the CDEC website (http://cdec.water.ca.gov/). Since 2004, the Coalition has collected data within the wasteway as part of its monitoring plan implemented under the CVRWQCB irrigated lands program. Measured water quality parameters includes field measurements such as pH, DO, and staff gage; general chemistry including nutrients, metals, enteric bacteria, and turbidity; pesticides including herbicides, organophosphates and carbamates, and toxicological tests on both aquatic and sediment organisms. Summaries of the water quality data collected from both agencies are provided in **Appendix F, Attachment F1**.

Newman Wasteway. Newman Wasteway flows from west to east with its headgate on the DMC, just upstream of Check 10 at Milepost 54.38. It is 8.2 miles long with the upper 1.5 miles concrete lined and the remainder unlined. Water flowing through it is primarily from agricultural tailwater that is pumped into the wasteway from surrounding fields but also comes from DMC seepage maintenance releases. Water quality data within Newman Wasteway collected by the U.S. Geological Survey in 2000–2001 and by the Westside SJR Coalition from 2004–2006 and are provided in **Appendix F, Attachment F1**. Water quality data collected during pilot recirculation studies can be found in the pilot study reports (Reclamation 2005c, 2008b, 2009b [The 2008 Pilot Study is provided as **Appendix M**.]) and are summarized by parameter in **Appendix F**.

Groundwater Resources

The focus of this section is on groundwater resources in the SJRHR (i.e., the SJR basin), because this portion of the Study area is the one most likely to be affected by the alternative plans.

Hydrologic Region Summary. The SJRHR covers approximately 9.7 million acres and includes the southern part of the Delta, the northern half of the San Joaquin Valley, the Sierra Nevada, and the Diablo Range. The region has approximately 1.6 million people (DWR 2003) and includes all of Calaveras, Tuolumne, Mariposa, Madera, San Joaquin, and Stanislaus counties, most of Merced and Amador counties, and parts of Alpine, Fresno, Alameda, Contra Costa, Sacramento, El Dorado, and San Benito counties.

The SJRHR contains the Yosemite Valley and Los Banos Creek Valley groundwater basins, and the northern portion of the San Joaquin Valley groundwater basin. This basin is broken into nine groundwater subbasins: the Eastern San Joaquin, Modesto, Turlock, Merced, Chowchilla, Madera, Delta-Mendota, Tracy, and Cosumnes. Groundwater accounts for approximately 30% of the annual supply used for agricultural and urban uses within the SJRHR. The primary source of groundwater within the SJRHR is the San Joaquin Valley groundwater basin.

The San Joaquin Valley is a structural trough approximately 200 miles long and 70 miles wide, and filled with up to 32,000 feet of marine and terrestrial sediments (DWR 2003). The SJRHR consists of multiple aquifers under confined and unconfined conditions composed of unconsolidated alluvium and consolidated rocks. A fairly continuous layer of clay known as Corcoran Clay has been documented at depths ranging from 50 to 300 feet within the central and southern subbasins of the SJRHR. The primary geologic formations within the SJRHR, although not continuous across the entire region, are the Laguna, Mehrten, Valley Springs, Ione, and Tulare formations. Groundwater is found in alluvium and flood deposits of varying age and thickness across the SJRHR.

Summary of Groundwater Quantity. The level of understanding of groundwater budgets and, therefore, the quantity of available groundwater, varies by groundwater subbasin. The DWR defines types of groundwater basins and subbasins based on how well the groundwater budget is understood: Type A is understood, Type B is estimated, and Type C means little is known about the groundwater budget. Most of the groundwater subbasins within SJRHR are Type B (Modesto, Turlock, Merced, Chowchilla, Madera, and Delta-Mendota), while the Eastern San Joaquin and Cosumnes subbasins, in the northern portion of the SJRHR, are Type A, and the Tracy subbasin, in the northwestern region of the SJRHR, is Type C. The Yosemite Valley and Los Banos Creek Valley groundwater basins are Type C.

Eastern San Joaquin Subbasin (Type A) is approximately 707,000 acres in area and has an average annual precipitation of 11 to 25 inches. The groundwater storage capacity for the subbasin is estimated to be approximately 42.4 million AF, with a specific yield of approximately 7%. Average well yields for municipal/agricultural wells within this subbasin range from 650 to 1,000 gallons per minute (gpm) and have an average depth of 349 feet below ground surface (bgs). Based on 1990 groundwater extraction data, there is a net annual overdraft within this subbasin of 113,000 AF/year.

Cosumnes Subbasin (Type A) covers 281,000 acres and has an average annual precipitation of 15 to 22 inches. Groundwater storage capacity is estimated to be approximately 6.0 million AF (DWR 1967, 1974). This estimate is based on the surface area of this subbasin, aquifer extent from 20 to 310 feet bgs, and a specific yield of approximately 7%. Average municipal/irrigation well yields within this subbasin range from 650 to 1,500 gpm and have an average depth of 473 feet bgs. Based on an estimate of recharge and extraction volumes measured from 1970 to 1995, a net subsurface inflow of 270,000 AF and a net outflow of 145,000 AF occur.

Less is understood about the subbasins with Type B groundwater budgets. Modesto Subbasin covers 246,000 acres and receives 11 to 15 inches of annual precipitation. It has a specific yield of approximately 9% and, as of 1961, had an estimated groundwater storage volume of 14.0 million AF. DWR calculations using 1995 groundwater data estimate 6.5 million AF of groundwater available to a depth of 300 feet bgs. Average municipal/irrigation well yields within this subbasin range from 1,000 to 2,000 gpm and range in depth from 50 to 500 feet bgs.

Turlock Subbasin covers 347,000 acres and receives an average annual rainfall of 11 to 13 inches. It has a specific yield of approximately 10% and an estimated 23.0 million AF of stored groundwater to a depth of 1,000 feet bgs as of 1961 (Williamson et al. 1989). Data from 1995 show that Turlock Subbasin has approximately 12.8 million AF of available groundwater to a depth of approximately 300 feet. Average municipal/irrigation well yields range from 1,000 to 2,000 gpm and range in depth from 50 to 350 feet bgs.

Merced Subbasin is 491,000 acres in area and receives an annual rainfall of approximately 11 to 13 inches. It has a specific yield of approximately 9% and an estimated storage (as of 1961) of 37.0 million AF to a depth of up to 1,000 feet bgs. 1995 hydrogeologic data indicate an available volume of 15.7 million AF to a depth of 300 feet bgs. Average well yields from within the subbasin range from 1,500 to 1,900 gpm for municipal/irrigation wells set at depths ranging from 100 to 800 feet bgs.

Chowchilla Subbasin covers an area of 159,000 acres and receives an average annual rainfall of 11 inches. It has an estimated average specific yield of approximately 9% and an estimated storage (as of 1961) of 15.0 million AF to a depth of up to 1,000 feet bgs. The volume of storage calculated in 1995 indicates an available volume of 5.5 million AF to a depth of 300 feet. Average well yields for municipal/irrigation wells range from 750 to 2,000 gpm and well depths range from 100 to 800 feet bgs.

Madera Subbasin is 393,000 acres and its annual precipitation ranges from 11 to 15 inches. It has a specific yield of approximately 10% and an estimated storage (as of 1961) of 24.0 million AF to a depth of 1,000 feet bgs. Calculations completed by the DWR in 1995 show an available budget of 12.6 million AF to a depth of 300 feet bgs. Municipal/irrigation wells range in depth from 100 to 600 feet bgs and yield an average of 750 to 2,000 gpm.

Delta-Mendota Subbasin covers 749,000 acres and its annual precipitation ranges from 9 to 11 inches. It has a specific yield of approximately 12% and an available storage (as of 1961) of 51.0 million AF to a depth of 1,000 feet bgs. Revised estimations of available groundwater based on 1995 data indicate approximately 26.6 million AF to a depth of 300 feet bgs. Municipal/irrigation wells have an average depth of 400 to 600 feet bgs and yield an average of 800 to 2,000 gpm.

In the northern portion of the SJRHR, Tracy Subbasin covers 345,000 acres and is the only subbasin within the San Joaquin Valley groundwater basin with a Type C groundwater budget. This subbasin receives annual precipitation of 11 to 16 inches and has an inferred approximate storage capacity of 1.3 million AF. Municipal/irrigation wells range in depth from 60 to 1,020 feet and yield an average rate of 500 to 3,000 gpm, with specific capacities of 10 to 100 gpm/foot (DWR 2003).

Both Yosemite Valley and Los Banos Creek Valley groundwater basins have a Type C Budget. Yosemite Valley basin covers 7,680 acres and its average annual precipitation ranges from 32 to 44 inches. Municipal/irrigation wells range in depth from 870 to 1,015 feet bgs and produce average yields from 650 to 1,200 gpm. Los Banos Creek Valley basin is also small, covering only 5,120 acres, and receives annual average precipitation of 9 to 11 inches. Average yield and groundwater storage capacities are unavailable for both of these basins.

Groundwater storage in the central and southern portions of the SJRHR has diminished over time as a result of an increase in agricultural groundwater usage within the area. Groundwater overdraft has caused land subsidence and loss of groundwater storage capacity since the mid-1920s.

Summary of Groundwater Quality. Despite some localized problems, groundwater in the SJRHR is suitable for most urban and agricultural uses (DWR 2003). In 1994, 74% of municipal wells tested met drinking water criteria. The primary constituents of concern are TDS, nitrate, boron, chloride, and organic compounds. High TDS primarily occurs along the western side of the San Joaquin Valley due to recharge of stream flow from Coast Range marine sediments. TDS is also high in the trough of the valley due to salts formed from evaporation of irrigation water. Nitrates are present from both natural sources and artificial sources, such as human or animal waste products and fertilizers. Agricultural pesticides and herbicides are found throughout the SJRHR, but are most problematic along the eastern side of the valley. Organic compounds such as the industrial solvents trichloroethene and dichloroethene present localized water quality concerns.

2.2.4 Biological Resources

Terrestrial Biological Resources

Regional Setting. The following subsections describe biological resources including vegetation, habitats, wildlife, and aquatic resources within the general

Project region or the vicinity of the wasteways. The general Project region of interest for terrestrial biology is defined as that area within a 1.0-mile radius of the potentially affected resources. The project vicinity is defined by ground-disturbing activities that could occur within a 0.1-mile radius of Newman and Westley wasteways. In addition, two database searches were performed to determine prevalence of special-status wildlife in the general Project region:

- A California natural diversity database (CNDDB) database search and a Service database search of the U.S. Geological Survey (USGS) 7.5-minute quadrangle where the Westley Wasteway is located (Westley) and the eight quadrangles surrounding the project sites (Vernalis, Ripon, Salida, Crows Landing, Patterson, Brush Lake, Solyo and Copper Mountain)
- A CNDDB database search and a Service database search of the two USGS 7.5-minute quadrangles where the Newman Wasteway is located (Newman and Gustine) and the eight quadrangles surrounding the project sites (San Luis Ranch, Ingomar, Howard Ranch, Crevison Peak, Turlock, Hatch, Stevinson, and Orestimba Peak)

Therefore, this section presents a description of the terrestrial biology in the general Project region and, for special status species analysis, the vicinity of these wasteways.

The general Project region has a Mediterranean climate and supports a mosaic of agricultural land use practices including pastures, dairies, alfalfa fields, hay, row crops, orchards, and low-density rural residences. Most of these agricultural land use practices remain prevalent in the region, although housing and industrial land uses are becoming more common. Irrigation ditches are common in the region, providing narrow bands of wetland vegetation.

The vicinity of the wasteways contains several vegetation communities including valley oak riparian woodland, freshwater emergent wetland, annual grassland, and agricultural lands. These vegetation communities were classified by the California Wildlife Habitat Relationship System (CDFG 2008a) as habitat types for wildlife and are described below.

Vegetation Communities

Valley Foothill Riparian. Valley foothill riparian occurs on river banks, on levees, and along unmaintained channel banks of south Delta sloughs and rivers. The most common species in the area are black willow (*Salix nigra*), Fremont cottonwood (*Populus fremontii*), and valley oak (*Quercus lobata*). These species form a nearly contiguous overstory.

Dominant understory species include Himalayan blackberry (*Rubus discolor*), California blackberry (*Rubus ursinus*), California button-willow (*Cephalanthus occidentalis* var. *californicus*), Indian hemp (*Apocynum cannabinum*), California rose (*Rosa californica*), coyote brush (*Baccharis pilularis*), and California black walnut (*Juglans californica*).

Herbaceous cover occurs where shrubs are sparse or absent and includes Santa Barbara sedge (*Carex barbarae*), hoary nettle (*Urtica holosericea*), creeping wild rye (*Leymus triticoides*), bracken fern (*Pteridium aquilinum*), hedge-nettle (*Stachys bullata*), and prickly lettuce (*Lactuca serriola*) (CDFG 2008a). Disturbed areas support stands of black mustard (*Brassica nigra*) and giant reed (*Arundo donax*), a particularly noxious weed that is becoming more prevalent in California (Cal-IPC 2008).

Fresh Emergent Wetland. Fresh emergent wetland occurs in saturated or periodically flooded soils. Fresh emergent wetland communities occur anywhere from the outlet of river channels to unlined irrigation ditches. The most important feature of the community is its saturation with water. This saturation leads to a hydrophytic vegetation regime, where the most common species in the community include common cattail (*Typha latifolia*), bulrush (*Scirpus* sp.), and arrowhead (*Sagittaria* sp.). This hydrophytic vegetation forms a tall (up to 6-foot) erect stand in saturated soils (CDFG 2008a). Other associated species include duckweed (*Lemna* sp.).

Annual Grassland. Annual grassland communities in California are dominated by grass species including wild oats (*Avena barbata*), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), red brome (*Bromus madritensis*), wild barley (*Hordeum vulgare* ssp. *spontaneum*), and foxtail fescue (*Vulpia myuros*). The majority of the species composition is nonnative and also includes forbs such as filaree (*Erodium* sp.), turkey mullein (*Eremocarpus setigerus*), clovers (*Trifolium* sp.), and burr clovers (*Medicago polymorhpa*) (CDFG 2008a).

Agricultural Lands. Agriculture use in the general Project region includes production of wheat and barley, corn, sorghum, safflower, tomatoes, sugar beets, hay, alfalfa, pastures, orchards, and vineyards.

Common Wildlife Species

Nonlisted species including CDFG harvest species occur in the project vicinity. Upland game includes California quail (*Callipepla californica)*, mourning dove (*Zenaida macroura)*, and ring-necked pheasant (*Phasianus colchicus)*. Waterfowl use stock ponds, small lakes, and refuges during winter migration and, to a lesser extent, for summer nesting in the grasslands along drainage ditches.

Wildlife species that are typical of the habitats in the general Project region include voles (*Microtus californicus)*, mice (*Mus musculus),* coyote (*Canis latrans*), opossum (*Didelphis virginianus)*, striped skunk (*Mephitis mephitis)*, killdeer (*Charadrius vociferus*), and long-billed curlew (*Numenius americanus*). Typical raptors commonly include red-tail hawk (*Buteo jamaicensis)* and northern harrier (*Circus cyaneus*). Typical common reptiles and amphibians include gopher snake (*Pituophis melanoleucas)* and racer (*Coluber constrictor)* (Zeiner et al. 1990a, b, c; Jennings 1983; Stebbins 1985).

Regional Special-Status Species

Species with the potential to occur in the general Project region that are federally listed by the Service, State-listed by the CDFG, or listed by the California Native Plant Society (CNPS) are presented in **Table 2.2.4-1**.

Some special-status plants are listed under the Federal ESA and are afforded the same protection as any other threatened or endangered species, but most special-status plants are listed by CNPS. Plants so described are afforded protection under the Native Plant Protection Act (California Fish and Game Code 1900-1913). This act requires a project that would potentially cause adverse impacts to rare plants to notify and provide opportunity to the CDFG to relocate the plants out of the disturbed area, or make other arrangements to protect the species.

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Table 2.2.4-1. Special-Status Species with the Potential to Occur within the Delta-Mendota Canal Recirculation Wasteway Vicinity[1]

Taxon	Scientific Name	Common Name	Federal[2]	State[3]	CNPS[4]	Preferred Habitat	Potential to Occur at Westley Wasteway	Potential to Occur at Newman Wasteway
Amphibians	*Ambystoma californiense*	California tiger salamander	T	—	—	Annual grasslands and grassy understory of valley-foothill hardwood habitats, need underground refuges, need vernal pools, stock ponds, or other seasonal water sources for breeding.	Low potential to occur. There is possible suitable aquatic habitat near the eastern end of Westley Wasteway. The closest known occurrence is approximately 5 miles south of the northernmost portion of Westley Wasteway (CDFG 2008g). This is out of dispersal range of the species and no vernal pool areas are present in the immediate vicinity.	Low potential to occur. The aquatic habitat within Newman Wasteway is most likely not suitable for the tiger salamander. The closest known occurrence is approximately 6 miles southeast of Newman Wasteway (CDFG 2008g). This location is out of dispersal range of the species and no vernal pool areas are present in the immediate vicinity.
	Rana draytonii	California red-legged frog	T	SSC	—	Dense, shrubby riparian vegetation associated with deep (> 0.2 foot), still or slow-moving water. Lowlands and foothills in or near permanent sources of deep water with dense, shrubby, or emergency riparian vegetation. Requires 11-20 weeks of permanent water for larval development, must have access to aestivation habitat.	Potential to occur. Within the current range of the species. The species may be present in non-aquatic areas in the vicinity of the Westley Wasteway. The nearest recorded occurrence is approximately 1 mile southwest of southernmost Westley Wasteway (CDFG 2008g).	Low potential to occur. The habitat in the Newman Wasteway study area may provide marginally suitable habitat, although there are no documented occurrences within 10 miles of Newman Wasteway (CDFG 2008a). In addition, red-legged frog occurrences in the valley floor are very scarce (Service 2002).
	Spea hammondii	Western spadefoot toad	—	SSC	—	Prefers open areas with sandy or rocky soils in a variety of habitats. Pools not containing bullfrogs, fish, or crayfish are necessary for breeding.	Low potential to occur. Marginally suitable habitat present within Westley Wasteway. The closest recorded occurrence is on the western side of Interstate 5, approximately 6 miles southwest of westernmost Westley Wasteway (CDFG 2008g).	Low potential to occur. Marginally suitable habitat present within Newman Wasteway. The closest recorded occurrence is on the western side of Interstate 5, approximately 6 miles southwest of westernmost portion Newman Wasteway (CDFG 2008g).
Reptiles	*Actinemys marmorata*	Western pond turtle	—	SSC	—	Inhabits permanent or nearly permanent water bodies and low gradient, slow-moving streams below 6,000 feet elevation. Range extends throughout California's streams and creeks. Frequently seen basking on logs, on shorelines, or beneath algal mats at the water's surface where refugia habitat (deep waters, undercut banks, woody debris) are present.	Potential to occur. The area surrounding Westley Wasteway provides suitable aquatic habitat. No occurrences of the species are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	Potential to occur. The aquatic features connected to Newman Wasteway have documented occurrences of western pond turtles and suitable habitat lies within Newman Wasteway's unlined channel. The closest recorded occurrence is less than half a mile east of a portion of Newman Wasteway (CDFG 2008g).
	Gambelia (=Crotaphytus) sila	Blunt-nosed leopard lizard	E		—	Inhabit sparsely vegetated alkali and desert scrub habitats, alkali flats, large washes, arroyos, and canyons; find shade under shrubs or in mammal burrows. Occur at elevations between 98 and 2,953 feet.	No potential to occur. Appropriate scrub habitat is not present within Westley Wasteway or in the vicinity. In addition, no occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	No potential to occur. Appropriate scrub habitat is not present within Newman Wasteway or in the vicinity. In addition, no occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g).
	Masticophis flagellum ruddocki	San Joaquin whipsnake	—	SSC	—	Occurs in open, dry areas including scrub habitats. Takes refuge in rodent burrows and under vegetation.	Low potential to occur. Suitable open, dry habitat adjacent to Westley Wasteway. Only marginally suitable habitat is within the wasteway vicinity. One occurrence is recorded approximately 9 miles northwest of Westley Wasteway (CDFG 2008g).	Low potential to occur. Suitable open, dry habitat adjacent to Newman Wasteway. There is no suitable habitat with Newman Wasteway, however. There are no recorded occurrences within 10 miles of Newman Wasteway (CDFG 2008g).
	Thamnophis gigas	Giant garter snake	T	T	—	Marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways or agricultural wetlands. The habitat must have sufficient water during breeding season (early spring–mid fall), emergent wetland vegetation, and openings in wetland vegetation for basking, high elevation uplands to provide cover and refuge during winter seasons.	Potential to occur. Suitable marsh habitat present adjacent to Westley Wasteway. No occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	Potential to occur. Suitable marsh habitat present in the unlined channel of Newman Wasteway. No occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g).

Table 2.2.4-1. Special-Status Species with the Potential to Occur within the Delta-Mendota Canal Recirculation Wasteway Vicinity[1]

Taxon	Scientific Name	Common Name	Federal[2]	State[3]	CNPS[4]	Preferred Habitat	Potential to Occur at Westley Wasteway	Potential to Occur at Newman Wasteway
Invertebrates	*Branchinecta conservatio*	Conservancy fairy shrimp	E	—	—	Found in large, turbid pools in the northern two-thirds of the Central Valley, inhabit astatic pools in swales formed by old, braided alluvium, filled by winter/spring rains, until June.	No potential to occur. No appropriate vernal pool habitat is found within or adjacent to Westley Wasteway. The nearest recorded occurrence is approximately 6 miles south of northernmost Westley Wasteway (CDFG 2008g).	No potential to occur. No appropriate vernal pool habitat is found within or adjacent to Newman Wasteway. The nearest recorded occurrence is approximately 7 miles southeast of Newman Wasteway (CDFG 2008g).
	Branchinecta longiantenna	Longhorn fairy shrimp	E	—	—	Vernal pools; small swales, earth slumps in alkali sink and alkali scrub plant communities.	No potential to occur. No appropriate vernal pool habitat is found within or adjacent to Westley Wasteway. No occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	No potential to occur. No appropriate vernal pool habitat is found within or adjacent to Newman Wasteway. The nearest recorded occurrence is approximately 6 miles southeast of Newman Wasteway (CDFG 2008g).
	Branchinecta lynchi	Vernal pool fairy shrimp	T	—	—	Vernal pools; small swales, earth slumps, or basalt-flow depression basins with grassy or occasionally muddy bottom, in unplowed grassland.	No potential to occur. No appropriate vernal pool habitat is found within or adjacent to Westley Wasteway. The nearest recorded occurrence is approximately 6.5 miles south of northernmost Westley Wasteway (CDFG 2008g).	No potential to occur. No appropriate vernal pool habitat is found within or adjacent to Newman Wasteway. The nearest recorded occurrence is approximately 9 miles southeast of Newman Wasteway (CDFG 2008g).
	Desmocerus californicus dimorphus	Valley elderberry longhorn beetle	E	—	—	Almost always found in relation to elderberry bushes throughout the Central Valley. Elderberry bushes are associated with riparian forests along rivers and streams.	Potential to occur. Although no elderberry shrubs were observed during the site reconnaissance visit in September 2008, riparian habitat occurs within the vicinity. The nearest recorded occurrence is approximately 5 miles north of Westley Wasteway (CDFG 2008g).	Potential to occur. Elderberry shrubs were observed along Newman Wasteway's banks during a reconnaissance level visit in April. No occurrences are recorded within a 10-mile radius of Newman Wasteway (CDFG 2008g).
	Lepidurus packardi	Vernal pool tadpole shrimp	E	—	—	Seasonal pools in unplowed grassland with old alluvial soils underlain by hardpan or in sandstone depressions	No potential to occur. No appropriate vernal pool habitat is found within or adjacent to Westley Wasteway. No occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	No potential to occur. No appropriate vernal pool habitat is found within or adjacent to Newman Wasteway. The nearest recorded occurrence is approximately 7 miles southeast of Newman Wasteway (CDFG 2008g).
Mammals	*Antrozous pallidus*	Pallid bat	—	SSC	—	Inhabits rocky terrain in open areas in lowlands, foothills and mountainous areas near water throughout California below 6,560 feet. Roost in caves, rock crevices, mines, hollow trees, buildings, and bridges in arid regions in low numbers (<200). Active from March-November; migrates in some areas, but may hibernate locally.	Potential to occur. Potentially suitable forested roosting habitat is around the old San Joaquin River oxbow, adjacent to the wasteway vicinity. No occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	Potential to occur. Potentially suitable roosting structures, such as bridges that cross Newman Wasteway, are adjacent to the wasteway vicinity. An occurrence is documented within 10 miles of Newman Wasteway (CDFG 2008g).
	Dipodomys nitratoides exilis	Fresno kangaroo rat	E	E	—	Prefer saline and sandy soils in chenopod scrub and annual grasslands of the Central Valley floor in California.	No potential to occur. Westley Wasteway is not within the historic or current distribution range of Fresno kangaroo rats (Service 1998). In addition, no occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	No potential to occur. Newman Wasteway is not within the historic or current distribution range of Fresno kangaroo rats (Service 1998). In addition, no occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g).
	Neotoma fuscipes riparia	Riparian (=San Joaquin Valley) woodrat	E	SSC	—	Prefer habitat with dense shrub cover and nearby open areas. Often found in willow thickets with an oak overstory. They are also associated with deciduous oaks (such as valley oaks) and less common among live oaks (such as coast live oaks) (Service 2008a).	No potential to occur. Appropriate habitat not present within or adjacent to Westley Wasteway. The nearest recorded occurrence is approximately 9 miles north of Newman Wasteway (CDFG 2008g). This occurrence is in Caswell Memorial State Park, where the only known extant population of this species occurs (Service 1998).	No potential to occur. Appropriate habitat not present within or adjacent to Newman Wasteway. No occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g). In addition, only one extant population is known and that is in Caswell Memorial State Park, approximately 28 miles north of Newman Wasteway (Service 1998).

Table 2.2.4-1. Special-Status Species with the Potential to Occur within the Delta-Mendota Canal Recirculation Wasteway Vicinity[1]

Taxon	Scientific Name	Common Name	Federal[2]	State[3]	CNPS[4]	Preferred Habitat	Potential to Occur at Westley Wasteway	Potential to Occur at Newman Wasteway
Mammals (cont.)	*Sylvilagus bachmani riparius*	Riparian brush rabbit	E	E	—	Inhabits riparian areas consisting of willow thickets with an understory of blackberry, wild rose, wild grape, and coyote bush.	No potential to occur. No suitable riparian thicket habitat present within or adjacent to Westley Wasteway. The closest recorded occurrence is approximately 10 miles north of Westley Wasteway (CDFG 2008g).	No potential to occur. No suitable riparian thicket habitat present within or adjacent to Westley Wasteway. No occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g).
	Taxidea taxus	American badger	—	SSC	—	Inhabits open areas with friable soils within woodlands, grasslands, savannah, and desert habitats. A fossorial mammal that preys predominately on ground squirrels and pocket gophers.	Potential to occur. Suitable open habitat is in the Westley Wasteway vicinity. The closest recorded occurrence is approximately 9 miles northwest of Westley Wasteway (CDFG 2008g).	Potential to occur. Suitable open grassland habitat is in the Newman Wasteway vicinity. The nearest recorded occurrence is approximately 6 miles east of Newman Wasteway (CDFG 2008g).
	Vulpes macrotis mutica	San Joaquin kit fox	E	E	—	They inhabit grazed grasslands, grasslands with wind turbines, and live adjacent to and forage in tilled and fallow fields, and irrigated row crops. Kit foxes prefer loose-textured soils, but are found on virtually every soils type.	Potential to occur. Within the current range of the species. The species may be present in the Westley Wasteway vicinity. The nearest recorded occurrence is approximately 1 mile southwest of southernmost Westley Wasteway (CDFG 2008g).	Potential to occur. Within the current range of the species. The species may be present in the non-aquatic areas in the vicinity of the Newman Wasteway. The nearest recorded occurrence is approximately 3 miles west of westernmost Newman Wasteway (CDFG 2008g).
Birds	*Agelaius tricolor*	Tri-colored blackbird	—	SSC	—	Highly colonial species, most numerous in the Central Valley and vicinity. Largely endemic to California. Nest in emergent vegetation within aquatic and riparian habitats. Breeding begins in March; double-brooded.	Potential to occur. Suitable emergent wetland vegetation habitat is immediately adjacent to the wasteway vicinity. The closest recorded occurrence is approximately 4 miles east of Westley Wasteway (CDFG 2008g).	Known to occur. Suitable emergent marsh vegetation is in Newman Wasteway's unlined channel. Two occurrences are recorded within Newman Wasteway (CDFG 2008g).
	Aquila chrysaetos	Golden eagle	—	FP	—	Found in mountains and foothills throughout California. Nest in mountainous regions usually on cliff edges or high trees. Forages in open grasslands.	Potential to occur. May use surrounding area, particularly the eastern wasteway area as foraging habitat. No occurrences are recorded within a 10-mile radius of Westley Wasteway (CDFG 2008g).	Potential to occur. May use surrounding area as foraging habitat. The closest recorded occurrence is approximately 4 miles west of westernmost Newman Wasteway (CDFG 2008g).
	Athene cunicularia hypugea	Burrowing owl	—	SSC	—	Valley bottoms and foothills with low vegetation and fossorial mammal activity. Breeding begins in March; single-brooded.	Potential to occur. Suitable open grassland habitat is within the Westley Wasteway vicinity. The nearest recorded occurrence is approximately 4 miles north of northernmost Westley Wasteway (CDFG 2008g).	Potential to occur. Suitable open grassland habitat surrounds much of Newman Wasteway. The nearest recorded occurrence is approximately 6 miles southeast (CDFG 2008g).
	Buteo swainsoni	Swainson's hawk	—	T	—	Nests in the Central Valley within riparian areas and oak woodlands as well as isolated and roadside trees close to grassland or agricultural foraging habitat; winters in Mexico and Central and South America. Average home range is 640 to 1,280 acres.	Potential to occur. Suitable nesting habitat within the eastern Westley Wasteway vicinity. The closest recorded occurrence is approximately 4 miles east of Westley Wasteway (CDFG 2008g).	Potential to occur. Suitable foraging habitat present in the Newman Wasteway vicinity, although nesting habitat is relatively scarce along the majority of the wasteway. The nearest recorded occurrence is less than 1 mile north of northernmost Newman Wasteway (CDFG 2008g).
	Coccyzus americanus occidentalis	Western yellow-billed cuckoo	C	—	—	Inhabits extensive deciduous riparian thickets or forests with dense, low-level or understory foliage, and that abut on slow-moving watercourses, backwaters, or seeps. Now, this species is likely found only along the upper Sacramento Valley portion of the Sacramento River, the Feather River in Sutter County, the south fork of the Kern River in Kern County, and along the Santa Ana, Amargosa, and lower Colorado rivers.	Potential to occur in riparian areas near the San Joaquin River. The majority of Westley Wasteway does not provide suitable habitat, however. No occurrences of the species are recorded within a 10-mile radius of Westley Wasteway (CDFG 2008g).	Potential to occur in riparian areas near the San Joaquin River. The majority of Newman Wasteway does not provide suitable habitat, however. The nearest recorded occurrence is approximately 9 miles north of Newman Wasteway (CDFG 2008g).
	Eremophila alpestris actia	California horned lark	—	SSC	—	Prefer large open areas with sparse vegetation and exposed soils. Often occupy pastures land or grassy fields.	Potential to occur in the open habitat along Westley Wasteway. This area provides potentially suitable open habitat. The nearest recorded occurrence is approximately 10 miles northwest of Westley Wasteway (CDFG 2008g).	Potential to occur in the open habitat along Newman Wasteway. This area provides potentially suitable open habitat. No occurrences are recorded within a 10-mile radius of Newman Wasteway (CDFG 2008g).

Table 2.2.4-1. Special-Status Species with the Potential to Occur within the Delta-Mendota Canal Recirculation Wasteway Vicinity[1]

Taxon	Scientific Name	Common Name	Federal[2]	State[3]	CNPS[4]	Preferred Habitat	Potential to Occur at Westley Wasteway	Potential to Occur at Newman Wasteway
Birds (cont.)	*Falco mexicanus*	Prairie falcon	—	SSC	—	Nests on cliffs and at times in old raven or eagle stick nests on cliff, bluff, or rock outcrop. Inhabits perennial grasslands, savannahs, rangeland, some agricultural fields, and desert scrub communities. Breeding begins in April; single-brooded.	Potential to occur. No suitable nesting habitat present; however, foraging habitat may be present along Westley Wasteway's length. The nearest recorded occurrence is approximately 4 miles south of easternmost Westley Wasteway (CDFG 2008g).	Potential to occur. No suitable nesting habitat present; however, foraging habitat may be present along Newman Wasteway's length. No occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g).
	Haliaeetus leucocephalus	Bald eagle	D	E	—	Winters throughout most of California at lakes, reservoirs, river systems, and some rangelands and coastal wetlands on protected cliffs and ledges. Also nests on bridges and buildings in urban areas. Nests are normally built in the upper canopy of large trees, usually conifers.	Potential to occur in riparian areas near where Westley Wasteway meets the San Joaquin River. The nearest recorded occurrence is approximately 9 miles north of Westley Wasteway (CDFG 2008g).	No potential to occur. No suitable habitat in the vicinity of Newman Wasteway. No occurrences of the species are recorded within a 10-mile radius of Newman Wasteway (CDFG 2008g).
	Lanius ludovicianus	Loggerhead shrike	—	SSC	—	Prefers open habitats with scattered shrubs and trees in the lowlands. They occur in high densities in valley foothill hardwood, valley foothill riparian, desert riparian, pinyon-juniper, and juniper habitats in California.	Potential to occur in the eastern Westley Wasteway area. This area provides potentially suitable open habitat. The nearest recorded occurrence is approximately 5 miles south of Westley Wasteway along the Delta-Mendota Canal (CDFG 2008g).	Potential to occur in the open area along Newman Wasteway. This area provides potentially suitable open habitat. No occurrences are recorded within a 10-mile radius of Newman Wasteway (CDFG 2008g).
Plants	*Atriplex cordulata*	Heartscale	—	—	1B.2	Suitable habitat includes shadscale scrub, chenopod scrub, valley grassland, wetland-riparian, valley and foothill grassland and meadow communities, and on sandy, saline or alkaline flats or scalds. This species is also equally likely to occur in wetlands or non wetlands. This species blooms between April and October and occurs at elevations between 0 and 1,000 feet.	Potential to occur. Potentially suitable habitat present where Westley Wasteway meets the San Joaquin River. The nearest recorded occurrence is approximately 8 miles north of Westley Wasteway (CDFG 2008g).	Potential to occur. Potentially suitable habitat present within Newman Wasteway. The nearest recorded occurrence is approximately 8 miles east of Newman Wasteway (CDFG 2008g).
	Atriplex depressa	Brittlescale	—	—	1B.2	Playas in shaded scrub, valley grassland, alkali sink, and wetland riparian habitats. Blooms May to October.	Low potential to occur. Marginally suitable habitat may be present in Westley Wasteway or the vicinity. No occurrences within a 10 mile radius of Westley Wasteway (CDFG 2008g).	Potential to occur. Marginally suitable habitat may be present within Newman Wasteway. The nearest recorded occurrence is approximately 8 miles east of Newman Wasteway (CDFG 2008g).
	Atriplex miniscula	Lesser saltscale	—	—	1B.1	Playas in shaded scrub, valley grassland, alkali sink, and wetland riparian habitats with sandy soils. It occasionally occurs in wetlands but it usually is found in non-wetlands (CNPS 2008). It ranges in elevation from 50 to 655 feet and blooms from May to October.	Potential to occur. Marginally suitable habitat present at the outlet of Westley Wasteway between the wasteway and the San Joaquin River. The nearest recorded occurrence is approximately 3 miles south of Westley Wasteway (CDFG 2008g).	Potential to occur. Marginally suitable habitat present at within Newman Wasteway. The nearest recorded occurrence is approximately 8 miles north of Newman Wasteway (CDFG 2008g).
	Atriplex joaquiniana	San Joaquin spearscale	—	—	1B.2	Chenopod scrubs, playas, meadows and seeps, and valley and foothill grasslands at elevations ranging from 3 to 2,740 feet. Blooms from April to October (CNPS 2008).	No potential to occur. No seeps in valley grassland, chenopod scrub, or other suitable habitat present within or adjacent to Westley Wasteway. No occurrences are recorded within a 10-mile radius of Westley Wasteway (CDFG 2008g).	No potential to occur. No seeps in valley grassland, chenopod scrub, or other suitable habitat present within or adjacent to Newman Wasteway. The nearest recorded occurrence is approximately 3 miles southeast of Newman Wasteway (CDFG 2008g).
	Atriplex persistens	Vernal pool smallscale	—	—	1B.2	Large, alkaline vernal pools at elevations ranging from 25 to 345 feet.	No potential to occur. No vernal pool habitat present within or adjacent to Westley Wasteway. The nearest recorded occurrence is approximately 9 miles southeast of Westley Wasteway (CDFG 2008g).	No potential to occur. No vernal pool habitat present within or adjacent to Newman Wasteway. The nearest recorded occurrence is approximately 6 miles southeast of Newman Wasteway (CDFG 2008g).
	Astragalus tener var. *tener*	Alkali milk-vetch	—	—	1B.2	Playas and vernal pools in valley grassland, alkali sink, freshwater wetlands and wetland riparian habitats (CNPS 2008).	Potential to occur. Freshwater wetland and riparian habitat present within the vicinity of Westley Wasteway. No occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	Potential to occur. Freshwater wetland and riparian habitat present within the vicinity of Newman Wasteway. The nearest recorded occurrence is less than 1 mile southeast of Newman Wasteway (CDFG 2008g).

Table 2.2.4-1. Special-Status Species with the Potential to Occur within the Delta-Mendota Canal Recirculation Wasteway Vicinity[1]

Taxon	Scientific Name	Common Name	Federal[2]	State[3]	CNPS[4]	Preferred Habitat	Potential to Occur at Westley Wasteway	Potential to Occur at Newman Wasteway
Plants (cont.)	*Blepharizonia plumosa* ssp. *plumosa*	Big tarplant	—	—	1B.1	Valley grassland habitats (CNPS 2008).	Potential to occur. Suitable grassland habitat present in the Westley Wasteway vicinity. An occurrence is recorded within less than a mile of Westley Wasteway (CDFG 2008g).	Potential to occur. Suitable grassland habitat present in the Newman Wasteway vicinity but not within the wasteway. No occurrences are recorded within a 10-mile radius of Newman Wasteway (CDFG 2008g).
	Caulanthus coulteri S. Watson var. *lemmonii*	Lemmon's jewelflower	—	—	1B.2	Dry exposed slopes between 262 and 2,625 feet (CNPS 2008).	No potential to occur. No dry exposed slopes occur within Westley Wasteway. The nearest occurrence is approximately 3 miles south of southernmost Westley Wasteway (CDFG 2008g).	No potential to occur. No dry exposed slopes occur within Newman Wasteway. In addition, no occurrences are known within a 10-mile radius of Newman Wasteway (CDFG 2008g).
	Cordylanthus mollis ssp. *hispidus*	Hispid bird's-beak	—	—	1B.1	Meadows and playas in alkali sink, valley grassland, and wetland-riparian areas.	Low potential to occur. Extirpated from most of the lower San Joaquin Valley although potentially suitable wetland riparian areas are present in the Westley Wasteway vicinity. The nearest recorded occurrence is approximately 6 miles southeast of Westley Wasteway (CDFG 2008g).	Low potential to occur. Extirpated from most of the lower San Joaquin Valley although potentially suitable wetland riparian areas are present in the Newman Wasteway vicinity. No occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g).
	Coreopsis hamiltonii	Mt. Hamilton coreopsis	—	—	1B.2	Cismontane on dry exposed slopes at elevations ranging from 1,804 to 4,265 feet. Blooms from March to May (CNPS 2008).	No potential to occur. Suitable foothill woodland habitat not present within or adjacent to Westley Wasteway. The nearest recorded occurrence is approximately 8 miles east of Westley Wasteway (CDFG 2008g).	No potential to occur. Suitable foothill woodland habitat not present within or adjacent to Newman Wasteway. No occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g).
	Delphinium californicum ssp. *interius*	Hospital Canyon larkspur	—	—	1B.2	Openings in chaparral and cismontane woodland at elevations ranging from 750 to 3,600 feet. Blooms from April to June.	No potential to occur. Suitable cismontane woodland habitat not present within or adjacent to Westley Wasteway. No occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	No potential to occur. Suitable cismontane woodland habitat not present within or adjacent to Newman Wasteway. The closest recorded occurrence is approximately 10 miles southwest of Newman Wasteway (CDFG 2008g).
	Eschscholzia rhombipetala	Diamond-petaled California poppy	—	—	1B.1	Valley and foothill grassland, fallow fields and open places at elevations ranging from sea level to 3,200 feet (CNPS 2008).	Potential to occur. Fallow field is present in the Westley Wasteway study area. An occurrence is recorded within 3 miles of Westley Wasteway (CDFG 2008g).	Potential to occur. Open grassland habitat is present along the Newman Wasteway study area. No occurrences are recorded within 10 miles of Newman Wasteway (CDFG 2008g).
	Erodium macrophyllum var. *macrophyllum*	Round-leaved filaree	—	—	1B.1	Dry slopes in cismontane woodland, valley and foothill grassland at elevations ranging from 49 to 3,937 feet. Blooms March to May	Low potential to occur. Suitable grassland and woodland habitat not present within Westley Wasteway. An occurrence is recorded less than 1 mile northeast of the wasteway (CDFG 2008g).	Low potential to occur. Suitable grassland and woodland habitat not present within Newman Wasteway. The nearest recorded occurrence is approximately 6 miles south of the wasteway along the Delta-Mendota Canal (CDFG 2008g).
	Eryngium racemosum	Delta button celery	—	E	1B.1	Riparian scrub, freshwater wetlands from sea level to 100 feet. Blooms from June to September.	Potential to occur adjacent to Westley Wasteway study area. Wetlands and desilting basins are in the area. The nearest recorded occurrence is less than a mile away in northern Westley Wasteway (CDFG 2008g).	Potential to occur adjacent in wetlands in the Newman Wasteway study area. Wetlands and desilting basins are in the area. The nearest recorded occurrence is in northern Newman Wasteway (CDFG 2008g).
	Madia radiata	Showy madia	—	—	1B.1	Cismontane woodland, valley and foothill grassland. Ranges in elevation from 82 to 2,953 feet. Blooms from March to May.	Potential to occur. Suitable valley grassland is within the study area. An occurrence is documented within 10 miles of Westley Wasteway (CDFG 2008g).	Potential to occur. Suitable valley grassland is within the study area. No occurrences are documented within 10 miles of Newman Wasteway (CDFG 2008g).
	Malacothamnus hallii	Hall's bush-mallow	—	—	1B.2	Chaparral and coastal scrub habitats. Ranges in elevation from 30 to 2,500 feet. Blooms from May to September.	No potential to occur. Suitable chaparral and coastal scrub habitat not present within Westley Wasteway. The nearest recorded occurrence is approximately 8 miles east of Westley Wasteway (CDFG 2008g).	No potential to occur. Suitable chaparral and coastal scrub habitat not present within Newman Wasteway. No occurrences are recorded within a 10-mile radius of Newman Wasteway (CDFG 2008g).

Table 2.2.4-1. Special-Status Species with the Potential to Occur within the Delta-Mendota Canal Recirculation Wasteway Vicinity[1]

Taxon	Scientific Name	Common Name	Federal[2]	State[3]	CNPS[4]	Preferred Habitat	Potential to Occur at Westley Wasteway	Potential to Occur at Newman Wasteway
Plants (cont.)	*Navarretia prostrata*	Prostrate vernal pool navarretia	—	—	1B.1	Wetland riparian areas in coastal sage scrub, meadows and seeps, vernal pools, valley and foothill grasslands between sea level and 2,296 feet. Blooms from April to July (CNPS 2008).	No potential to occur. Appropriate coastal sage scrub wetland riparian habitat not present within the Westley Wasteway study area. No occurrences are recorded within 10 miles of Westley Wasteway (CDFG 2008g).	No potential to occur. Appropriate coastal sage scrub wetland riparian habitat not present within the Newman Wasteway study area. An occurrence is recorded approximately 6 miles southeast of Newman Wasteway (CDFG 2008g).
	Potamogeton filiformis	Slender-leaved pondweed	—	—	2.2	Freshwater wetlands and marsh between 900 and 7,000 feet. Blooms from May to July.	Potential to occur. Suitable freshwater wetlands present within the Westley Wasteway study area. No occurrences are documented within a 10-mile radius of Westley Wasteway (CDFG 2008g).	Potential to occur. Suitable freshwater wetlands present within the Newman Wasteway study area. The nearest documented occurrence is approximately 9 miles south of Newman Wasteway (CDFG 2008g).
	Sagittaria sanfordi	Sanford's arrowhead	—	—	1B.2	Marshes and swamps from sea level to 2,100 feet. Blooms from May to October.	Potential to occur. Suitable freshwater wetlands present within the Westley Wasteway study area. No occurrences are documented within a 10-mile radius of Westley Wasteway (CDFG 2008g).	Potential to occur. Suitable freshwater wetlands present within the Newman Wasteway study area. The nearest documented occurrence is approximately 4 miles southeast of Newman Wasteway (CDFG 2008g).

Sources: CNPS 2008; Service 1998, 2008a. U.S. Fish and Wildlife Service species list (Service 2008f). California Natural Diversity Database (CDFG 2008g) search of U.S. Geological Survey quadrangles San Luis Ranch, Ingomar, Howard Ranch, Crevison Peak, Turlock, Hatch, Gustine, Stevinson, Crows Landing, Patterson, Orestimba Peak, Newman, Copper Mountain, Salida, Ripon, Westley, Brush Lake, Vernalis, and Solyo on October 23, 2008.

Notes:

[1] The results presented in the table are preliminary assessments based on a literature review and limited site visits.

[2] Federal and Endangered Species Act
C = Candidate for listing status
D = Delisted
E = Endangered
T = Threatened

[3] California Endangered Species Act
E = Endangered
FP = Species that cannot be taken or possessed without a permit from the Fish and Game Commission and/or Department of Fish and Game
SSC = California Department of Fish and Game Species of Special Concern
T = Threatened

[4] California Native Plant Society (CNPS)
1A = Plant species that are presumed extinct in California
1B = Plant species that are rare, threatened, or endangered in California and elsewhere
2 = Plant species that are rare, threatened, or endangered in California but more common elsewhere
3 = Plant species about which we need more information (a review list)

Wasteways Setting

Westley Wasteway. Westley Wasteway is a lined channel set among agricultural fields in Stanislaus County. Vegetation communities in the vicinity include agricultural communities as well as natural riparian communities near the outlet of Westley Wasteway. The study area for this location is at the outlet of Westley Wasteway as it drains into an old oxbow channel of the SJR. A new conveyance spanning approximately 0.66 mile would be required at this location to divert water from Westley Wasteway into the SJR. In the study area the vegetation communities include valley oak riparian woodland, annual grassland, and freshwater emergent wetland communities as well as agricultural communities.

Valley oak riparian woodland occurs on river banks, on levees, and along unmaintained channel banks of south Delta sloughs and rivers. At the end of the lined portion of Westley Wasteway water drains into the riparian area of the old oxbow channel of the SJR. This area is dominated by valley oak riparian woodland. This habitat dominates the majority of the area adjacent to the proposed channel location. **Photograph 2.2.4-1** was taken during the site reconnaissance visit in September 2008 and is representative of this community in the Westley Wasteway study area.

Freshwater emergent wetland communities occur at the Westley Wasteway outlet, both in the human-made desilting basin present and the portions of old SJR channel. Because the area around eastern Westley Wasteway is inundated with water, wetlands are very prevalent. A desilting basin is present adjacent to the wasteway and other seasonally inundated areas. The old SJR channel provides an excellent wetland area, as does the current use of the area as a desilting basin. **Photograph 2.2.4-2** was taken during the site reconnaissance visit in September 2008 and is representative of this community in the Westley Wasteway study area.

Photograph 2.2.4-1. Photograph of Valley Foothill Riparian Woodland Taken Facing Southeast Approximately 0.2 mile from Outlet of Westley Wasteway

Photograph 2.2.4-2. Photograph of the Desilting Basin Taken Facing West Approximately at the Outlet of Westley Wasteway

Annual grassland occurs in fields adjacent to Westley Wasteway. This habitat is present between the current end of Westley Wasteway and the SJR. An extension of the wasteway would cross a field of annual grassland so that water may drain into the SJR. **Photograph 2.2.4-3** was taken during the site reconnaissance visit in September 2008 and is representative of this community in the Westley Wasteway study area.

In the Westley Wasteway vicinity lie recently tilled agriculture fields as well as fallow fields dominated by grass species. Agricultural use directly adjacent to the Westley Wasteway study area consisted primarily of orchards. A portion of the annual grassland field was recently tilled at the time of the site visit in September 2008, suggesting that it may be used for agriculture in the future. **Photographs 2.2.4-4 and 2.2.4-5** were taken during the reconnaissance visit in September 2008 and show this community.

Photograph 2.2.4-3. Annual Grassland Area Where an Extension of Westley Wasteway Would Cross Near the SJR

Photograph 2.2.4-4. Recently Tilled Portion of Annual Grassland Field within the Westley Wasteway Study Area

Photograph 2.2.4-5. End of Paved Portion of Westley Wasteway (Note Agricultural Land Use of the Surrounding Area and the Orchard on Left)

Special-status wildlife species with the potential to occur near Westley Wasteway include the following (see **Table 2.2.4-1**):

- California tiger salamander (*Ambystoma californiense*)
- California red-legged frog (*Rana draytonii*)
- western spadefoot toad (*Spea hammondii*)
- western pond turtle (*Actinemys marmorata*)
- San Joaquin whipsnake (*Masticophis flagellum ruddocki*)
- giant garter snake (*Thamnophis gigas*)
- valley elderberry longhorn beetle (*Desmocerus californicus dimorphus)*
- pallid bat (*Antrozous pallidus*)
- American badger (*Taxidea taxus*)
- San Joaquin kit fox (*Vulpes macrotis mutica*)
- tri-colored blackbird (*Agelaius tricolor*)
- golden eagle (*Aquila chrysaetos*)
- burrowing owl (*Athene cunicularia hypugea*)
- Swainson's hawk (*Buteo swainsoni*)
- western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)
- California horned lark (*Eremophila alpestris actia*)
- prairie falcon (*Falco mexicanus*)
- loggerhead shrike (*Lanius ludovicianus*)
- heartscale (*Atriplex cordulata*)
- brittlescale (*Atriplex depressa*)
- lesser saltscale (*Atriplex miniscula*)
- alkali milk-vetch (*Astragalus tener* var. *tener*)
- big tarplant (*Blepharizonia plumosa* ssp. *plumosa*)
- hispid bird's-beak (*Cordylanthus mollis* ssp. *hispidus*)
- diamond-petaled California poppy (*Eschscholzia rhombipetala*)
- round-leaved filaree (*Erodium macrophyllum* var. *macrophyllum*)
- delta button celery (*Eryngium racemosum*)
- showy madia (*Madia radiata*)
- slender-leaved pondweed (*Potamogeton filiformis*)
- Sanford's arrowhead (*Sagittaria sanfordii*)

Numerous California Species of Special Concern, such as the pallid bat (*Antrozous pallidus)* and western pond turtle (*Actinemys marmorata)*, and candidate species also occur in the wasteway vicinity (DWR and Reclamation 2005). Several State-listed species (Swainson's hawk [*Buteo swainsoni*]) and species of concern (burrowing owl [*Athene cunicularia hypugea*], white-tailed kite [*Elanus leucurus*], California horned lark [*Eremophila alpestris actia*], tri-colored blackbird [*Agelaius tricolor*]) could forage in areas adjacent to the wasteway. Special-status plants that could occur in the vicinity include big tarplant (*Blepharizonia plumosa* ssp. *plumosa)* and Delta button celery (*Eryngium racemosum*).

Newman Wasteway. Newman Wasteway is both a lined and unlined channel set among agricultural fields in Stanislaus County. Vegetation communities in the vicinity include annual grassland and freshwater emergent wetland as well as agricultural communities. These communities are described in more detail below. The study area for this location is the entire length of Newman Wasteway. To control turbidity, a low-flow or high-flow lined channel may be constructed in the unlined channel, spanning approximately 6.7 miles. In addition, water levels in the wasteway would vary periodically as a result of recirculation.

Annual grassland is a dominant community along Newman Wasteway's banks as well as in the surrounding areas. This community is dominant along Newman Wasteway's banks as well as in the surrounding areas that are not being used for agriculture. **Photograph 2.2.4-6** was taken during the April 2008 reconnaissance site visit and shows the annual grassland community lining Newman Wasteway's banks.

Freshwater emergent wetland communities occur within Newman Wasteway's unlined channel. On Newman Wasteway's banks a few scattered riparian trees exist as well, including willow (*Salix* sp.) and blue elderberry (*Sambucus mexicana*). Freshwater emergent wetland communities most likely occur within the length of Newman Wasteway's unlined channel, although the entire area has not yet been surveyed. The channel of wetland vegetation width varies across the 6.7 miles, although at the time of the reconnaissance site visit in April 2008 the width was approximately 60 feet. **Photograph 2.2.4-6** shows the typical wetland vegetation present in Newman Wasteway.

Photograph 2.2.4-6. View of the Unlined Newman Wasteway Where the Wetland Vegetation Approximately 60 feet Across Is Visible

In the Newman Wasteway vicinity are mostly grain crops and cattle grazing pastures. **Photograph 2.2.4-7** shows some of the agricultural land use facilities such as a paved irrigation canal and other structures adjacent to Newman Wasteway.

Special-status wildlife species with the potential to occur near Newman Wasteway include (see **Table 2.2.4-1**):

- California tiger salamander (*Ambystoma californiense*)
- California red-legged frog (*Rana draytonii*)
- western spadefoot toad (*Spea hammondii*)
- western pond turtle (*Actinemys marmorata*)
- San Joaquin whipsnake (*Masticophis flagellum ruddocki*)
- giant garter snake (*Thamnophis gigas*)
- valley elderberry longhorn beetle (*Desmocerus californicus dimorphus)*
- pallid bat (*Antrozous pallidus*)
- American badger (*Taxidea taxus*)
- San Joaquin kit fox (*Vulpes macrotis mutica*)

Photograph 2.2.4-7. Example of Agricultural Land Use Adjacent to Newman Wasteway Including an Irrigation Canal and Structures to the Right

- tri-colored blackbird (*Agelaius tricolor*)
- golden eagle (*Aquila chrysaetos*)
- burrowing owl (*Athene cunicularia hypugea*)
- Swainson's hawk (*Buteo swainsoni*)
- western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)
- California horned lark (*Eremophila alpestris actia*)
- prairie falcon (*Falco mexicanus*)
- bald eagle (*Haliaeetus leucocephalus*)
- loggerhead shrike (*Lanius ludovicianus*)
- heartscale (*Atriplex cordulata*)
- brittlescale (*Atriplex depressa*)

- lesser saltscale (*Atriplex miniscula*)
- alkali milk-vetch (*Astragalus tener* var. *tener*)
- big tarplant (*Blepharizonia plumosa* ssp. *plumosa*)
- hispid bird's-beak (*Cordylanthus mollis* ssp. *hispidus*)
- diamond-petaled California poppy (*Eschscholzia rhombipetala*)
- round-leaved filaree (*Erodium macrophyllum* var. *macrophyllum*)
- delta button celery (*Eryngium racemosum*)
- showy madia (*Madia radiata*)
- slender-leaved pondweed (*Potamogeton filiformis*)
- Sanford's arrowhead (*Sagittaria sanfordii*)

Numerous California Species of Special Concern, such as the American badger (*Taxidea taxus*), and candidate species also occur in the project study area (DWR and Reclamation 2005). Several State-listed species (Swainson's hawk) and species of concern (burrowing owl, white-tailed kite, California horned lark, tri-colored blackbird) could forage in the Study area. Special-status plants that could occur in the vicinity include the Delta button celery.

Aquatic Biological Resources

The Study area (**Figure 1-1**) sustains a broad range of ecologically, commercially, and recreationally important fisheries. The Sacramento–San Joaquin ecosystem supports five fish species that are listed under the Federal and California ESAs, one of the largest recreational fisheries in California, and one of the largest commercial fisheries of the Pacific Coast. The fisheries provide substantial economic, cultural, scientific, and social value. This section describes fishery-related conditions in all water bodies that may be affected by implementation of the DMC Recirculation Project. For the species of primary management concern in the Sacramento–San Joaquin ecosystem (listed below), the habitat associations are described in the context of the species' life stage requirements for the area of analysis, and more specifically described for the identified water bodies.

The DMC Recirculation Project would be expected to affect flows, at times, in some reaches of the Stanislaus River and SJR while increasing Delta exports. Changes in flow would be expected to influence temperature and salinity as well. As a result, the DMC Recirculation Project would be expected to affect fisheries resources within three major aquatic ecoregions in the project study area: the Delta, the SJR, and tributaries to the SJR.

Principal Management Species. Species of primary management concern were identified based on their legal status and ecological, commercial, and recreational significance (**Table 2.2.4-2**). Species descriptions are provided in **Appendix H, Attachment H1**. Fish species listed under Federal and California ESAs are both ecologically and institutionally important; some listed species are also recreationally and commercially important. The Federally and State-listed species within the area of analysis are:

- Winter-run Chinook salmon
- Central Valley spring-run Chinook salmon (*O. tshawytscha*)
- Central Valley steelhead (*O. mykiss*)
- Longfin smelt
- Delta smelt
- Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*)

Fall- and late-fall-run Chinook salmon are species of concern under the Federal ESA.

Longfin smelt have recently been proposed for listing as endangered under the Federal and California ESAs (Bay Institute et al. 2007a, b). The California Fish and Game Commission ruled in February 2008 that listing of longfin smelt appeared to be warranted and imposed emergency regulations governing their take, while CDFG undertakes a review of their status. On March 4, 2009, the California Fish and Game Commission approved listing the longfin smelt as threatened under the California ESA (CDFG 2009). The Service accepted the petition for listing of longfin smelt in May 2008 and requested information for their review (Service 2008b). On April 9, 2009 the Service ruled that the Federal listing was not warranted as the delta population was not a distinct segment.

Table 2.2.4-2. Sacramento–San Joaquin Fish Species of Primary Management Concern

Regulatory Status	Species	Location (Area of Analysis)	Reason for Management Consideration
ESA Listed	Winter-run Chinook Salmon	Upstream and Delta areas	FE, SE
	Spring-run Chinook Salmon	Upstream and Delta areas	FT, ST
	Steelhead	Upstream and Delta areas	FT, Recreation
	Delta smelt	Upstream and Delta areas	FT (proposed for FE), SE
	Longfin smelt	Upstream and Delta areas	ST
	Green sturgeon	Upstream and Delta areas	FT, Recreation
Species of Concern	Fall-/late-fall-run Chinook Salmon	Upstream and Delta areas	FSC, SSC Commercial, Recreation
	Sacramento Splittail[1]	Upstream and Delta areas	SSC
	Longfin smelt	Upstream and Delta areas	ST (proposed for FE)
None	White sturgeon	Upstream and Delta areas	Ecological, Recreation
	Striped bass	Upstream and Delta areas	Recreation
	American shad	Upstream and Delta areas	Recreation

Note:
[1] Sacramento splittail were previously listed as threatened, but this listing has been rescinded.

Key:

FE = Federal endangered
FC = Federal candidate
FT = Federal threatened
FSC = Federal species of concern
SE = State endangered
SSC = State special concern
ST = State threatened

Petitions have been filed to change the status of Delta smelt from threatened to endangered under both the Federal and California ESAs (Center for Biological Diversity et al. 2006; Bay Institute et al. 2007c). On March 4, 2009, the California Fish and Game Commission voted to uplist the Delta smelt to endangered status under the California ESA ("State gives delta smelt species new protections" 2009). A determination on the proposed Federal uplisting has not been made.

Recreationally important species in addition to salmon and steelhead include American shad and striped bass. Two species were also identified due to their ecological significance and sensitivity to flow and temperature: white sturgeon and Sacramento splittail (*Pogonichthys macrolepidotus*), the latter of which is a California Species of Concern.

Evaluating potential impacts on fishery resources requires an understanding of both the physical habitat and the fish species' life histories and life stage-specific environmental requirements within the project study area. Refer to the Fisheries Technical Memorandum (ENTRIX 2008) for general information regarding the life histories of species that are of primary management concern and the water bodies (ecoregions) that would be affected by the DMC Recirculation Project.

Pelagic Organism Decline. Pelagic organism decline (POD) refers to the recent (2002–present) step decline of pelagic fishes (fish that occupy open-water habitats) within the Bay-Delta (Armor et al. 2005; Interagency Ecological Program 2005; DWR and CDFG 2007; Sommer 2007). This issue has emerged as one of overwhelming concern in the Delta.

Although the causes of this decline are not fully understood, Delta operations and associated hydrodynamics have been identified as one of the potential causal factors. Because the DMC Recirculation Project would alter Delta hydrodynamics and SJR inflow to the Delta and because of the POD's current importance in the management of Delta operations, POD is discussed in more detail below.

The issues surrounding the POD were announced in early 2005 as a possible change in the estuary's ability to support pelagic species and appeared to be a "step-change" from the preceding long-term decline. Four fish species are of primary concern: Delta smelt, longfin smelt, young-of-year striped bass, and threadfin shad. From 2002 to present, despite moderate hydrologic conditions in the estuary that would have been expected to result in moderate increases in population sizes, the populations of these species experienced sharp declines, as indicated by the results of the annual fall midwater trawl[1] survey and confirmed through other sampling programs. Populations of each of the four species have been at or near all-time record lows since 2002.

This change has persisted for a sufficiently long period to conclude that it is the result of something other than the pattern of widely variable population levels observed historically or part of the long-term decline previously observed. However, some disagreement exists over whether this steep decline is truly different from the long-term decline (California Bay-Delta Authority Science Program 2005).

[1] The fall midwater trawl is a long-term survey conducted in the fall (usually September through December) to monitor the abundance of young-of-year striped bass. Other species are also caught, so the dataset is used to evaluate the abundance of these species, as well.

Larval phases of Delta and longfin smelt, striped bass, and threadfin shad occur primarily in the Delta and occupy open water, feeding upon zooplankton and other small fishes in the water column. Because these four species share a pelagic life stage that occurs within the Delta, and fish species with different life history patterns or in other parts of San Francisco Bay have not shown similar declines over this same period, it is believed that the decline in these four species may stem from the same cause or suite of causes (DWR and CDFG 2007; Sommer 2007). To date, research has failed to identify a single factor responsible for the decline of all species or even that of a single species (Bennett 2005; Michael Chotkowski, Acting Regional Environmental Officer, Reclamation, pers. comm., April 2007; Sommer 2007).

POD researchers currently believe that important factors responsible for the decline may be different for each species, and that even for a single species these factors may differ between seasons and by hydrologic condition (wet and dry years) (Sommer 2007; DWR and CDFG 2007). These factors may operate cumulatively to cause the observed population declines.

The POD Management Team has hypothesized that the three factors most likely to be responsible for the decline are the effects of exotic species, toxins, and water operations (DWR and CDFG 2007). The individual importance of these three potential factors is still an unresolved question. Many of the Interagency Ecological Program studies to evaluate the causes of the POD have focused on these factors. According to the 2005 POD Synthesis (Interagency Ecological Program 2005) and the 2007 Pelagic Fish Action Plan (DWR and CDFG 2007), these three potential causal factors are likely to work in direct and indirect ways through “top-down,” “bottom-up,” and habitat pathways.

Top-down pathways reduce the populations of pelagic species through direct mortality caused by predation, entrainment, or other factors. Bottom-up pathways reduce the populations of pelagic species by reducing the productivity of the ecosystem at the lower levels of the food web, thereby reducing the amount of food available for the pelagic fish species, or through competition, which reduces the availability of the food produced. Habitat pathways are changes in the amount or quality of habitat available (Sommer 2007). These pathways are not entirely separate or distinct. For example, a change in salinity (one habitat parameter) might not affect striped bass directly, but might reduce the population of one of its prey items. Declines in the population of the prey items may then cause a subsequent reduction in striped bass survival. In this example, a change in habitat resulted in a bottom-up effect on the striped bass population.

Salmonids. The four runs of Chinook salmon, fall, late-fall, winter, and spring, as well as Central Valley steelhead, have all experienced long-term declines over the past several decades. Within the past decade some stocks have declined while others have stabilized or even improved, creating the current complex situation in regard to Central Valley salmonids. The heavy influence of hatchery stocks among all of these runs further complicates the overall assessment of the current species status. Fall-run returns have improved over the past decade but the population has become heavily dependent on hatchery production, leaving managers uncertain of the overall sustainability of wild populations (Williams 2006).

However, the 2007 Central Valley fall-run totaled only 90,400 fish, the lowest count since 1973 and below the Pacific Fishery Management Council's minimum conservation target of 122,000 fish. Additionally, the count of early spawners known as jacks fell to 2,021 fish, well below the 36-year average of 40,000. Jacks are considered a reliable indication of the number of fish that will spawn in the next year as 3-year olds. The late-fall run is included in the Central Valley fall-run evolutionarily significant unit and has received very little attention in terms of research and monitoring. As a result, the population trajectory of this run, and the factors governing it, remain unclear (Williams 2006).

The winter-run remains a small population with limited habitat downstream of Keswick Dam. The population has grown in recent years, but remains far from recovery (NMFS 2004; Williams 2006).

The spring-run population in Sacramento River tributary streams such as Butte Creek has grown in recent years, while stocks in the main stem Sacramento River have declined (Williams 2006). Overall, the spring-run has shown broad fluctuations in abundance (NMFS 2004).

Wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries with other much smaller populations in the lower Sacramento River and SJR basins. Data on Central Valley steelhead are limited but the Distinct Population Segment is thought to be highly fragmented and suffering a continued decline corresponding with declining habitat conditions throughout the Central Valley (NMFS 2004).

Sturgeon. Although the San Francisco Bay-Delta population of white sturgeon was seen as a success story after recovering from historical overfishing (Moyle 2002), in the past few years the population may have suffered another decline (CDFG 2006). The recent decline and the reasons for it are currently the subject of research. Green sturgeon as a species have benefited from a decline in fishing pressure on them. While the larger West Coast population may be robust (S.P. Cramer & Associates 2002), the Bay-Delta population may be experiencing a long-term decline in productivity (NMFS 2005b).

Splittail. Sacramento splittail are obligate floodplain spawners (Moyle and Crain 2007). High fecundity and multiple breeding year classes make their populations resilient under wet conditions when floodplain spawning habitat is available (Moyle et al. 2004). Splittail reached their lowest numbers after a series of drought years, but have recovered in recent years due to favorable hydrologic conditions and improved habitat access.

Project Ecoregions. For the assessment of impacts to aquatic resources, the study area is divided into three ecoregions: the Delta, the SJR, and tributaries to the SJR. These ecoregions have different physical conditions, biological uses, and potential project effects and therefore the evaluation of potential effects differs within these ecoregions.

Sacramento–San Joaquin River Delta. The Bay-Delta makes up the largest estuary on the West Coast. The Delta covers over 48,000 acres of tidally influenced river channels and sloughs, separated by leveed islands that surround the confluence of the Sacramento River and SJR. The legal boundaries for the Delta form a triangle-shaped area defined by Collinsville in the west, Freeport on the Sacramento River, and Vernalis on the SJR (ENTRIX 2008, Figure 2-14).

The north Delta is dominated by Sacramento River water that is relatively low in salinity; the SJR and south Delta are relatively higher in salinity. The south Delta is dominated by inflows from the SJR and tidal influence. The western end of the Delta is dominated by ocean tides that enter through the Golden Gate and transit San Francisco Bay, San Pablo Bay, Carquinez Strait, Suisun Bay, and Honker Bay. The central or interior Delta comprises interconnecting channels that convey tidal flows and river inflows into and out of the Delta.

The south Delta is bounded by the SJR on the north and east and by Old River on the south. Flow through the south Delta is strongly influenced by SJR flows, riparian pumping and various discharges, exports at the CVP and SWP pumps, and the operation of temporary barriers in Old River, Middle River, and Grant Line Canal. The hydrodynamic conditions in the south Delta strongly affect both the entrainment risk of numerous species at the pumps and habitat conditions.

The Delta supports one or more life stages of a diverse assemblage of anadromous, freshwater, euryhaline, and saltwater species. Portions of the estuary have been identified as critical habitat under the Federal ESA for spring- and winter-run Chinook salmon, Central Valley steelhead, and Delta smelt and Essential Fish Habitat under the Magnuson Act for commercially important fish species. The Delta provides spawning or nursery habitat for more than 40 fish species, including Delta smelt, Sacramento splittail, American shad, white sturgeon, and striped bass. The Delta is a migration corridor and provides seasonal rearing habitat for Chinook salmon and steelhead. Species such as green sturgeon use the Delta as a migratory corridor, juvenile nursery, and adult foraging habitat. Longfin smelt spawn in the Delta estuary and rear in Suisun Bay and San Pablo Bay. Delta smelt complete their entire life cycle in the Delta and Suisun Bay.

Hydrodynamics. Flows in the Delta are influenced by the water management upstream and within the Delta. Water developments have altered the timing and magnitude of river flows into the Delta, affecting the timing and location of salinity gradients. These changes affect a variety of parameters that are used to govern operation of the Delta and many others that influence fish habitat and their populations. Regulatory requirements include, but are not limited to, Delta outflow, X2 (the 2-part-per-thousand isopleth) location, and E/I ratios. In addition, negative flows in Old and Middle rivers have been used as a management tool to protect Delta smelt. These parameters are described in **Section 2.2.1**.

D-1641 limits the ratio of the water exported by the combined CVP/SWP pumps to the total inflow to the Delta (E/I ratio) to be less than 65% from July through January, or 35% from February through June. Exceptions to the 35% requirement are allowed in February under some circumstances. Lower E/I ratios are presumed to be beneficial to fish (NMFS 2005a; Service 2004), in that a smaller proportion of the total flow is being diverted and, thus, presumably a smaller proportion of the fish are subjected to the adverse effects of the pumps.

Statistical relationships between E/I and biological productivity or population indices have not been developed. Furthermore, substantially different conditions could be present in the Delta at the same E/I ratio (e.g., 1,000 cfs exports with 10,000 cfs inflow versus 10,000 cfs exports with 100,000 cfs inflow).

Biologists with expertise in Delta operations have stated that no biologically meaningful thresholds or specific amount of change in E/I could be identified as significance criteria (Victoria Poage, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, and Jim White, Staff Environmental Scientist, California Department of Fish and Game, pers. comm., August 24, 2007). For these reasons, changes in E/I ratios were not used in the evaluation of alternative plans.

Entrainment. As described previously, export operations of the SWP and CVP affect fish survival within the Delta, both directly and indirectly (Service 2005). An unknown fraction of the fish entrained by the pumps is lost, but both entrainment and loss are assumed to be proportional to salvage. Relative entrainment numbers do not necessarily represent changes in population size, however, as fish distribution within the Delta varies widely within and among water year types (described in detail in the Fisheries Technical Memorandum [ENTRIX 2008]).

Table 2.2.4-3 presents the estimated annual average entrainment index calculated for existing conditions for all modeled water years and for wetter and drier hydrologic conditions. The entrainment index is equal to the volume of water pumped by export facilities multiplied by the average salvage density for each species. The average salvage densities are based on observed salvage densities from 1993 through 2003 and consider fish densities, movement patterns, and Delta operations during those years.

The data in **Table 2.2.4-3** provide a basis for comparing the effects of the alternative plans but do not represent the absolute number of fish entrained. The absolute numbers differ from actual salvage numbers, which are not reported on a monthly basis because of the recent declines in fish populations relative to those present when the actual salvage densities used in the model were estimated. Additionally, actual values would severely distort the relative effects of the alternatives if the actual values were compared to modeled values. The values have changed in recent years, as described previously.

As shown in **Table 2.2.4-3,** for most species, more fish are entrained in wetter conditions than in drier conditions, which is consistent with the amount of water diverted during these two hydrologic conditions. The entrainment index for longfin smelt and threadfin shad is considerably greater in drier conditions than in wetter conditions. Drier conditions result in these species being brought into closer proximity to the pumps. The entrainment indices are highest for most native Delta species from February through April and again in September. For salmonids, entrainment indices are highest in September through March with peak monthly values varying by species.

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Table 2.2.4-3. Estimated Entrainment Index[1] at SWP and CVP Combined for Existing Conditions

Species	Water Year Type[2]	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1–15	Apr 16–30	May 1–15	May 16–31	Jun	Jul	Aug	Sep	Annual Total
Delta Smelt	Wet	3,052	2,166	879	363	25,887	43,512	2,108	8	3	0	4	643	252	37,960	116,837
	Above Normal	2,895	1,897	875	400	14,672	30,171	1,977	8	3	0	4	600	145	25,255	78,902
	Below Normal	1,851	1,700	1,721	1,027	31,629	22,309	1,192	0	0	9	101	486	417	73,568	136,010
	Dry	1,923	1,531	1,378	666	24,751	17,250	1,099	0	0	10	105	497	296	54,394	103,900
	Critical	1,486	1,243	1,089	401	14,284	10,695	897	0	0	7	87	395	199	30,001	60,784
Striped Bass	Wet	105,144	48,402	11,139	1,789	112,193	2,322,072	1,015,021	166,496	33,439	27,841	78,606	68,967	1,235	163,024	4,155,368
	Above Normal	100,741	42,568	11,261	1,999	63,144	1,720,679	919,986	157,231	32,177	27,302	79,223	64,318	714	108,675	3,330,018
	Below Normal	32,791	37,123	34,036	7,095	105,061	2,097,606	504,203	31,943	22,327	123,815	209,257	56,185	2,571	250,500	3,514,513
	Dry	32,602	33,375	28,750	4,802	82,936	1,711,073	491,733	27,200	18,189	130,364	216,056	57,711	1,924	206,760	3,043,475
	Critical	27,694	27,048	23,247	3,067	53,870	1,103,590	335,514	18,899	14,991	99,720	142,841	45,740	1,447	116,075	2,013,743
Longfin Smelt	Wet	78	27	13	13,946	663	52	42	11	0	0	0	20	10,846	901	26,599
	Above Normal	74	25	12	10,218	355	36	40	10	0	0	0	18	6,137	609	17,534
	Below Normal	79	35	323	12,850	24,478	1,055	1	0	0	11	6	15	4,773	56,674	100,300
	Dry	78	32	281	8,621	19,124	805	1	0	0	12	6	15	3,530	40,985	73,490
	Critical	67	27	230	5,443	10,781	494	1	0	0	9	4	12	2,592	22,518	42,178
Threadfin Shad	Wet	403,695	231,704	13,061	8,565	3,639	225,441	730,490	1,145,928	578,916	475,831	398,824	381,098	6,067	4,624	4,607,883
	Above Normal	392,180	216,331	13,469	8,886	1,851	161,268	651,773	1,067,989	561,553	453,389	401,884	357,547	3,491	3,177	4,294,788
	Below Normal	364,051	170,003	31,197	14,435	1,415	351,763	2,247,953	821,616	302,487	991,077	535,013	261,874	5,086	3,266	6,101,236
	Dry	349,090	149,428	26,004	9,862	1,104	289,753	2,142,216	718,844	248,300	1,040,874	556,408	264,068	3,858	2,327	5,802,136
	Critical	319,490	118,910	20,912	6,379	613	188,160	1,576,997	531,586	203,774	871,852	434,473	212,070	2,978	1,275	4,489,469
Fall-Run Chinook Salmon	Wet	5,219	18,918	3,743	7,650	32,340	18,137	324	62	335	39	127	199	5,761	48,310	141,164
	Above Normal	5,078	16,920	3,632	6,434	18,592	13,101	291	59	313	38	128	186	3,278	32,016	100,066
	Below Normal	87	90	2,562	17,511	19,410	542	2	21	0	223	132	241	8,024	44,217	93,062
	Dry	86	81	2,005	10,760	15,079	440	2	19	0	235	138	247	5,401	29,431	63,924
	Critical	74	66	1,569	5,947	7,793	282	1	15	0	178	109	196	3,163	15,924	35,317
Winter-Run Chinook Salmon	Wet	8,699	2,194	1,998	312	7	1	0	0	0	0	0	1,073	239	9	14,532
	Above Normal	8,211	1,872	1,879	247	4	1	0	0	0	0	0	999	135	6	13,354
	Below Normal	2,614	4,096	7,666	446	14	0	0	0	0	0	0	2,017	187	32	17,072
	Dry	2,777	3,774	5,865	285	11	0	0	0	0	0	0	2,062	131	20	14,925
	Critical	2,041	3,118	4,539	168	5	0	0	0	0	0	0	1,640	85	11	11,607

Table 2.2.4-3. Estimated Entrainment Index[1] at SWP and CVP Combined for Existing Conditions

Species	Water Year Type[2]	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1–15	Apr 16–30	May 1–15	May 16–31	Jun	Jul	Aug	Sep	Annual Total
Spring-Run Chinook Salmon	Wet	7	150	8,054	36,280	12,336	2,835	0	0	3	7	0	0	27,557	18,420	105,649
	Above Normal	7	130	7,766	29,476	7,090	1,989	0	0	3	7	0	0	15,656	12,209	74,333
	Below Normal	7	3	3,244	17,455	3,980	7	0	0	0	0	0	0	7,818	9,062	41,576
	Dry	7	3	2,522	10,842	3,091	6	0	0	0	0	0	0	5,314	6,015	27,800
	Critical	6	2	1,966	6,101	1,593	4	0	0	0	0	0	0	3,196	3,252	16,120
Steelhead	Wet	9,326	15,980	5,926	2,008	720	342	117	2	0	56	63	361	1,468	1,037	37,406
	Above Normal	8,922	13,982	5,818	1,884	403	250	93	2	0	56	63	338	840	693	33,344
	Below Normal	2,427	11,878	14,199	1,923	311	126	65	0	0	4	93	190	754	716	32,686
	Dry	2,535	10,755	11,375	1,265	243	105	60	0	0	5	96	196	544	502	27,681
	Critical	1,937	8,765	8,993	777	132	69	49	0	0	3	65	155	378	274	21,597
Splittail	Wet	5,972	2,733	2,347	2,742	53,279	903,266	223,203	5,135	699	423	177	272	1,998	68,606	1,270,852
	Above Normal	5,699	2,397	2,254	2,601	27,373	710,624	190,335	4,785	671	409	179	254	1,143	46,989	995,713
	Below Normal	1,170	1,251	2,124	2,046	141	3,410	429	68	91	171	110	307	927	341	12,586
	Dry	1,220	1,157	1,648	1,264	112	2,916	428	61	74	180	114	315	627	298	10,414
	Critical	935	958	1,285	705	77	1,942	270	46	61	138	75	250	372	168	7,282
American Shad	Wet	88,893	10,688	859	763	1,463	56,608	441,595	283,395	91,075	159,424	285,668	162,950	589	2,261	1,586,231
	Above Normal	85,292	9,395	817	575	864	38,820	399,655	266,214	86,091	152,940	287,878	152,662	334	1,488	1,483,025
	Below Normal	37,424	6,379	981	542	41	10,369	209,409	86,978	37,125	144,452	270,324	154,992	224	93	959,333
	Dry	37,868	5,785	770	349	32	7,830	199,112	79,674	29,993	151,798	280,811	157,384	158	64	951,628
	Critical	30,990	4,721	604	208	17	4,764	147,629	64,735	24,839	124,592	213,949	125,764	104	35	742,951

Notes:

[1] The entrainment index is equal to the volume of water pumped by export facilities multiplied by the average salvage density for each species based on observed salvage densities from 1993 through 2003 and are based on fish densities, movement patterns, and Delta operations during those years.

[2] Water year hydrologic classifications include wet, above normal, below normal, dry, and critical year types. The Sacramento or San Joaquin Basin Index, originally specified in the 1995 Bay/Delta Plan, is used to determine water year type as implemented in D-1641. Index value is calculated from unimpaired run-off for either the Sacramento or San Joaquin Basin.

Key:

CVP = Central Valley Project
SWP = State Water Project

Flows in the south Delta. Flows within the Delta are influenced by the tides, flows from upstream areas, exports, in-Delta diversions, and agricultural return flows. The influence of these elements varies depending on the location within the Delta. Water within channels in the Delta "sloshes" back and forth with the tides. When the tide ebbs, downstream flow (toward the ocean) increases. When the tide floods, downstream flows decrease and even "reverse" (flow away from the ocean). The effects of in-Delta diversions and exports can increase the magnitude and duration of these reverse flows and in some areas reverse flows are the norm.

The flows in the south Delta are described in the hydrology section (**Section 2.2.1**), with further detail on flow and stage data at additional locations presented in **Appendix F, Attachment F1**. The magnitude and direction of flows in the south Delta affect habitat values in this area and can influence the vulnerability of some species to predation.

Flows within the south Delta are influenced by the VAMP, a 31-day pulse flow that occurs in the lower SJR as a D-1641 condition. More information on VAMP flows is provided in **Section 1.8.7** and in the SJRA discussion under **Section 2.2.2**.

Proportion of Sacramento and San Joaquin Rivers Flows in the south Delta. Changes in water composition in south Delta waters may affect the ability of anadromous salmonids to return to their natal streams. The water in the Delta comes from a variety of sources including the Sacramento River, the SJR, Suisun Bay, and many other sources.

As a result of the DMC Recirculation Project, the proportion of these various sources may change, with Delta water, containing a large fraction of Sacramento River water, being released down the SJR. This change is expected to affect primarily the proportion of Sacramento River and SJR water. Water from other sources would remain similar to existing conditions or the No-Action Alternative. These changes in source water may result in increased straying of fish. For the PFR, source fractions were analyzed at three locations: Middle River east of Bacon Island, Old River west of Bacon Island, and SJR at Rindge Pump (**Figure 2.2.4-1**). This analysis excludes June through August, as few salmonids are migrating during that period. Source fractions were predicted using the Delta Simulation Model 2 (DSM2) model, as described in **Appendix B** with results summarized in **Appendix H**.

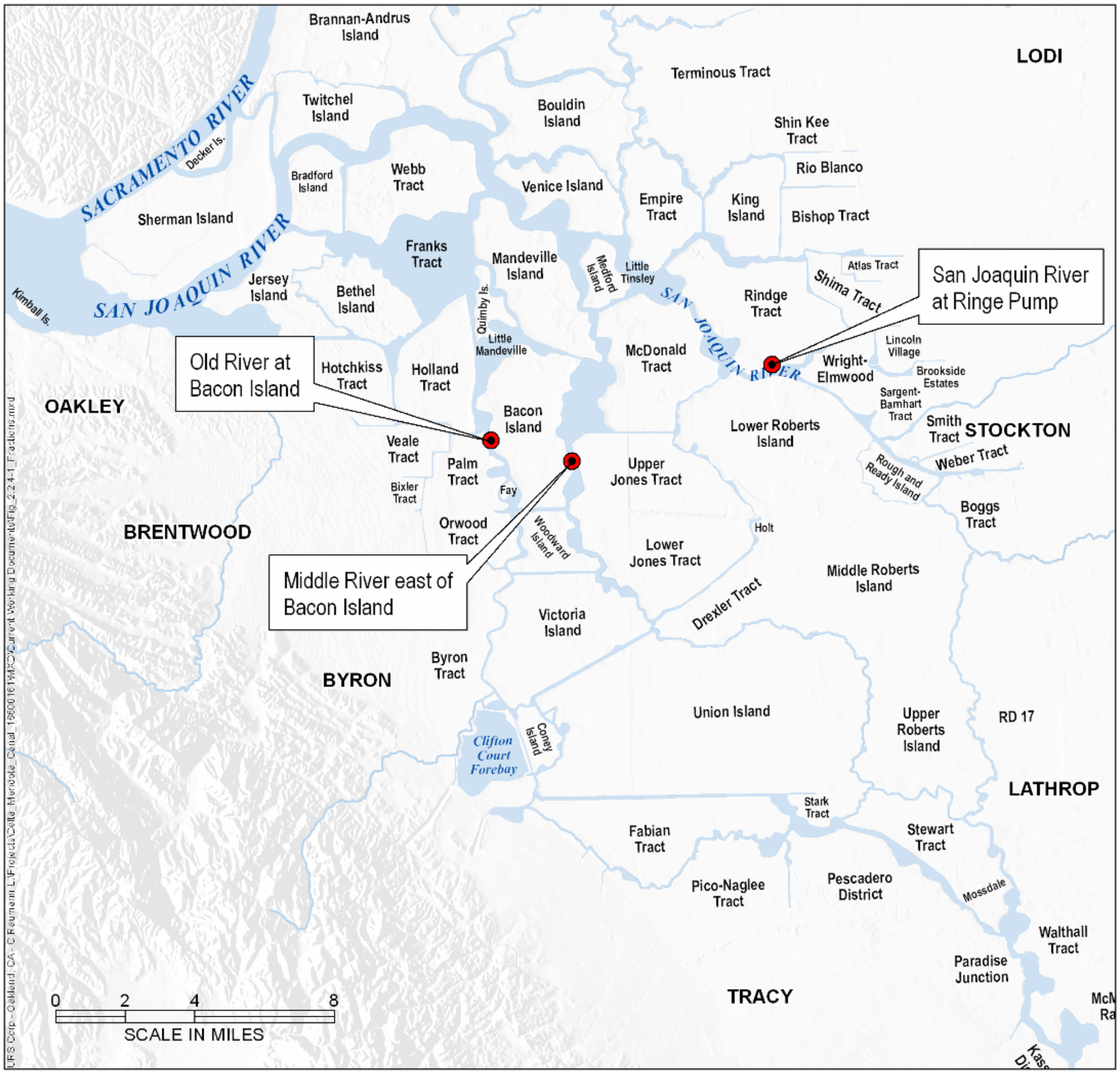

Figure 2.2.4-1. Delta Locations for the Source Fraction Analysis

Because existing data for source fractions are not available, DSM2-modeled results for existing conditions are shown in **Tables 2.2.4-4 through 2.2.4-9**. In Middle River east of Bacon Island, Sacramento River water is predicted to constitute the majority of the water during the winter months, and most of the year during dry water years (**Table 2.2.4-4**).

In wet years, the proportion of Sacramento River water is over 60% of Middle River in the fall, but less than 10% during the spring months. In critically dry years, Sacramento River water constitutes 60 to 80% of Middle River water most of the year. The proportion of SJR water dominates the water during wet water years (54 to 84%) between February and July, and during the spring months of most water year types (**Table 2.2.4-5**).

In Old River at Bacon Island, Sacramento River water constitutes the majority of the water most of the time (generally more than 70%, **Table 2.2.4-6**). In spring of wet water years, the proportion of Sacramento River water in Middle River is lower (24 to 50%). Only in May of wet water years is the SJR water dominant in Old River (**Table 2.2.4-7**). In all other water year types, the proportion of SJR water is less than 10% most of the year (with the exception of May, when it composes 10 to 40% of the water).

Sacramento River water comprises a very small proportion of water in the SJR at Rindge Pump, with the largest proportion occurring in June and July of drier years (up to 30%, **Table 2.2.4-8**). SJR water is dominant at all times, with more than 85% in October, November, April, and May. Approximately 20% of the water comes from other rivers during the wet months (December–April). During critically dry summers, up to 60% of the water comes from different sources (**Table 2.2.4-9**).

Table 2.2.4-4. Modeled Average Proportion of Total Water Composition from Sacramento River in the Middle River east of Bacon Island under Existing Conditions

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-15	Apr 16-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
Wet	0.67	0.65	0.62	0.40	0.19	0.10	0.09	0.09	0.05	0.05	0.09	0.23	0.49	0.59
Above Normal	0.64	0.60	0.59	0.52	0.27	0.20	0.25	0.23	0.15	0.11	0.36	0.69	0.78	0.77
Below Normal	0.70	0.67	0.73	0.75	0.65	0.59	0.62	0.53	0.28	0.22	0.53	0.78	0.85	0.83
Dry	0.64	0.63	0.70	0.76	0.67	0.59	0.60	0.53	0.27	0.22	0.59	0.81	0.84	0.81
Critical	0.70	0.64	0.74	0.81	0.75	0.66	0.64	0.61	0.45	0.39	0.60	0.79	0.83	0.81
All	0.67	0.64	0.67	0.62	0.46	0.38	0.39	0.36	0.22	0.18	0.39	0.61	0.73	0.74

Table 2.2.4-5. Modeled Average Proportion of Total Water Composition from San Joaquin River in the Middle River at Bacon Island under Existing Conditions

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-15	Apr 16-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
Wet	0.23	0.25	0.21	0.34	0.54	0.68	0.71	0.73	0.81	0.84	0.77	0.61	0.34	0.25
Above Normal	0.26	0.28	0.25	0.27	0.45	0.52	0.50	0.53	0.68	0.74	0.39	0.12	0.08	0.11
Below Normal	0.20	0.24	0.15	0.09	0.15	0.17	0.15	0.25	0.55	0.62	0.25	0.07	0.04	0.07
Dry	0.26	0.27	0.14	0.08	0.13	0.18	0.18	0.26	0.58	0.64	0.24	0.05	0.04	0.10
Critical	0.21	0.27	0.16	0.07	0.09	0.13	0.15	0.18	0.37	0.45	0.23	0.05	0.03	0.08
All	0.23	0.26	0.19	0.19	0.31	0.38	0.39	0.44	0.62	0.68	0.42	0.23	0.13	0.14

Table 2.2.4-6. Modeled Average Proportion of Total Water Composition from Sacramento River in the Old River at Bacon Island under Existing Conditions

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-15	Apr 16-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
Wet	0.92	0.91	0.83	0.66	0.46	0.36	0.37	0.34	0.24	0.30	0.41	0.62	0.84	0.91
Above Normal	0.91	0.89	0.81	0.73	0.61	0.63	0.70	0.60	0.41	0.48	0.76	0.90	0.93	0.92
Below Normal	0.93	0.93	0.92	0.90	0.87	0.87	0.87	0.76	0.54	0.62	0.83	0.91	0.93	0.93
Dry	0.93	0.93	0.92	0.91	0.89	0.88	0.88	0.80	0.64	0.68	0.84	0.90	0.92	0.92
Critical	0.92	0.91	0.91	0.91	0.88	0.87	0.86	0.85	0.79	0.78	0.84	0.89	0.90	0.91
All	0.92	0.91	0.87	0.80	0.71	0.68	0.69	0.63	0.49	0.54	0.70	0.82	0.90	0.92

Table 2.2.4-7. Modeled Average Proportion of Total Water Composition from San Joaquin River in the Old River at Bacon Island under Existing Conditions

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-15	Apr 16-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
Wet	0.01	0.02	0.05	0.14	0.32	0.43	0.43	0.46	0.58	0.52	0.42	0.25	0.07	0.02
Above Normal	0.01	0.03	0.09	0.11	0.16	0.14	0.10	0.18	0.37	0.32	0.09	0.01	0.00	0.00
Below Normal	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.08	0.26	0.22	0.05	0.01	0.00	0.00
Dry	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.06	0.20	0.20	0.05	0.01	0.00	0.00
Critical	0.01	0.01	0.01	0.00	0.01	0.02	0.02	0.02	0.08	0.10	0.05	0.01	0.00	0.00
All	0.01	0.02	0.04	0.06	0.13	0.16	0.15	0.20	0.33	0.30	0.16	0.08	0.02	0.01

Table 2.2.4-8. Modeled Average Proportion of Total Water Composition from Sacramento River in the San Joaquin River at Rindge Pump under Existing Conditions

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-15	Apr 16-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
Wet	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Above Normal	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00
Below Normal	0.00	0.00	0.02	0.04	0.01	0.01	0.02	0.00	0.00	0.00	0.02	0.08	0.07	0.01
Dry	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.00	0.00	0.00	0.04	0.14	0.08	0.01
Critical	0.00	0.00	0.04	0.08	0.02	0.02	0.05	0.01	0.00	0.01	0.10	0.30	0.22	0.04
All	0.00	0.00	0.02	0.03	0.01	0.01	0.02	0.00	0.00	0.00	0.03	0.10	0.07	0.01

Table 2.2.4-9. Modeled Average Proportion of Total Water Composition from San Joaquin River in the San Joaquin River at Rindge Pump under Existing Conditions

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-15	Apr 16-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
Wet	0.95	0.91	0.75	0.76	0.79	0.84	0.85	0.93	0.97	0.97	0.96	0.93	0.92	0.95
Above Normal	0.96	0.89	0.76	0.79	0.81	0.83	0.91	0.96	0.97	0.95	0.89	0.80	0.82	0.91
Below Normal	0.95	0.93	0.79	0.74	0.82	0.86	0.86	0.95	0.97	0.93	0.82	0.67	0.70	0.86
Dry	0.96	0.89	0.68	0.76	0.82	0.85	0.86	0.95	0.96	0.91	0.75	0.58	0.66	0.87
Critical	0.94	0.95	0.84	0.73	0.79	0.80	0.75	0.87	0.93	0.88	0.66	0.39	0.45	0.76
All	0.95	0.91	0.77	0.76	0.81	0.83	0.84	0.93	0.96	0.93	0.83	0.70	0.73	0.88

San Joaquin River. The SJR area of analysis is focused primarily on the SJR between the confluence of Newman Wasteway with the SJR (just upstream of the SJR's confluence with the Merced River) downstream to where the SJR flows into the Delta, at the head of Old River. Details regarding the facilities and water bodies within the SJR area of analysis and the fisheries resources they support are described in IAIR, Section 3.1.1.1 (Reclamation 2008).

The reaches considered for this analysis are:

- Newman Wasteway Confluence to Merced River Confluence (River Miles 119 to 118)
- Merced River Confluence to Tuolumne River Confluence (River Miles 118 to 86)
- Tuolumne River Confluence to Stanislaus River Confluence (River Miles 86 to 80)
- Stanislaus River Confluence to Old River (River Miles 80 to 54)

The SJR's lower reaches from the Merced River to Vernalis are used by anadromous salmonids for immigration, seasonal rearing, and emigration from September to June. Spawning habitat is not available in this reach for salmonids due to substrate, water temperature, and water quality conditions. This 43-mile reach includes the confluences of the Stanislaus, Tuolumne, and Merced rivers, the main tributaries to the SJR entering from the eastern side of the valley. Flows in the SJR at Vernalis are influenced by the operations of dams on the tributary rivers, as well as releases from Mendota Pool on the SJR.

Flow. Flow requirements are described in **Section 2.2.2**, and flows under existing conditions are described in **Section 2.2.1**, with further detail on flow and stage data at additional locations presented in **Appendix F, Attachment F1**.

Water Quality. The water quality regulatory requirements and existing conditions are described in **Section 2.2.3**, with further detail presented in **Appendix F, Attachment F1**.

Stanislaus River. The DMC Recirculation Project may affect flow and water temperature and quality on the Stanislaus River downstream of New Melones Reservoir.

Temperature. The *Biological Opinion on Long-Term Central Valley Project and State Water Project Operations Criteria and Plan* (NMFS 2004) includes terms and conditions relating to temperature on the Stanislaus River at Orange

Blossom Bridge, as presented in **Section 2.2.3**. As noted in **Section 1.8.6**, the CVP/SWP operations BO has recently beeen revised.

Available temperature information for Orange Blossom Bridge from 2001 through 2007 was downloaded and is presented in **Section 2.2.3**. Monthly average temperatures ranged from 49°F to 62°F between 2001 and 2007, reaching the low 60s in the summer of drier years.

Merced and Tuolumne Rivers. The DMC Recirculation Project would have little effect on flows or water quality on the Merced and Tuolumne rivers. It may affect the anadromous fish resources of these rivers because these fish must pass through the SJR and Delta on their way to and from the ocean. Changes in water quality and composition in these waters may affect the ability of these fish to home effectively to their natal streams. Additionally, these changes in source water may result in increased straying of fish from other rivers into the Merced and Tuolumne rivers.

2.2.5 Socioeconomic Resources

This section describes existing socioeconomic conditions in the Study area. The main purposes of this section are to (1) provide a general overview of the local economies and other socioeconomic resources that may be affected by the proposed DMC Recirculation Project, and (2) provide context to potential economic impacts of the project. The socioeconomic resources addressed in this section include demographics (i.e., population and race/ethnicity) and the economic base of local counties (i.e., industries, employment, and income). In addition, economic values associated more specifically with DMC water supplies are also presented, focusing on agricultural production, urban and environmental uses, recreation, and electrical energy demand and generation.

The study area for the economic analysis varies by resource topic. The primary study area corresponds to areas affected by CVP water supplies in and south of the Delta, and includes a number of water agencies serving agricultural and urban interests in Calaveras, Contra Costa, Fresno, Kings, Merced, San Benito, San Joaquin, Santa Clara, Stanislaus, and Tuolumne counties. As such, the potential socioeconomic effects of the DMC Recirculation Project are expected to be concentrated in these 10 counties, and accordingly, data on existing economic conditions are focused on these areas.

However, certain socioeconomic effects could also occur in other regions of the State. For example, reoperation of the CVP water system could result in changes in water releases from reservoirs in the northern Sacramento Valley, which in turn could affect energy generation. As a result, the delineation of the relevant study area for each resource topic will be identified on a case-by-case basis based on the nature of potential impacts.

The data used to describe existing socioeconomic conditions are derived from a variety of Federal, State, and local sources. Data sources used in this section include the U.S. Census Bureau, U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics, California Department of Finance, California Employment Development Department, and county government reports and websites. Due to the large size of the study area, the information presented here is primarily at the county level.

Demographics

This section provides an overview of the demographic characteristics of residents living in the 10-county study area, focusing on population and race/ethnicity. Demographic parameters that represent economic indicators of social well-being (e.g., per-capita income, poverty rates, unemployment) are addressed in the context of income and employment, which are presented as part of the discussion on the regional economy. Other demographic characteristics, such as age and gender, are not pertinent to the DMC Recirculation Project and, therefore, are not discussed here.

Population. The population in the 10-county study area represents a substantial component of California's population base. In total, approximately 5.5 million people resided in the study area in 2007, which accounts for nearly 15% of the State's population (**Table 2.2.5-1**). Most of this population is concentrated in the urban Bay Area region, namely Contra Costa and Santa Clara counties, with populations of 1.0 million and 1.8 million residents, respectively. Population levels in the Central Valley counties vary considerably, ranging from about 46,000 in Calaveras County to 917,500 in Fresno County.

Since 1990, regional population growth in the study area has outpaced growth at the State level. Population in the 10-county area grew at an average annual rate of 1.6% between 1990 and 2000, and between 2000 and 2007, the annual

Table 2.2.5-1. Population and Population Growth in the Study Area (1990 to 2007)

County/Area	Population			Population Growth[1]	
	1990	2000	2007	1990–2000	2000–2007
Calaveras	31,998	40,554	46,028	2.4%	1.8%
Contra Costa	803,732	948,816	1,042,341	1.7%	1.4%
Fresno	667,490	799,407	917,515	1.8%	2.0%
Kings	101,469	129,461	151,381	2.5%	2.3%

Table 2.2.5-1. Population and Population Growth in the Study Area (1990 to 2007)

County/Area	Population			Population Growth[1]	
	1990	2000	2007	1990–2000	2000–2007
Merced	178,403	210,554	251,510	1.7%	2.6%
San Benito	36,697	53,234	57,803	3.8%	1.2%
San Joaquin	480,628	563,598	679,687	1.6%	2.7%
Santa Clara	1,497,577	1,682,585	1,808,056	1.2%	1.0%
Stanislaus	370,522	446,997	521,497	1.9%	2.2%
Tuolumne	48,456	54,501	57,223	1.2%	0.7%
Study Area	**4,216,972**	**4,929,707**	**5,533,041**	**1.6%**	**1.7%**
State of California	**29,758,213**	**33,871,648**	**37,662,518**	**1.3%**	**1.5%**

Sources: California Department of Finance (2002, 2007a)

Note:

[1] Population growth reported on an average annual basis.

growth rate increased slightly, to 1.7%. During these same timeframes, population growth in the State was 1.3% and 1.5%, respectively. During the 1990s, the highest rates of population growth were concentrated in San Benito, Kings, and Calaveras counties. Since 2000, the highest rates of population growth shifted to the Central Valley, including San Joaquin, Merced, Kings, Stanislaus, and Fresno counties, all of which had growth rates exceeding 2% annually.

Race and Ethnicity. Race and ethnicity are important factors for evaluating potential environmental justice-related effects of the DMC Recirculation Project. The racial and ethnic composition of the 10-county study area is presented in **Table 2.2.5-2**. Generally, the racial and ethnic composition of the study area population matches closely with that of the State. The two predominant racial groups in the study area are Whites (Caucasians) and Hispanics; together, these groups comprise roughly 78% of the region’s population. The Hispanic population is more prominent in most of the Central Valley counties, such as Fresno, Kings, and Merced counties, where they

Table 2.2.5-2. Race and Ethnicity in the Study Area by County and in the State of California (2004)

County/Area	Race (Percent of Total Population)						
	White	Black/ African American	American Indian/ Alaska Native	Asian	Native Hawaiian / Pacific Islander	Multirace	Hispanic / Latino
Calaveras	85.9%	0.7%	1.6%	0.8%	0.1%	2.4%	8.4%
Contra Costa	55.8%	8.7%	0.4%	11.9%	0.4%	2.1%	20.7%
Fresno	37.2%	4.9%	0.8%	8.9%	0.1%	1.3%	46.9%
Kings	41.4%	8.0%	0.9%	2.7%	0.1%	1.4%	45.5%
Merced	37.0%	2.9%	0.5%	6.1%	0.1%	1.5%	51.9%
San Benito	42.6%	1.0%	0.6%	2.4%	0.2%	1.4%	51.8%
San Joaquin	43.6%	6.7%	0.7%	13.3%	0.3%	2.4%	33.1%
Santa Clara	43.0%	2.7%	0.4%	26.6%	0.5%	2.2%	24.8%
Stanislaus	52.1%	2.4%	0.8%	4.6%	0.3%	1.9%	37.8%
Tuolumne	85.1%	1.9%	1.6%	0.6%	0.1%	1.7%	8.8%
Study Area[1]	**45.9%**	4.8%	0.6%	**14.9%**	**0.3%**	**1.9%**	**31.7%**
State of California	**44.6%**	6.0%	0.6%	**11.6%**	**0.4%**	**2.0%**	**34.8%**

Source: California Department of Finance (2006)

Note:

[1] Figures represent an average of the counties in the Study area, weighted by population.

account for about half of the population. The relatively large proportion of Hispanics living and working in the Central Valley is characteristic of many agricultural areas where related agricultural industries support a large Hispanic workforce. The other racial groups, combined, represent approximately 22% of the regional population in the study area, consisting mainly of Asians (14.9%) and Blacks/African-Americans (4.8%), with the other groups accounting for less than 3% of the population.

The racial composition varies substantially among study area counties. Calaveras and Tuolumne counties have the highest White population (about 85%) and the lowest Hispanic population (about 8%). In addition, these two counties have the highest Native American populations in the study area, roughly 1.6% of their total populations. As indicated above, the Hispanic population is highest in the Central Valley counties, primarily due to the need for agricultural labor. Finally, as is the case with many urban counties, Contra Costa and Santa Clara counties appear to be some of the more racially diverse counties in the study area. In these two counties, the Black/African American population ranges from 2.7 to 8.7%, and the Asian population ranges from 11.9 to 26.6%, respectively.

Regional Economy and Economic Base

This section describes the regional economies that comprise the study area, focusing on the components of the economic base that may be affected by the DMC Recirculation Project. Such economic effects could include changes in production and employment across a range of economic sectors, as well as related effects on earnings and income of local workers.

Employment and Major Industries. Information on total and industry employment provides important insight into the size, strength, and diversity of a local economy. Total employment across the 10 counties in the study area is presented in **Table 2.2.5-3**. In total, the study area counties supported roughly 2.8 million part- and full-time jobs in 2005. Overall, the largest number of jobs is found in Santa Clara County, which provides over 1.1 million jobs and accounts for over 40% of the study area job base. Other counties generating substantial employment include Contra Costa County (501,700 jobs) and Fresno County (436,800 jobs). Conversely, several smaller economies provide substantially fewer jobs, including Calaveras County (17,800 jobs), San Benito County (23,700 jobs), and Tuolumne County (27,800 jobs).

Growth in regional employment has shifted over time. Between 1990 and 2000, the number of jobs in the study area grew at an average rate of 1.9% per year, which exceeded the rate of job growth in the State (1.5%). However, since 2000, regional employment in the overall study area has declined, falling by

Table 2.2.5-3. Employment and Employment Growth in the Study Area by County and in the State of California (1990 to 2005)

County/Area	Employment (Jobs)			Employment Growth[1]	
	1990	2000	2005	1990–2000	2000–2005
Calaveras	11,738	15,440	17,767	2.8%	2.8%
Contra Costa	400,160	477,646	501,710	1.8%	1.0%
Fresno	345,726	411,608	436,751	1.8%	1.2%
Kings	40,344	50,611	56,778	2.3%	2.3%
Merced	77,254	84,576	90,803	0.9%	1.4%
San Benito	15,618	21,604	23,687	3.3%	1.9%
San Joaquin	215,763	259,492	286,411	1.9%	2.0%
Santa Clara	1,044,672	1,282,671	1,117,157	2.1%	–2.7%
Stanislaus	173,179	209,914	225,706	1.9%	1.5%
Tuolumne	20,593	24,340	27,828	1.7%	2.7%
Study Area	**2,345,047**	**2,837,902**	**2,784,598**	**1.9%**	**–0.4%**
State of California	**16,965,207**	**19,626,033**	**20,548,594**	**1.5%**	**0.9%**

Source: U.S. Department of Commerce–Bureau of Economic Analysis, 2005a

Note:

[1] Employment growth reported on an average annual basis.

approximately 53,000 jobs, or an average of 0.4% annually. The decline was precipitated by regional job losses in Santa Clara County. In fact, the other counties in the study area all experienced job growth between 2000 and 2005, led by Calaveras County, which experienced an average annual growth rate of 2.8%.

Information on which industries are providing these jobs demonstrates the relative importance of specific industries in these economies. Employment by industry under existing conditions in the 10-county study area is presented in **Table 2.2.5-4**. Generally, the local economies that comprise the study area are diverse in terms of industries and jobs. Overall, the largest grouping of industries in the study area in 2005 was Other Services, which supports approximately 1.3 million jobs and accounts for about 46% of the regional job base. Other prominent industries in the regional economy include Wholesale and Retail Trade (at least 13% of the total job base) and Government[1] (about 12%).Farm and agricultural employment in the study area supported nearly 69,000 jobs or 2.5% of the study area total in 2005. At the county level, Fresno

[1] Includes Federal, State, and local government, as well as military employment.

Table 2.2.5-4. Employment by Industry in the Study Area (2005)

Industry/ Sector[1]	Employment (Jobs) by County[2]										Study Area[3]	
	Calaveras	Contra Costa	Fresno	Kings	Merced	San Benito	San Joaquin	Santa Clara	Stanislaus	Tuolumne	Total	Percent of Total
Farm and Agriculture	525	1,204	23,559	5,365	9,159	1,779	11,613	4,046	10,949	351	68,550	2.5
Natural Resources and Mining	(D)	2,315	34,458	4,059	(D)	(D)	9,511	1,943	8,004	371	*<60,661>*	*<2.2>*
Construction	2,487	40,462	27,484	1,827	5,113	2,414	21,451	55,988	17,217	2,389	176,832	6.4
Manufacturing	696	22,416	28,896	4,066	11,307	3,000	22,045	175,411	22,958	1,182	291,977	10.5
Wholesale and Retail Trade	2,316	69,535	60,799	6,028	(D)	3,116	44,787	144,851	35,809	3,774	*<371,015>*	*<13.3>*
Transportation and Warehousing	398	10,042	11,553	1,033	2,675	(D)	14,740	16,231	7,208	400	*<64,580>*	*<2.3>*
Utilities	99	1,582	1,552	116	(D)	(D)	1,158	1,599	269	105	*<6,480>*	*<0.2>*
Finance and Insurance	399	38,445	16,666	963	1,890	533	10,346	36,395	6,556	641	112,834	4.1
Other Services	(D)	265,829	165,435	14,238	28,856	7,734	112,270	584,738	88,734	12,688	*<1,280,522>*	*<46.0>*
Government	2,475	49,880	66,349	19,083	14,534	2,976	38,490	95,955	28,002	5,927	323,671	11.6
Total[4]	**17,767**	**501,710**	**436,751**	**56,778**	**90,803**	**23,687**	**286,411**	**1,117,157**	**225,706**	**27,828**	**2,784,598**	**100.0**

Source: U.S. Department of Commerce–Bureau of Economic Analysis 2005b

Notes:

1 Industry/sectors based on a summary of the North American Industry Classification System.

2 (D) = Estimates not available to avoid disclosure of confidential information. Values included in county totals.

3 Italicized numbers in brackets represent partial totals based on available data at the county level and exclude figures that are not available because of disclosure issues (see footnote 2).

4 Totals may not equal the sum of column values because of disclosure issues (see footnote 2).

County provided the greatest number of agricultural jobs (roughly 23,600); however, on a proportional basis, agriculture in Merced and San Benito counties plays a larger role, accounting for 10.1 and 7.5% of county jobs, respectively. Indirectly, farming and agriculture also support numerous jobs in those industries that supply inputs to agricultural operations (e.g., farm machinery and fertilizers) and industries that are reliant on agricultural commodities (e.g., food-processing plants).

Unemployment. Local unemployment figures are a common indicator of social and economic well-being within a community. Information on the size of the labor force and average annual unemployment rates in the study area since 1990 is presented in **Table 2.2.5-5**. Unemployment in the study area has remained fairly stable since 1990, falling from 7.0% in 1990 to 5.6% in 2000 and subsequently rising to 6.0% in 2005. Although the pattern of these historical fluctuations in unemployment holds across individual counties and the State, there is substantial variation in unemployment rates across the study area. Generally, unemployment rates are lower in more urban areas, such as Contra Costa County (4.3% in 2005) and Santa Clara County (4.5%). During this same period, unemployment in parts of the Central Valley reached as high as 9.3% (Merced County).

Income. Total personal income[1] levels in the study area are presented in **Table 2.2.5-6**. In total, personal income in the 10-county study area in 2005 was \$203.7 billion. In real terms, total income in the study area has increased by approximately 47% between 1990 and 2005. In a manner similar to employment, income levels declined between 2000 and 2005 (–1.1% annually), unlike the previous decade when income growth averaged 4.5% annually; again, recent declines in aggregated income levels has been driven by decreases in income levels in Santa Clara County. In absolute terms, Santa Clara County had the highest personal income in 2005 (\$87.2 billion) and Calaveras County had the lowest (\$1.3 billion). However, growth in personal income since 2000 has been highest in Kings County (4.7% annually).

[1] Personal income is defined as the income that is received by persons from participating in production, from both government and business transfer payments, and from government interest (which is treated like a transfer payment). It is calculated as the sum of wage and salary disbursements, other labor income, proprietors' income with inventory valuation and capital consumption adjustments, rental income of persons with capital consumption adjustment, personal dividend and interest income, and transfer payments to persons, less personal contributions for social insurance (Bureau of Economic Analysis 2005a).

Table 2.2.5-5. Unemployment in the Study Area by County and in the State of California (1990, 2000, and 2005)

County/Area	1990		2000		2005	
	Labor Force	Unemp. Rate[1,2]	Labor Force	Unemp. Rate[1,2]	Labor Force	Unemp. Rate[1,2]
Calaveras	13,450	6.8%	18,100	5.6%	20,900	5.8%
Contra Costa	435,400	4.0%	500,700	3.5%	518,500	4.3%
Fresno	328,900	11.7%	388,100	10.4%	414,800	8.0%
Kings	37,600	11.3%	49,200	10.0%	55,600	8.5%
Merced	76,900	12.9%	90,300	9.6%	100,200	9.3%
San Benito	21,000	12.2%	27,400	6.0%	25,100	7.0%
San Joaquin	227,200	9.9%	258,800	7.0%	287,800	7.4%
Santa Clara	852,800	4.0%	940,300	3.1%	834,400	4.5%
Stanislaus	180,500	11.9%	207,700	7.8%	227,100	8.0%
Tuolumne	19,880	6.7%	22,800	5.9%	26,300	5.9%
Study Area	**2,193,630**	**7.0%**	**2,503,400**	**5.6%**	**2,510,700**	**6.0%**
State of California	**15,168,500**	**5.8%**	**16,857,500**	**4.9%**	**17,901,900**	**4.9%**

Source: California Employment Development Department (2007)

Notes:

1 Annual unemployment rates are based on nonseasonally adjusted monthly unemployment data.

2 Unemployment rates represent an average for the Study area counties, weighted by population.

Table 2.2.5-6. Total Personal Income and Income Growth in the Study Area (1990 to 2005)

County/Area	Income[1] (in thousands of dollars)			Income Growth	
	1990	2000	2005	1990–2000	2000–2005
Calaveras	$832,054	$1,168,170	$1,336,573	3.5%	2.7%
Contra Costa	$32,276,144	$49,163,949	$49,475,309	4.3%	0.1%
Fresno	$16,936,997	$20,431,153	$22,796,108	1.9%	2.2%
Kings	$2,030,598	$2,454,403	$3,089,692	1.9%	4.7%
Merced	$4,098,575	$4,791,306	$5,538,179	1.6%	2.9%
San Benito	$981,213	$1,809,328	$1,728,453	6.3%	–0.9%
San Joaquin	$12,209,026	$15,945,070	$17,331,848	2.7%	1.7%
Santa Clara	$58,611,893	$105,920,139	$87,154,432	6.1%	–3.8%
Stanislaus	$9,429,897	$12,254,100	$13,552,168	2.7%	2.0%
Tuolumne	$1,187,859	$1,470,542	$1,662,474	2.2%	2.5%
Study Area	**$138,594,257**	**$215,408,159**	**$203,665,236**	**4.5%**	**–1.1%**
State of California	**$972,874,001**	**$1,279,395,717**	**$1,335,386,437**	**2.8%**	**0.9%**

Source: U.S. Department of Commerce–Bureau of Economic Analysis (2005a)

Note:

[1] Monetary values reported in constant 2005 dollars.

Table 2.2.5-7 presents earnings by industry (a component of total personal income) in the study area in 2005. The measure of earnings by industry is more relevant than total personal income for evaluating the potential impacts of the DMC Recirculation Project on the local economy because it focuses on wages/salaries of employees and proprietor's (or business) income and excludes other factors such as transfer payments, which are unlikely to be affected by the Project. In 2005, total earnings in the study area were $164.1 billion, representing 80% of total personal income. Following patterns similar to employment, the Other Services sector grouping had the highest level of earnings (at least $64.5 billion), which accounted for about 40% of all earnings in the study area. Other sectors that provide a relatively high proportion of employment earnings include Manufacturing (20.1%) and Government (12.2%). Farm-related earnings account for only 1.5% of the study area total. At the county level, however, farm earnings in Merced and San Benito counties account for a significantly higher proportion of total earnings at 14.2 and 11.0%, respectively.

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Table 2.2.5-7. Earnings by Industry in the Study Area (2005)

Industry/ Sector[1]	Earnings (by County)[2,3]										Study Area[4]	
	Calaveras	Contra Costa	Fresno	Kings	Merced	San Benito	San Joaquin	Santa Clara	Stanislaus	Tuolumne	Total	Percent of Total
Farm and Agriculture	–$5,978	$786	$692,773	$171,738	$509,056	$101,972	$339,448	$129,870	$488,025	$425	$2,428,115	1.5%
Natural Resources and Mining	(D)	$280,449	$808,668	$104,027	(D)	(D)	$249,015	$107,986	$205,506	$15,202	*<$1,770,853>*	<1.1%>
Construction	$118,734	$3,046,141	$1,446,606	$87,262	$282,088	$107,076	$1,376,725	$3,772,051	$852,986	$95,032	$11,184,701	6.8%
Manufacturing	$20,908	$2,757,260	$1,676,090	$249,795	$489,982	$155,736	$1,138,387	$25,120,905	$1,356,442	$57,668	$33,023,173	20.1%
Wholesale and Retail Trade	$56,608	$2,883,057	$2,118,418	$180,078	(D)	$114,872	$1,604,660	$8,335,112	$1,234,501	$96,243	*<$16,623,549>*	*<10.1%>*
Transportation and Warehousing	$16,555	$748,172	$571,559	$40,347	$125,750	(D)	$769,907	$726,193	$411,476	$14,876	*<$3,424,835>*	*<2.1%>*
Utilities	$8,617	$346,242	$154,633	$9,968	(D)	(D)	$115,532	$1,934,319	$21,118	$7,847	*<$2,598,276>*	<1.6%>
Finance and Insurance	$10,982	$3,111,728	$755,452	$38,325	$78,889	$19,297	$471,264	$2,863,776	$295,820	$21,929	$7,667,462	4.7%
Other Services	(D)	$11,948,743	$5,434,158	$376,649	$816,801	$143,274	$3,479,675	$39,064,748	$2,954,532	$330,240	*<$64,548,820>*	*<39.3%>*
Government	$122,637	$3,225,673	$3,696,814	$1,168,578	$733,658	$172,442	$2,266,622	$6,739,309	$1,565,761	$294,722	$19,986,216	12.2%
Totals[5]	**$526,880**	**$28,348,251**	**$17,355,171**	**$2,426,767**	**$3,576,517**	**$926,908**	**$11,811,235**	**$88,794,269**	**$9,386,167**	**$934,184**	**$164,086,349**	**100.0%**

Source: U.S. Department of Commerce–Bureau of Economic Analysis (2005c)

Notes:

1 Industry/sectors based on a summary of the North American Industry Classification System.

2 Values in thousands of dollars.

3 (D) = Estimates not available to avoid disclosure of confidential information. Values included in county totals.

4 Italicized numbers in brackets represent partial totals based on available data at the county level and excludes values that are not available due to disclosure issues (see footnote 3).

5 Totals may not equal to the sum of column values due to disclosure issues (see footnote 3).

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Income-Related Measures of Social Well-Being. As derivatives of personal income, per-capita income, median household income, and poverty rates represent additional economic indicators of social well-being. These three measures are presented in **Table 2.2.5-8**.

Table 2.2.5-8. Economic Indicators of Social Well-Being in the Study Area and the State of California

County/Area	Per Capita Income (2004)	Median Household Income (1999)[1]	Poverty Rates (1999)[1]
Calaveras	$27,480	$41,022	11.8%
Contra Costa	$46,211	$63,675	7.6%
Fresno	$25,573	$34,725	22.9%
Kings	$21,253	$35,749	19.5%
Merced	$23,379	$35,532	21.7%
San Benito	$30,442	$57,469	10.0%
San Joaquin	$25,527	$41,282	17.7%
Santa Clara	$49,132	$74,335	7.5%
Stanislaus	$25,885	$40,101	16.0%
Tuolumne	$26,578	$38,725	11.4%
Study Area[2]	**$37,042**	**$54,830**	**13.2%**
State of California	**$35,219**	**$47,493**	**14.2%**

Source: California Department of Finance (2007b)

Notes:

[1] Based on 2000 Census data.

[2] Figures presented for the study area are based on an average for the study area counties, weighted by population.

In 2004, average per-capita personal income in the study area was $37,042, which is slightly higher than per-capita income levels at the State level ($35,219). Across counties, per-capita income levels ranged from a high of $49,132 in Santa Clara County down to $21,253 in Kings County. Further, the average median household income in the study area was $54,830, which is about 15% higher than the statewide figure of $47,493.

Poverty rates represent the percentage of an area’s total population living at or below the poverty threshold established by the U.S. Census Bureau. The average poverty rate in the study area is 13.2%, which is lower than the Statewide rate of 14.2%. The poverty rate in individual counties is highest in Fresno County (22.9%) and lowest in Santa Clara County (7.5%).

Economic Conditions Related to DMC Water Supplies

In addition to the information presented above on regional economic conditions across the entire 10-county study area, it is also important to consider the existing economic effects related directly to CVP and DMC water supplies. More specifically, CVP water that is ultimately pumped through the DMC serves a wide variety of uses resulting in a range of market and nonmarket economic benefits. The primary driver of economic benefits under existing conditions is agricultural production in the Delta and other areas served by CVP water supplies in the Central Valley. Other byproducts of CVP water supplies that generate economic benefits and/or costs include M&I and environmental uses, recreation, and electrical energy generation and demand.

Agricultural Production and Values. Agriculture is one of the primary economic activities within the study area, particularly in the Delta region, and relies extensively on CVP water supplies. Agriculture is important in providing crops for final consumption in the local area and other national and international markets, supporting the local dairy and food-processing industries, and stimulating overall economic activity in the region. Existing agricultural production and values, as well as the regional economic activity generated from agriculture, are addressed below.

Current cropping patterns and related agricultural production values in the 10-county study area are presented in **Table 2.2.5-9**. More than 3.5 million acres of land were in crop production in the study area in 2006. The majority of crop production was in field crops (56.4%). The individual shares of fruit, nut, and vegetable crops ranged between 13 and 15% of total acreage, and seed crops accounted for approximately 1% of the total. (No acreage values are associated with nursery crops.) In terms of production value, field crops, which represented over half of the production acreage, only accounted for about 17% of production value in the study area ($1.3 billion). Fruits, nuts, and vegetables had the highest values, each between $1.8 billion and $2.2 billion; together, these three crop groups accounted for over 77% of the total production value in the study area, which was estimated at over $8.0 billion in 2006. The average production value in the 10-county study area was $2,140 per acre.

Changes in agricultural production set in motion a series of “ripple” (or multiplier) effects, which collectively result in changes in output, employment, and income throughout the regional economy. The total economic effects generated by these inter-industry linkages are frequently quantified by the use of input-output models. **Table 2.2.5-10** presents the total economic impacts of current agricultural production in the 10-county study area, which consist of direct, indirect, and induced impacts. As referenced above, the direct output (or value) of agricultural crop production in the study area was over $8.0 billion in

Table 2.2.5-9. Crop Acreage and Value in the Study Area (2006)

Crop Group	Acres	Percentage of Total Acres	Value[1,2]	Percentage of Total Value	Value per Acre[3]
Field crops	1,994,602	56.4%	$1,338,741	16.7%	$671
Fruits	521,586	14.7%	$2,188,920	27.3%	$4,197
Nuts	467,353	13.2%	$1,848,877	23.1%	$3,956
Seed crops	42,339	1.2%	$45,590	0.6%	$1,077
Vegetables	512,017	14.5%	$2,150,688	26.8%	$4,200
Nursery crops	—	—	$438,457	5.5%	—
TOTAL	**3,537,897**	**100.0%**	**$8,011,273**	**100.0%**	**$2,140**

Sources: National Agricultural Statistics Service (2007)

Notes:

[1] Monetary values reported in 2006 dollars

[2] Values in thousands of dollars

[3] Average value per acre excludes nursery crops

Table 2.2.5-10. Regional Economic Impacts – Existing Agricultural Production in the Study Area (2006)

Measure	Direct	Indirect	Induced	Total
Output (in millions of dollars)[1]	$8,011.3	$1,897.8	$2,448.6	$12,357.7
Labor Income (in millions of dollars)[1]	$2,332.3	$921.7	$877.9	$4,131.9
Employment (Jobs)	67,377	30,895	20,770	119,042

Source: IMPLAN data for the 10-county Study area

Notes:

[1] Values reported in 2006 dollars

2006. This level of agricultural production generated an additional $4.3 billion in indirect and induced output, and the total value of output supported by agricultural production in the study area is estimated to be approximately $12.4 billion.

Related measures of income and employment are more relevant to the economic benefits realized at the local level. The direct labor income generated by existing agricultural production was over $2.3 billion, and total labor income was estimated to be over $4 billion in 2006. Finally, the direct and total employment effects of existing agricultural production in the study area were approximately 67,400 and 119,000 jobs, respectively.

Urban Land Uses and Values. Although CVP water primarily serves agricultural uses, it also represents an important source of urban water supplies that support a variety of M&I uses. Several classes of urban water users in the study area may be affected by the DMC Recirculation Project. First, a number of IDs are served by tributaries of the SJR that provide water to local municipalities for domestic use. Next, water that flows from the SJR into the Delta provides urban water supplies to M&I users in the Delta area. Lastly, CVP water that is pumped from the Delta via the DMC serves urban users in the San Felipe Unit of the CVP, in San Benito and Santa Clara counties.

Urban water supplies have economic value. This value is derived from two main sources: the domestic value of water that serves the local population base and the value of production from industrial and other business that rely on water to produce goods and commodities.

The value of domestic water supplies can be difficult to quantify; however, insight can be gained from the amount of money residential water users would be willing to pay to avoid water shortages, which was the subject of numerous studies in the context of the 1987−1992 drought in California. For example, *Drought Management Policies and Economic Effects in Urban Areas of California, 1987−1992* (Dixon et al. 1996) found that the average welfare losses per household associated with the implementation of drought management strategies ranged between $14 and $23 per household over an 18-month period in the early 1990s. Further, *The Value of Water Supply Reliability: Results of a Contingent Valuation Survey of Residential Customers* (California Urban Water Agencies 1994) reported that California residents were willing to pay between $12 and $17 more per month per household on their water bills to avoid water shortages.

For urban water supplies that support industrial and other business production, the value of water is tied to the value of goods and services produced by water-dependent industries. Water is a critical input for many industries in the study area, including food processing, electronics, petroleum production and refining, and chemicals. Reliable water supplies are critical for industrial users, and disruptions can have severe impacts. During the 1987−1992 California drought, industries implemented many programs to reduce both water costs and the risks of production losses. These cost savings (relative to higher-cost alternative water supplies) may be passed along to consumers in the form of lower prices and/or to producers as increases in profits. In either case, economic gains are attributable to low-cost and reliable water supplies for industrial users.

Several empirical studies have evaluated the value of industrial water supplies. The *Cost of Industrial Water Shortages* (California Urban Water Agencies 1991) found that 1 AF of water supports an average of nearly $400,000 of manufacturing plant shipments and 2.6 jobs. More recently, *Envisioning Futures for the Sacramento–San Joaquin Delta* (Lund et al. 2007) found that in the case where no water is exported from the Delta, a scarcity cost of $321.0 million is associated with urban water supplies.

Environmental Uses and Values. CVP water supplies are also used to contribute to the EWA and Level 4 refuge supplies. To the extent that water supplies are used for environmental purposes, a reduction in agricultural water supplies and production may occur. Therefore, the economic value of environmental water supplies can be viewed as the opportunity costs related to reductions in agricultural values and/or acquisition of higher-priced agricultural water supplies. From a more theoretical perspective, CVP water supplies that serve EWA and refuges in the Central Valley are in essence enhancing environmental quality and helping to preserve a range of aquatic and wildlife species, which also have intrinsic economic values. Those values can be quantified in part by using nonmarket valuation techniques; these nonmarket values have not been quantified as part of this Study.

Recreational Activity and Values. A wide range of recreational activities and sites are available in the study area. The prominent recreation sites potentially affected by the DMC Recirculation Project include New Melones Reservoir and the Stanislaus River, which feed the SJR, and SLR, which is affected by flows in the DMC. At the reservoir sites, typical recreation activities include, but are not limited to, boating, fishing, and camping. Along the Stanislaus River, whitewater recreation (e.g., rafting and kayaking) and fishing below New Melones Reservoir are popular activities.

The total economic value of recreation facilitated by CVP water supplies is based, in part, on the number of recreation visitors and visits to the sites referenced above. New Melones Reservoir, the fifth largest lake in California, is estimated to receive approximately 800,000 visitors per year (Reclamation 2007). Most visitor use at New Melones Reservoir occurs within two designated recreation areas, Glory Hole and Tuttletown, which include five campgrounds. At SLR, including O'Neill Forebay and Los Banos Reservoir, approximately 532,000 recreation days were recorded in 2004 (DWR 2006). (Recreation use estimates along the Stanislaus River are not available.)

To the extent that CVP water supplies facilitate recreation opportunities in the study area, these supplies generate recreation values. Economic values attributed to recreation include both use values (i.e., values derived from actual use of a good or service) and nonuse values (i.e., values attributed to resources that are independent of the use of those resources). In the context of recreation, use values are attributed to actively participating in a particular activity, such as fishing, while nonuse values mainly entail the knowledge that a particular recreation opportunity exists and could be used in the future by current or future generations. The use value of recreation can be quantified based on expenditure (or monetary worth) that a person would be willing to pay to participate in a particular recreation activity.

Further, the "net economic value" of recreation is based on the expenditures that someone is willing to pay to recreate above what is actually paid, a concept referred to as "consumer surplus." Because recreational services typically are not directly traded in an open market, recreation values are considered nonmarket values, which require nonmarket valuation estimation techniques.

Using benefit-transfer-methodology-based average consumer surplus values for typical reservoir-based recreation activities, it is possible to estimate the recreation value generated at New Melones Reservoir and SLR under existing conditions. The average consumer surplus value for reservoir-based activities is $47.66 per recreation day (U.S. Forest Service 2005). Applying this value to the approximate 1.3 million recreation days at these two reservoirs yields a total recreation value of approximately $63.5 million per year. In addition, recreation activity induces spending in local economies, thereby resulting in regional economic benefits in the form of increased production, income, and jobs; these regional effects have not been quantified as part of this Study.

Electrical Power–Hydropower Generation and Pumping Demands. The DMC Recirculation Project could affect energy demand at CVP pumping facilities based on increased pumping loads for recirculation, as well as hydropower production throughout the CVP and SWP systems resulting from system re-operations. Changes in both pumping demands and hydropower generation would affect the net amount of energy used in these systems and related energy values. Information on existing energy demands and generation in the CVP and SWP systems is presented below.

Operation of CVP and SWP systems require a substantial amount of energy to pump water from the northern to southern regions of the State. The DMC Recirculation Project would primarily affect pumping loads at Jones Pumping Plant, which pumps water from the Delta through the DMC as part of the CVP. Its counterpart on the SWP system is Banks Pumping Plant, which pumps water from the Delta through the California Aqueduct. The energy requirements related to the operation of these and other pumping plants in the CVP and SWP systems are summarized in **Table 2.2.5-11**.

Table 2.2.5-11. Energy Used at Pumping Plants – CVP and SWP

Facility		Total Energy Used – Annual (in GWH)
CVP[1]	Jones Pumping Plant	599
	O'Neill Pumping Plant	85
	San Luis Pumping Plant[2]	178
	Dos Amigos Pumping Plant[2]	178
	CVP Total	**1,039**
SWP[3]	Banks Pumping Plant	893
	SWP Total	**9,801**

Sources: Reclamation, Central Valley Operations Office (2006); DWR (2006)

Notes:

[1] Based on 2006 data

[2] CVP portion of the joint-use facility

[3] Based on 2004 data

Key:

CVP = Central Valley Project
GWH = gigawatt-hours
SWP = State Water Project

Total energy use at Jones Pumping Plant was approximately 599 gigawatt-hours (GWH) in 2006, which represents nearly 58% of the total energy requirements in the CVP system. Pumping at Banks Pumping Plant generally has a larger energy requirement; roughly 893 GWH of energy was used to pump water at Banks Pumping Plant in 2004, which represents about 9% of total SWP energy use.

The CVP and SWP systems are also significant sources of energy generation. Existing levels of energy generation at CVP and SWP facilities are summarized in **Table 2.2.5-12**. In total, CVP facilities generated approximately 7,300 GWH of energy in 2006. The largest generating facility was at Shasta Lake, which generated about 2,700 GWH of energy, or 36% of total CVP generation. Slightly less energy was generated at SWP facilities in 2004, approximately 6,100 GWH, with the Hyatt-Thermalito Power Plant generating the highest amount of energy (2,300 GWH).

Energy use and generation have associated economic costs and values, which are tied directly to the wholesale value of energy. Wholesale energy values in

Table 2.2.5-12. Energy Generated at Power Plants – CVP and SWP

CVP/SWP	Facility	Total Energy Generated – Annual (GWH)
CVP[1]	Shasta Power Plant	2,653
	Keswick Power Plant	533
	Trinity Power Plant	655
	Judge Francis Carr Power Plant	619
	Spring Creek Power Plant	824
	Folsom Power Plant	897
	Nimbus Power Plant	78
	New Melones Power Plant	912
	O'Neill Pumping Plant	88
	San Luis Pumping Plant[2]	131
	CVP Total	**7,301**
SWP[3]	Hyatt-Thermalito Power Plant	2,294
	San Luis Pumping Plant[4]	183
	Alamo Power Plant	121
	Mojave Siphon Power Plant	80
	Devil Canyon Power Plant	1,282
	Reid Gardner Unit	1,605
	Warne Power Plant	491
	SWP Total	**6,056**

Sources: Reclamation, Central Valley Operations Office (2006); DWR (2006.)

Notes:

1 Based on 2006 data

2 CVP portion of the joint-use facility

3 Based on 2004 data

4 SWP portion of the joint-use facility

Key:

CVP = Central Valley Project
GWH = gigawatt-hours
SWP = State Water Project

California vary by region; for Existing Conditions energy values are estimated at approximately $70 per MWH ($70,000 per GWH).[1] At this price, the estimated value of energy used annually at Jones Pumping Plant is $39.1 million and $72.7 million for all CVP pumping plants. In the SWP system, energy loads at the pumping plants have an estimated total annual value of $686.1 million, of which $62.5 million is attributed to Banks Pumping Plant. Helping to offset these energy costs are values associated with hydropower generation. The values of hydropower generation in the CVP and SWP systems are $511.1 million and $423.9 million, respectively.

2.2.6 Land Use

The SJR basin is in central California and covers approximately 9.6 million acres. It encompasses all or portions of Alameda, Alpine, Amador, Calaveras, Contra Costa, El Dorado, Fresno, Madera, Mariposa, Merced, Sacramento, San Benito, San Joaquin, Stanislaus, and Tuolumne counties. The region is bordered on the east by the Sierra Nevada and on the west by the Diablo Range of the coastal mountains. The SJR basin is hydrologically separated from the neighboring Tulare Lake basin by a low, broad ridge that extends across the San Joaquin Valley between the SJR and Kings River (DWR 2005a).

Although the basin includes a larger number of counties, most of the population and agricultural land use occurs in San Joaquin, Stanislaus, Merced, Contra Costa, and Madera counties. The most productive farmland and rapidly growing urban areas of Stockton, Tracy, Modesto, Manteca, and Merced are in the valley portions of the basin.

The 2007 U.S. Census Bureau data shows that the most populated cities are Stockton, Modesto, Merced, Tracy, and Manteca. Within the SJR basin are approximately 40 Federal, 3 State, and 90 private water and IDs.

According to the *California Water Plan Update 2005* (DWR 2005a), agriculture is the major economic activity in the area with roughly 2.0 million acres of irrigated cropland (approximately 21% of the basin land area) in the year 2000. Agriculture is the major economic activity and this area is viewed as one of California’s most important agricultural regions. Irrigated crops include permanent orchards and vineyards (34%); grains, hay, and pasture (29%); and other major crops including cotton, corn, and tomatoes (DWR 2005a).

Table 2.2.6-1 presents an estimated land use breakdown for the SJR basin and **Figure 2.2.6-1** illustrates dominant land uses.

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[1] The wholesale energy value is based on the average wholesale price of power between 2005 and 2008 in the NP-15 zone in the California Independent System Operator energy system (CAISO 2009).

Table 2.2.6-1. Land Uses in the San Joaquin River Basin

Land Use	Acreage
Urban Area[1]	
Residential	107,600
Urban	153,520
Urban Landscape	12,970
Commercial	9,970
Industrial	34,070
Agricultural Area[2]	
Citrus and Subtropical	9,200
Deciduous Fruits and Nuts	507,520
Field Crops	554,880
Grain and Hay Crops	155,170
Idle Agricultural Land	31,940
Pasture	432,360
Semiagricultural and Incidental to Agriculture	58,110
Truck, Nursery, and Berry Crops	207,040
Rice	21,210
Vineyards	233,010
Native Vegetation[3]	5,378,560
Riparian Vegetation[1]	30,400
Barren/Wasteland/ Vacant/Unknown[1]	46,370
Water Surface[1]	154,970

Sources: DWR (2000); DWR (2005b)

Note:

[1] DWR (2000)

[2] DWR (2005b)

[3] DWR (2000); almost 3 million acres is national forest or national park land (DWR 2005b).

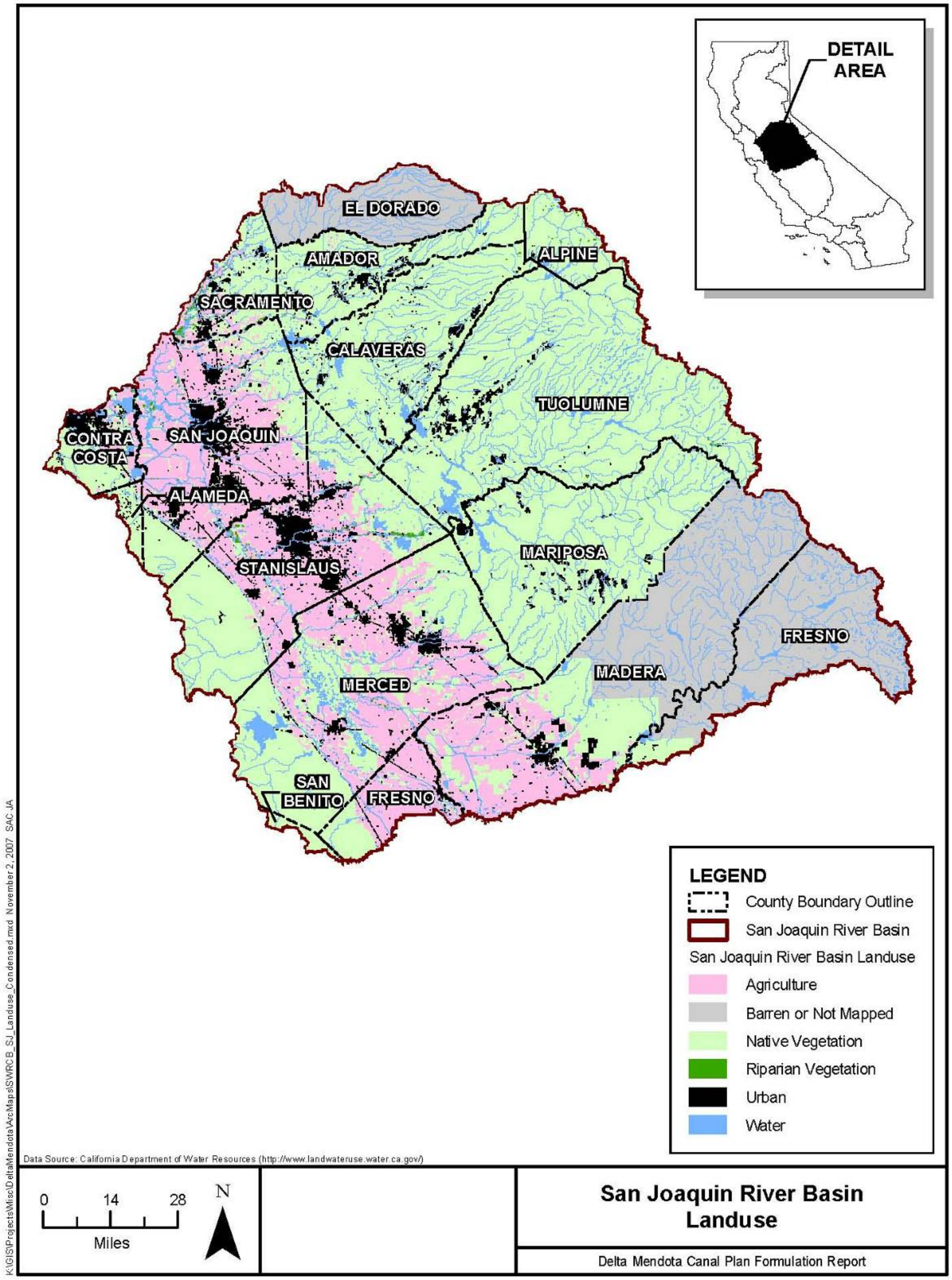

Figure 2.2.6-1. San Joaquin River Basin Land Use

Restoration of the SJR and providing essential habitat for fish and wildlife are also important within the Study area. Lands set aside for habitat restoration and wildlife refuge include the following:

- 26,600-acre San Luis National Wildlife Refuge (Service 2008c)
- 6,500-acre San Joaquin River National Wildlife Refuge (Service 2008d)
- 10,262-acre Merced National Wildlife Refuge (Service 2008e)
- 6,217-acre Los Banos Wildlife Area (CDFG 2008b)
- 2,891-acre Volta Wildlife Area (CDFG 2008c)
- 7,069-acre North Grasslands Wildlife Area (CDFG 2008d)
- 880-acre White Slough Wildlife Area (CDFG 2008e)
- 352-acre Isenberg Sandhill Crane Reserve (CDFG 2008f)
- 46,000-acre Cosumnes River Preserve (Cosumnes River Project and Preserve 2008)

Additional lands are set aside by private duck clubs for wetland habitat (DWR 2005a).

2.3 No-Action Conditions

This section of the document presents the approach for describing No-Action project conditions. As required under NEPA, future conditions with the DMC Recirculation Project must be compared to future conditions without the Project (i.e., the No-Action Alternative) to assess changes.

The planning period for the future condition evaluation varies depending on the resource area. Some resources may have several future condition years (e.g., 2010, 2020, 2030) as required to conduct the analysis, while other resources may only require one future condition year (e.g., 2030). The conditions under the No-Action Alternative are the conditions that are predicted to exist in the Study area during the planning period if recirculation is not implemented.

2.3.1 Physical Environment

Changes to the physical environment assumed for the No-Action Alternative are described in this section. The projection of future conditions is based on the most reasonable foreseeable actions that would occur without the Project, including projects that are currently authorized, funded, permitted, and/or highly likely to be implemented. No projects that would result in changes to the physical pumping, conveyance, or storage facilities were included in the conditions under the No-Action Alternative based on the reasonably foreseeable criteria described above.

2.3.2 Water System Operations, Regulations, and Agreements

Changes to the water system operation assumed for the No-Action Alternative are described in **Table A-1** of **Appendix A**. Several key assumptions relevant to the DMC Recirculation Project are presented in that table. Several key assumptions in the CalSim II modeling that are relevant to this Project include the following:

- 2030 level of development (LOD) for water demand
- Continuation of VAMP
- Implementation of the Salinity Management Plan
- Changes to CVP-SWP coordinated operations, such as:
  - Increase at Jones Pumping Plant to 4,600 cfs
  - Sharing of responsibility for in-basin use
  - Conveyance of Level 2 refuge water supplies at Banks Pumping Plant
  - Implementation of the Phase 8 Short-Term Agreement

2.3.3 Water Resources and Quality

Changes in water resources and quality assumed for the No-Action Alternative are described in **Appendices A through F**. In general, the No-Action Alternative conditions are those in the Study area through the planning time frame if recirculation is not provided to the SJR. The No-Action Alternative includes only regional management and facilities that existed in 2007 or authorized, funded future projects. One key assumption is the discontinuation of the Grassland Bypass Project, with subsequent improvement of water quality in the SJR and decrease in flow in the SJR. Another key assumption for the No-Action Alternative is the continuation of the Temporary Barriers Project for the south Delta. In addition, conditions under the No-Action Alternative reflect releases from New Melones for the purpose of meeting EC and flow objectives in the SJR at Vernalis.

The definitions of conditions under the No-Action Alternative vary slightly depending on the parameter of interest and how the parameter is evaluated (e.g., modeled, qualitative analysis). For parameters modeled by CalSim II or based on parameters modeled by CalSim II (i.e., flow, temperature, turbidity, total suspended solids [TSS], selenium, and boron), conditions under the No-Action Alternative are based on the 2030 LOD. Also, the conditions under the No-

Action Alternative are assumed to represent natural receiving water conditions. For parameters modeled by DSM2 (i.e., stage), the conditions under the No-Action Alternative are based on the 2030 LOD. However, in modeling conditions under the No-Action Alternative, DSM2 also assumes the 2030 level of Delta Island Consumptive Use, assumes no dredging, ignores north of Delta operations, and excludes SDIP but includes temporary barriers instead.

The evaluation of DO in the Port of Stockton DWSC is based on a relationship between flow and DO using historic measured data. The DO concentrations under the No-Action Alternative were calculated using this relationship, and the No-Action Alternative flows were modeled by DSM2. As with the other DSM2 modeling, the No-Action Alternative does not take into account the SDIP, which includes operable barriers within the Delta. The historic DO data used were measured at Rough and Ready Island before both the new WDRs for Stockton Wastewater Treatment Plant or the recent Port of Stockton Settlement requirements were put in place. Because the DO analysis was based on historic concentrations as well as conditions, the predicted concentrations reflect conditions that do not include these two programs, and so these two programs are not taken into consideration in the No-Action Alternative.

Selected water quality parameters (pesticides, metals, nutrients, organic carbon, bromide, pH, and TDS) are evaluated qualitatively using existing conditions as a baseline, because conditions under the No-Action Alternative could not be quantified for these parameters. The level for existing conditions is based on measured data collected from Water Years 2002–2007 where available.

2.3.4 Biological Resources

Future biological conditions will depend on trends in land use and water supply in the Study area. Based on current growth of population and continued conversion of open space and farmland for municipal development, the extent and diversity of biological resources outside defined refuges and reserves continues to shrink.

Various agencies have projected development rates in San Joaquin Valley and are preparing plans for future growth that can be used to make predictions about future conditions for biological resources. Example organizations include the Great Valley Center, the San Joaquin Multi-Species Habitat Conservation Plan, and the planning departments of San Joaquin, Merced, Fresno, and other affected counties. Increased conversion of open space may make the available habitat within the current Study area more valuable. However, the effect of land conversion on the surrounding area may decrease the overall value of the habitat in the proximity of the Study area.

Terrestrial Biological Resources

Changes to biological resources for the No-Action Alternative would be based primarily on changes in water operations and water quality and land use. These assumptions are described in **Sections 2.3.2, 2.3.3**, and **2.3.6**.

Aquatic Biological Resources

Changes to aquatic biological resources for the No-Action Alternative would be based primarily on changes in water operations and water quality. These assumptions are described in **Sections 2.3.2** and **2.3.3**.

2.3.5 Socioeconomic Resources

For the DMC Recirculation Project socioeconomic analysis, conditions under the No-Action Alternative are defined largely by the corresponding assumptions for the No-Action Alternative in three models used in the Study: CalSim II, DSM2, and the Central Valley Production Model (CVPM). Each is based implicitly or explicitly on future California population growth; urban, industrial, and agricultural water demands; and other macro-level variables. The baseline assumption for the No-Action Alternative is a 2030 LOD as incorporated in the CalSim II model. CalSim II outputs are used explicitly as inputs into the CVPM.

In addition, the socioeconomic analysis includes topics that are not explicit in those models. Because data are not available for some of those variables, the socioeconomic analysis for the No-Action Alternative is both quantitative and qualitative. The quantified concepts include those related to agricultural water supply and reliability, agricultural water quality, and hydropower generation. Concepts that are addressed qualitatively include fish survivability, recreation, urban water quality, and commercial fishing.

Central Valley Production Model

The CVPM is a nonlinear, multiregion, and multicrop simulation model of irrigated agriculture in the Central Valley. It is used to measure the economic benefits and costs associated with changes in agricultural water supplies and reliability in the Central Valley.

The CVPM reflects an assumption that agricultural water users make crop and irrigation decisions to optimize net returns, subject to the cost and availability of water supplies. If a water supply is reduced and no other water supply is available, CVPM estimates the mix of cropping and irrigation changes needed to adjust at minimal cost. Cost is defined as lost crop net revenue due to either acreage reductions or actual cost increases. If a new water supply is provided, CVPM estimates the gain in crop net revenue, either because additional acreage can be irrigated or, in most cases, because other more costly supplies such as groundwater can be reduced.

Some of the key assumptions for the No-Action Alternative that were incorporated in the CalSim II model and, by extension, in the CVPM model, include the following:

- Continued conversion of agricultural land to urban uses
- Changes in sources of water to meet changes in land uses
- No changes in water use efficiency in agriculture

Water Quality

Water-quality impacts are assessed based on outputs from the DSM2 model. The results from that model for the No-Action Alternative were used as the basis to calculate, for each alternative plan, the frequency with which salinity thresholds were exceeded for three principal crops grown in the Delta, namely corn, beans, and alfalfa. The analysis used the estimated salinity-yield relationships for these crops and projected levels of salinity in soil and applied water to estimate the potential impacts on crop yields, focusing on salinity measures during critical growing periods relative to threshold values.

Hydropower

The DMC Recirculation Project would affect energy demand at CVP pumping facilities based on increased pumping loads for recirculation, as well as hydropower production throughout the CVP and SWP systems resulting from system reoperation (change in water management decisions) (see **Appendix I**). The analysis assumes that Reclamation would not have to purchase additional energy for the purpose of the DMC Recirculation Project, but instead would use more of the energy generated by the CVP for CVP purposes. Under the conditions of the No-Action Alternative, annual energy use at Jones Pumping Plant is assumed to be 581 MWH in average years and 386 MWH in drought years.

Regional Economic Development Analysis

The regional economic development (RED) analysis shows the impacts of alternative plans on the distribution of regional economic activity, in particular output, employment, income, and population. RED analysis, while not required as part of Federal project evaluation, is often included in water project studies because of interest by local sponsors and stakeholders.

For this Study, regional economic impacts are quantified using IMPLAN, an input-output modeling package and database. Typically, RED analyses include impacts during both construction and operations phases of a project. For this

Study, however, neither construction nor operations and maintenance costs have been determined (except for energy requirements for water system operation), and the impacts of those activities have, therefore, not been quantified. However, the RED analysis does include changes in agricultural production and related regional economic impacts due to changes in surface water deliveries, which are measured at both the State and regional levels.

The assumptions of the No-Action Alternative for the RED analysis include those reflected in the IMPLAN database used. Because conditions for the No-Action Alternative are modeled first in CalSim II and then in CVPM, the results from the latter are used as inputs to the IMPLAN model. Thus, the 2030 LOD assumed in CalSim II and CVPM is reflected in the RED analysis as well. However, IMPLAN is based on fixed input-output coefficients that are based on current conditions and, therefore, the No-Action Alternative scenario for the RED analysis implicitly assumes no changes in the economic structure of affected industries.

2.3.6 Land Use

Future land uses will largely depend on population increase and the availability and reliability of high-quality water supply. According to the California Department of Finance (2007c), population growth in the Study area will range between 24 and 30% between 2000 and 2010. Population growth and the resulting urbanization will generate increasing land use challenges. As populations increase, lands currently used for agriculture will likely be converted for urban uses.

Ecosystem restoration programs will also likely seek agricultural lands for conversion to riparian habitat and refuge areas to provide increased habitat for fish and wildlife along the SJR and its tributaries. In addition, water quality in the Study area has been greatly impacted by historic land uses, so WQOs and requirements may have a significant impact on how land use practices are altered in the future.

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Chapter 3
Plan Formulation Process

The DMC Recirculation Project Feasibility Study must conform to the principles and guidelines in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC 1983), referred to in this report as P&Gs. The plan formulation process for Federal water resources investigations and projects, as defined in the P&Gs is a six-step approach to problem-solving that provides a rational framework for sound decision making. The six steps are:

Step 1: Define water resources problems and needs to be addressed.

Step 2: Identify existing resource conditions and forecast future conditions without implementation of a project.

Step 3: Develop planning objectives, constraints, and criteria.

Step 4: Identify resource management measures and formulate alternative plans for meeting the objectives.

Step 5: Evaluate and compare the alternative plans.

Step 6: Recommend an alternative plan for implementation.

The plan formulation process is iterative, and the steps can be revisited during any part of the planning process.

As shown in **Figure 3-1**, the emphasis in the planning phases changes as the Study progresses. Initially, emphasis is placed on defining problems, needs, and opportunities and on compiling and forecasting conditions in the Study area to support the development of the objectives. The emphasis then shifts to defining management measures and combining them to formulate and evaluate alternative plans, which are used later to prepare the EIS/EIR and Feasibility Study Report.

The results of the Initial Plans Phase, including the results of the initial alternatives evaluation, are documented in the IAIR. The PFR, a follow-up to the IAIR, presents the results of the further development and evaluation of the alternatives. If continued, the next steps in this process would be completion of an EIS/EIR and Feasibility Study Report. A Draft EIS/EIR would be made available for public review and comment, and after the comments have been

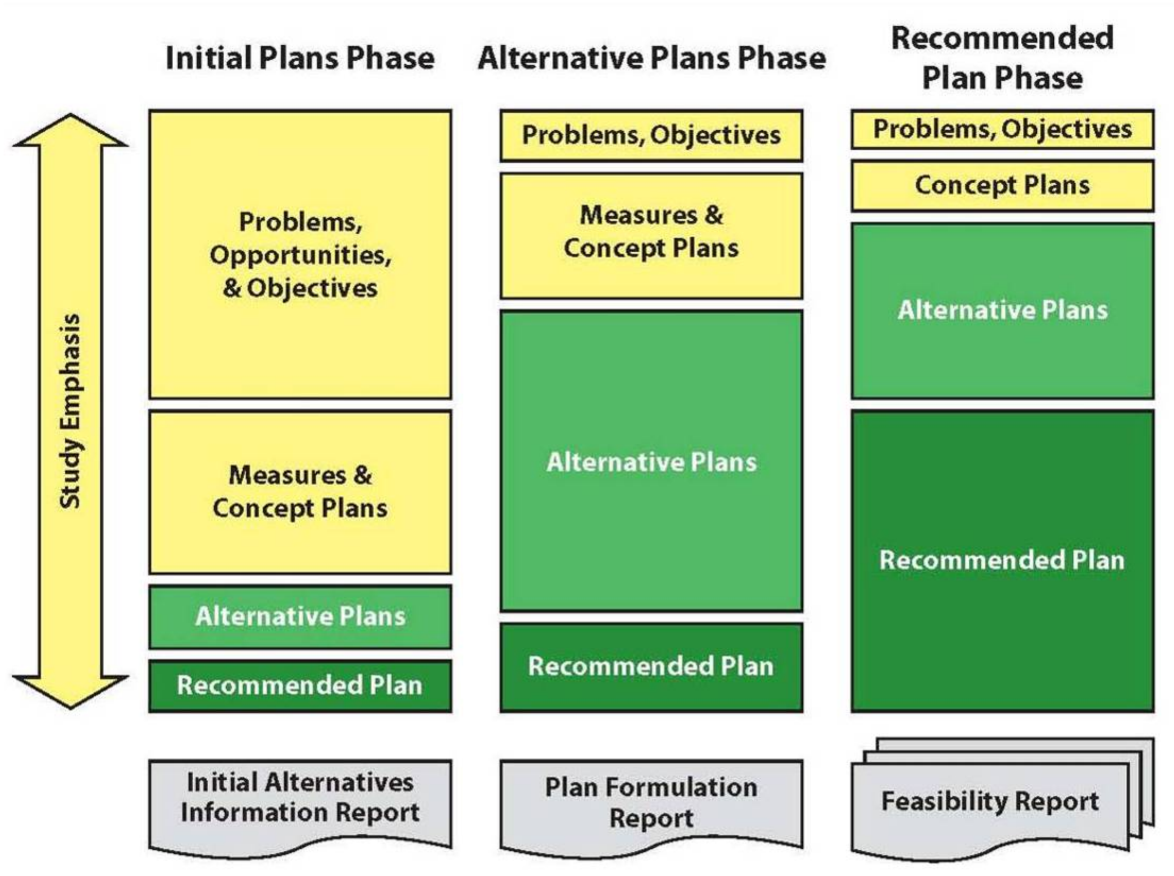


Figure 3-1. Federal Planning Process

addressed, the final EIS/EIR would be prepared and issued, followed by the Feasibility Study Report. The Feasibility Study Report presents an evaluation and comparison of the final alternative plans and a recommended plan. Reclamation would then file a Record of Decision (ROD) and DWR would file a Notice of Determination (NOD) before the project is implemented.

3.1 Development of Initial Alternatives

The IAIR presents the initial alternatives and the process that was used to develop them. The process includes the development of primary planning objectives and other potential benefits, constraints (see **Section 3.4**), and acceptance criteria and an evaluation of resource management measures.

The primary planning objectives are:

- **Objective A**: Provide supplemental flow in the lower SJR for meeting fishery flow objectives through the use of excess capacity[1] in export pumping and conveyance facilities.
- **Objective B**: Provide lower salinity water to the SJR for meeting WQOs at Vernalis through the use of excess capacity in export pumping and conveyance facilities.
- **Objective C**: Provide greater flexibility in meeting the existing water quality standards and objectives for which the CVP has responsibility to reduce the demand on water from the New Melones Reservoir used for that purpose and to assist the Secretary of the Interior in meeting any obligation to CVP contractors from the New Melones Project.

The other potential benefits of the project are:

- Improve DO in the SJR.
- Improve water quality and water levels in the interior south Delta through the use of excess capacity in export pumping and conveyance facilities.

A resource management measure is defined as a feature or activity, structural or nonstructural, that addresses a planning objective without adversely affecting other objectives. The measures were identified or developed during Study team meetings and field inspections with a consideration of relevant input from stakeholders. The measures that have been identified or developed are:

- Delta pumping facilities
- Conveyance facilities
- Storage facilities
- New Melones operational strategies

The measures were evaluated for the degree to which they would fulfill a specific objective, and the results of the evaluation were used to screen the measures. **Table 3-1** is a summary of the screening. See the IAIR for more information about measures screening.

Three main initial alternatives are presented in the IAIR. These alternatives are based on the objective they serve or the major facilities they would use. The alternatives are:

[1] Two definitions of "excess capacity" were utilized to develop the PFR alternatives in response to request by various stakeholders: Capacity in CVP facilities in excess of that needed to meet (1) CVP authorized purposes; or, (2) CVP environmental requirements.

- **Alternative 1: Supplement Current Operation.** Recirculation flows are added on top of New Melones releases, which typically remain at current levels.
- **Alternative 2: CVP Alone.** Only Jones Pumping Plant is used for recirculation flows or to place water in storage.

Table 3-1. Summary of Resource Management Measure Screening

Measure		Status	Comment	Objectives[1]
Delta Pumping Facilities	Jones Pumping Plant	Retained	Excess capacity, used for pilot project	A, B, C, D, E
	Banks Pumping Plant	Retained	Use requires no impact to SWP water deliveries	A, B, C, D, E
Conveyance Facilities	DMC	Retained	Excess capacity, used for pilot project	A, B, C, D, E
	California Aqueduct	Retained	Used to replace recirculated CVP water in SLR	A, B, C, D, E
	Newman Wasteway	Retained	Used for pilot project	A, B, C, D, E
	Westley Wasteway	Retained	Requires outlet conveyance analysis	A, B, C, D, E
	Mendota Pool	Eliminated	Would require sustained flow below Sack Dam for efficient delivery to Vernalis	—
	Friant Reservoir	Eliminated	Requires reliance on implementation of SJRRP. Potential changes in recirculation requirements to be included as sensitivity analysis	—
	Firebaugh and Volta Wasteways	Eliminated	Potential adverse water quality effects from saline shallow groundwater	—
	Natural Creeks	Eliminated	Requires new outlet structures and potential adverse effects from benthic sediment scour	—
	Refuge Pathway	Eliminated	Potential adverse effects on SJR water quality (salinity, organic carbon), refuge operation conflicts	—
Storage Facilities	SLR	Retained	Use for temporary storage of recirculation water	A, B, C
New Melones Operational Strategies	Release recirculation water before New Melones releases	Retained	Assist in bounding operational choices	A, B, C
	Release recirculation water after New Melones releases	Retained	Assist in bounding operational choices	A, B, C

Note:
[1] Objectives are defined in **Section 3.1**

Key:
Banks Pumping Plant = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
DMC = Delta-Mendota Canal
Jones Pumping Plant = C.W. “Bill” Jones Pumping Plant
SJR = San Joaquin River
SJRRP = San Joaquin River Restoration Program
SLR = San Luis Reservoir
SWP = State Water Project

- **Alternative 3: Enhance New Melones Water Supply.** New Melones releases are added as necessary on top of recirculation flows.

See **Section 3.2.2** for more information on the initial alternatives.

The resource management measures that were eliminated are not precluded from reconsideration later in the Study. Future events may create conditions that require reconsidering particular measures.

After the initial screening of measures, additional considerations specific to retained measures were identified, and the retained measures were further screened to ascertain measures that would be appropriate for consideration in the development of the initial alternatives.

3.2 Formulation of Complete Alternative Plans

Initial alternatives were formulated from the resource management measures described in **Section 3.1**. Theoretical combinations of physical facilities, conveyance pathways, and operational strategies were combined to create a list of potential complete alternative plans. The operational strategies packaged with the physical measures are described below.

3.2.1 Operational Strategies

The operational priorities, physical and regulatory constraints, and policy objectives may affect how a physical facility can be used in recirculation, which may in turn affect the effectiveness of a particular alternative plan. The operational assumptions and strategies that were considered in the formulation of the complete alternative plans are described below.

New Melones Water Supply

The New Melones water supply priority addresses the goal of reducing the reliance on New Melones for meeting WQOs and flow objectives in the SJR and Delta. Recirculation could provide an alternative source of CVP water to the SJR to assist in meeting standards and objectives. Recirculation could be used before or after the release of water from New Melones. In practice, recirculation would probably occur based on a flexible priority that would be determined by water supply conditions at the time of recirculation. For analysis purposes, recirculation both before and after the release of water from New Melones was evaluated to bookend the potential effects of recirculation on New Melones water supply.

The relative priority that recirculation has with New Melones releases has a direct implication for the water supply at New Melones; less dependence on New Melones for Delta and SJR objectives would result in more water available for CVP obligations from the Stanislaus River.

Direct Pumping and Release

This operational strategy would provide recirculation at times when WQOs or flow objectives require supplemental flow in the SJR (real-time pumping and release). The availability of supplemental flow through recirculation would occur only when available, unused, and allowed (regulatory) capacity occurs within the pumping, conveyance, and delivery system. That is, recirculation would be used when capacity was not already allocated to the existing purposes of the facilities. This strategy would provide the least risk to CVP Delta export water contractors because pumping and conveyance would be available only when they are not interfering with the current uses and priorities.

This operational strategy could function within any New Melones water supply priority described above. The New Melones water supply priority would affect the frequency and magnitude of required releases from New Melones and would therefore affect the amount of water supplied to the SJR and Delta from the Stanislaus River.

Pumping, Storage, and Release

An extension of the direct pumping and release strategy is the use of SLR storage as a tool to provide regulation between the need for supplemental flow to the SJR versus the availability of pumping and conveyance. Under this tool, storage at SLR would be used to offset wasteway releases that would otherwise reduce deliveries south of SLR. A storage recirculation operation could provide releases to the SJR during periods when pumping is constrained such that recirculation releases would otherwise result in reductions in the amount of CVP water stored in SLR.

Recirculation pumping through Jones Pumping Plant could occur prior to or after the increase in replacement stored water. This operation may or may not affect CVP Delta export deliveries, depending on the priority the additionally pumped water has in the CVP operation.

Recirculation Priority Over CVP Delta Export Deliveries

At the request of certain stakeholders, Reclamation evaluated the use of CVP pumping and conveyance capacity with recirculation as a high priority. This action has the potential to reduce CVP Delta export water contract deliveries, and to some extent, other CVP non-Stanislaus River deliveries. As mentioned above, the use of CVP pumping and conveyance could range from available, unused, and allowable capacity to a level that would effectively reallocate exported CVP water to the DMC Recirculation Project.

The extent to which DMC recirculation would be allowed to adversely affect CVP deliveries would be a policy decision. In addition, recirculation would likely occur with some measure of conveyance inefficiency. Recirculation could physically provide additional flow to the Delta (to the extent that additional flow is released to the SJR above that which would occur under No Action), conveyance losses may occur between the point of canal and stream conveyance and the recapture of the release at the pumping facilities. In other words, not all of the water released for recirculation may be available for recapture.

Other Facility Uses versus Recirculation

Other uses of the pumping, conveyance, and storage facilities include CVPIA actions, EWA commitments, water transfer commitments, and Coordinated Operations Agreement commitments. Rather than assume that each of these uses would be ranked in importance with recirculation, an alternative is established that would provide recirculation with a high priority relative to all other uses, and another alternative is established that would provide recirculation with a lower priority relative to all other uses.

Compliance

During the Study, certain configurations of physical features and operational conditions may result in operations that would provide partial or full compliance with both the WQOs and flow objectives. At that point, a strategy of compliance would be developed to allocate the limited resources among the compliance requirements and other contractual obligations. The strategy's sensitivity to alternative benefits and costs will be investigated.

SWP Integration and Facilities

SWP facilities would be used in a subset of alternative plans. No adverse water supply impact to the SWP should occur under any alternative. SWP facilities would be used in a subset of the recirculation alternatives to provide additional opportunities for pumping, conveyance, and storage as long as the SWP water supply is not affected.

3.2.2 Evaluated Alternative Plans

In this section, the alternative plans that have been analyzed further for the PFR are described. Retained alternatives will be evaluated subsequent to the PFR, and the results will be presented in the EIS/EIR and the Feasibility Study Report. The components of the alternatives are the physical facilities that deliver water to the SJR (measures) and the operational aspects (strategies) of the physical facilities. The alternatives have been formulated with the goal of encompassing the range of facilities and operational priorities that could be used to achieve the objectives of the DMC Recirculation Project.

No-Action/No-Project Alternative

The No-Action/No-Project Alternative is required for analysis of environmental effects under NEPA (the No-Action Alternative) and CEQA (the No-Project Alternative). Under the No-Action/No-Project Alternative, no recirculation would occur. For the NEPA analysis, the No-Action Alternative is used as the baseline in the comparison of the effects of the alternative plans. For the CEQA analysis, existing conditions at the time the Notice of Preparation of a Draft EIS/EIR was published are generally used as the baseline. The periods that are used to establish the existing conditions for the No-Project Alternative and the future conditions for the No-Action Alternative can vary depending on the resource area. **Section 2.2** describes the existing conditions considered in the PFR. The Notice of Intent to Prepare a Draft EIS and a Notice of Preparation of a Draft EIR for this Study were published in May 2007.

Alternative (Action) Plans

The alternative plans were formulated from the combination of physical facilities, conveyance pathways, and operational strategies.

As described in **Section 3.1**, three main initial alternatives are presented in the IAIR. These alternatives are based on the objective they serve or the major facilities they would use. The alternatives are:

- **Alternative 1: Supplement Current Operation.** Recirculation flows are added on top of New Melones releases, which typically remain at current levels.
- **Alternative 2: CVP Alone.** Only Jones Pumping Plant is used for recirculation flows or to place water in storage.
- **Alternative 3: Enhance New Melones Water Supply.** New Melones releases are added as necessary on top of recirculation flows.

Alternative 1 has two variations, Alternative 2 has five, and Alternative 3 has two. Variations are based on differences in the operational scenarios. Operational scenarios vary in the priority for use of the facilities to transport water for recirculation in relation to other existing uses and are designed to optimize a particular objective, such as achieving WQOs or minimizing impacts to Westside CVP contractors.

The alternative variations are as follows:

- **Alternative 1A** would attempt to fully comply with water quality and flow requirements regardless of CVP Delta export delivery impacts, supplementing releases for flow and quality made from New Melones within the allowances of the IPO. Both the CVP and SWP pumping, conveyance, and storage facilities would be assumed to be available for the DMC Recirculation Project; however, no water supply impact would occur to the SWP. The order of use of supplemental facilities would be (1) available, unused, and allowable capacity at Jones Pumping Plant, (2) available, unused, and allowable capacity at Banks Pumping Plant, and (3) as-required capacity at Jones Pumping Plant needed to contribute to compliance.
- **Alternative 1B** would use recirculation of water that is currently available through CVP and SWP facilities without impact to either the SWP or to CVP Delta export deliveries. Under this alternative, recirculation releases (pumping) would occur coincidently with flow or water quality needs and only limited "incidental" use of SLR would occur. Recirculation releases again supplement releases for flow and quality made from New Melones.
- **Alternative 2A** would use recirculation to supplement New Melones releases under the IPO. Recirculation to contribute to compliance would have high Delta pumping priority compared to CVP exports, and recirculation would include both coincidental and stored releases.
- **Alternative 2B** would use recirculation to supplement New Melones releases to contribute to compliance with objectives. Recirculation would have low Delta pumping priority compared to CVP exports and would not cause CVP delivery impacts. Recirculation releases would occur coincidently with pumping and only limited "incidental" use of SLR would occur.
- **Alternative 2C** would use a hybrid assumption for the Delta pumping priority whereby recirculation would be provided using coincidental pumping and stored water releases up to an assumed limit of impact to CVP Delta export deliveries.
- **Alternative 2D** would use recirculation before explicit New Melones releases for flow objectives and WQOs. Recirculation would have high Delta pumping priority compared to CVP exports and would include both coincidental pumping and stored releases.
- **Alternative 2E** would use recirculation before explicit New Melones releases for flow objectives and WQOs. Recirculation would have low

Delta pumping priority in compared to CVP exports, and recirculation releases would occur coincidently with available pumping and only limited "incidental" use of SLR.

- **Alternative 3A** would use whatever recirculation was possible to attempt to meet water quality and flow requirements (high Delta pumping priority). Recirculation would occur before explicit New Melones releases for those purposes. Both the CVP and SWP pumping, conveyance, and storage facilities would be assumed to be available for the DMC Recirculation Project; however, no water supply impact would occur to the SWP.
- **Alternative 3B** recirculation would occur before explicit New Melones releases for those purposes. Both the CVP and SWP pumping, conveyance, and storage facilities would be assumed to be available for the DMC Recirculation Project; however, no water supply impact would occur to the SWP or CVP (low Delta pumping priority).

Preliminary screening of these alternative plans was conducted using post-processing of CalSim II results and sequential CalSim II studies to determine the need for recirculation and the availability of facilities to supply water in light of the above assumptions. The preliminary screening was used to guide the team in refining the alternatives and selecting those for further analysis for the PFR.

Table 3-2 is a list of the alternative plans that were eliminated. Alternatives were eliminated if the benefits were similar to or within the range of other alternatives. Alternatives 1A and 2A were eliminated because major benefits from these alternatives would be captured largely in Alternative D. Alternative D included the same elements as Alternative 1A and provided more flexibility than Alternative 2A due to the use of both Jones and Banks pumping plants. Alternative 2C was reconfigured as Alternative C (new), which is similar to Alternative 2C but would allow use of Banks Pumping Plant to minimize impacts to CVP Delta export water deliveries. Alternative 2D was eliminated because its benefits are contained within Alternative D, which would allow use of Banks Pumping Plant to minimize impacts to CVP Delta export water deliveries.

After the preliminary screening was conducted, six alternative plans were selected for further analysis for the PFR, and the alternatives were renumbered. The six alternatives are summarized in **Table 3-3** and described in more detail as follows:

Table 3-2. Eliminated Alternative Plans

Alternative Plan	Screening Result	Delta Pumping Facilities	Delta Recirculation Pumping Priority for Recirculation	Recirculation Release Timing	Priority with New Melones Delta Operation
1A	Eliminated; benefits captured in Alternative D	Jones/Banks	High (no SWP impact)	Coincidental and stored	Supplemental
2A	Eliminated; benefits captured in Alternative D	Jones	High (no SWP impact)	Coincidental and stored	Supplemental
2C	Eliminated; new Alternative C enhances performance using CVP and SWP facilities	Jones	Medium (no SWP; some CVP SOD impact)	Coincidental and stored	Before
2D	Eliminated; new Alternative D enhances performance using CVP and SWP facilities	Jones	High (no SWP impact)	Coincidental and stored	Before

Key:

Banks Pumping Plant = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
Delta = Sacramento–San Joaquin River Delta
Jones Pumping Plant= C.W. “Bill” Jones Pumping Plant
SOD = South of Delta
SWP = State Water Project

Table 3-3. Alternatives Plans Retained for Further Analysis for the Plan Formulation Report

PFR Alt	IAIR Alt	Description of Alternative Plan	Delta Pumping Facilities	Delta Recirculation Pumping Priority for Recirculation	Recirculation Release Timing	Priority with New Melones Delta Operation
A1	2B	Supplement Vernalis compliance using available Jones capacity	Jones	Low (no CVP/SWP SOD impact)	Coincidental	Supplemental
A2	2E	Enhance New Melones water supply and supplement Vernalis compliance using available Jones capacity	Jones	Low (no CVP/SWP SOD impact)	Coincidental	Before
B1	1B	Supplement Vernalis compliance using available Jones/Banks capacity	Jones/ Banks	Low (no CVP/SWP SOD impact)	Coincidental	Supplemental
B2	3B	Enhance New Melones water supply and supplement Vernalis compliance using available Jones/Banks capacity	Jones/ Banks	Low (no CVP/SWP SOD impact)	Coincidental	Before
C	New	Limited reduction of CVP Delta export deliveries to enhance New Melones water supply and supplement Vernalis compliance using Jones/Banks capacity[1]	Jones/ Banks	Low – for WQOs High – for flow objectives (no SWP impact)	Coincidental and stored	Before
D	3A	Reduced CVP Delta export deliveries to enhance New Melones water supply and supplement Vernalis compliance using Jones/Banks[1]	Jones/ Banks	High (no SWP impact)	Coincidental and stored	Before

Key:

Alt = alternative plan
Banks = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
Delta = Sacramento–San Joaquin River Delta
IAIR = Initial Alternatives Information Report
Jones = C.W. “Bill” Jones Pumping Plant
PFR = Plan Formulation Report
SOD = South of Delta
SWP = State Water Project
WQO = water quality objective

[1] Carried forward at the request of certain stakeholders and is consistent with the 2nd definition of excess capacity.

- **Alternative A1**: *Supplement Vernalis compliance using available Jones Pumping Plant capacity.* This alternative plan uses only available capacity at Jones Pumping Plant to supplement explicit New Melones flow and water quality releases. No changes in water supply for either CVP Delta export or New Melones water contractors would occur.

- **Alternative A2**: *Enhance New Melones water supply and Vernalis compliance using available Jones Pumping Plant capacity.* This alternative plan is similar to Alternative A1 except that recirculation water is released prior to explicit New Melones releases for Vernalis flow and water quality purposes. This alternative could result in reduced demand from New Melones for Delta releases (to the extent that recirculation water is available) and increased water for New Melones water users. Because only available capacity at Jones Pumping Plant is used, no major changes in CVP Delta export water supply would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones Pumping Plant.

- **Alternative B1**: *Supplement Vernalis compliance using the available Jones/Banks pumping plant capacity.* This alternative plan is similar to Alternative A1 except that pumping from Banks Pumping Plant is added when capacity is available. Recirculation flow supplements New Melones releases (i.e., no changes in New Melones operations). No changes in water supply for either CVP Delta export or New Melones water contractors would occur.

- **Alternative B2**: *Enhance New Melones water supply and Vernalis compliance using available Jones/Banks pumping plant capacity.* This alternative plan is similar to Alternative A2 except that pumping from Banks Pumping Plant is added when capacity is available. Water is released prior to explicit New Melones Delta releases, which may result in enhanced New Melones water supply. No major changes in CVP Delta export water supply would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.

- **Alternative C**: *Limited reduction of CVP Delta export deliveries for enhanced New Melones water supply and Vernalis compliance using Jones/Banks pumping plants.* Alternative C was carried forward at the request of certain stakeholders. It is based on the definition of "excess capacity" as the capacity in CVP facilities in excess of that needed to meet CVP environmental requirements. This alternative plan is similar to Alternative D except that recirculation water that could affect CVP Delta export deliveries would be used only to comply with Vernalis flow requirements in the SJR. Recirculation could occur for water quality compliance if it was determined to be available at Jones/Banks pumping plants without affecting deliveries. Recirculation flow would be released prior to explicit New Melones Delta releases to enhance New Melones water supply. Jones Pumping Plant would be used as needed to contribute to flow compliance and water supply benefits to New Melones. Reductions in CVP Delta export deliveries would be less than those under Alternative D. No major changes to SWP deliveries would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.

- **Alternative D**: *Reduced CVP Delta export deliveries to enhance New Melones water supply and Vernalis compliance using Jones/Banks pumping plants.* Alternative D was carried forward at the request of certain stakeholders. It is based on the definition of "excess capacity" as the capacity in CVP facilities in excess of that needed to meet CVP environmental requirements. This alternative plan would use recirculation, as needed, to attempt to provide compliance with Vernalis WQOs and enhance New Melones water supply. Recirculation water would be released prior to explicit New Melones Delta releases for flow objectives and WQOs, resulting in additional water supply in New Melones. Reductions in CVP Delta export deliveries are anticipated. No major changes to SWP deliveries would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.
- **Conveyance Improvements (All Alternative Plans):** *Improve wasteways to mitigate environmental effects or enable use of alternative facilities.* All alternative plans may require improvements to wasteway conveyance facilities. Options for improvements are stabilizing the unlined portion of Newman Wasteway to reduce elevated turbidity and constructing new conveyance facilities at the outlet of Westley Wasteway to allow passage of recirculation flows to SJR.

Figure 3-2 shows the components (facilities and operational priorities) for the six alternative plans.

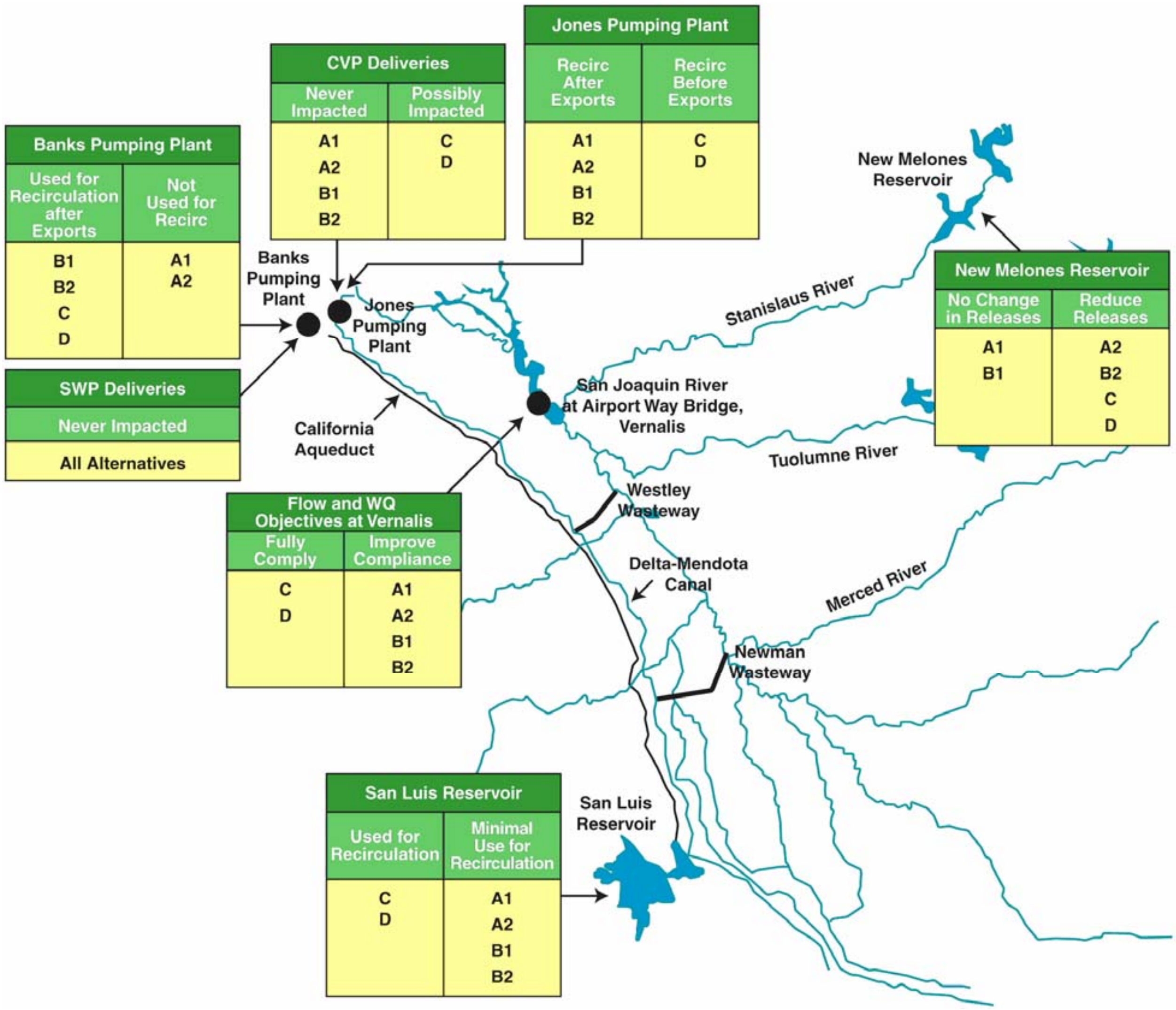


Figure 3-2. Components of the Alternative Plans

Additional Consideration

In the Fisheries Technical Memorandum (ENTRIX 2008) contains a discussion of concerns and potential impacts related to species of concern at various life stages. The alternative plans are currently not constrained by time of year or impacts to specific species. Rather, each alternative is evaluated for its potential to adversely affect or benefit fisheries resources.

3.2.3 Alternative Plan Evaluation Process

This section presents the process that is used to compare the alternative plans. The process includes the four acceptance criteria contained in the P&Gs (WRC 1983) and the evaluation metrics that were developed for the Study. The alternative plans were also assessed using the four "accounts" contained in the P&Gs (WRC 1983), which were established to facilitate evaluation and display of the effects of alternative plans.

Acceptance Criteria

All elements of the Study must be conducted according to the Federal P&Gs (WRC 1983). Each alternative must be formulated with consideration of the four acceptance criteria contained in the P&Gs: completeness, effectiveness, efficiency, and acceptability.

- **Completeness.** Completeness is the extent to which an alternative plan provides and accounts for all necessary investments or actions by Reclamation, DWR, or others to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities. Alternatives that do not rely significantly on any other actions would be ranked high for completeness.
- **Effectiveness.** Effectiveness is the extent to which an alternative plan contributes to achieving the planning objectives. Alternatives are evaluated for their ability to address the DMC Recirculation Project planning objectives.
- **Efficiency.** Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the planning objectives and does not adversely affect the environment.
- **Acceptability.** Acceptability is the extent to which an alternative plan meets the requirements of applicable laws, regulations, and public policies. This criterion is also used to assess the degree of acceptance by State and local entities and the public and the compatibility with existing laws, regulations, and public policies.

Evaluation Metrics

The effects of the alternative plans on the resource management areas are compared using metrics that were developed for the Study. **Table 3-4** is a list of the Study-specific resource management areas and the metrics.

The effects of the alternative plans are assessed using the four accounts contained in the P&Gs (WRC 1983). These accounts were established to facilitate evaluation and display of alternative water resource plans. The four accounts are:

- National economic development (NED). The NED account shows the effects on the national economy, as represented by changes in the economic value of the national output of market and nonmarket goods

Table 3-4. Metrics for Evaluating Resource Management Areas

Resource Management Area			Geographic Area	Metric
Achieving Planning Objectives	**Primary Planning Objectives**	Flow	SJR at Vernalis	Percentage of periods flow objective is predicted to be met
		Electrical conductivity	SJR at Vernalis	Percentage of periods WQO is predicted to be met
		Reliance on New Melones	New Melones	Change in New Melones releases for water quality and flow, TAF per year
	Other Potential Benefits	Dissolved oxygen	SJR at DWSC	Percentage of periods (Feb-June) when WQO (5 mg/L) is predicted to be met
		Water level	SJR at Vernalis	90th percentile change in average daily stage during recirculation (April-Aug), feet
		Electrical conductivity	Interior south Delta	Percentage of days WQO is predicted to be met
Water Supply		CVP Delta export contractor deliveries	Delta export area	CVP deliveries, TAF per year
		CVP Stanislaus contractor deliveries	Stockton East Water District	Stanislaus River deliveries, TAF per year
Water Quality		Municipal and industrial water quality	Municipal and industrial intakes in Delta locations	Number of days chloride is increased or decreased by at least 5 mg/L
		Turbidity	SJR above Merced River (6,500 feet)	Number of periods (out of 24) predicted to be above the WQO in the SJR above Merced River
		Temperature	Stanislaus River at Orange Blossom Bridge	Percentage of 6-hour periods for which the temperature is predicted to increase by more than 5ºF
Fisheries		Entrainment	Delta	Index for specific species
		Salmonid straying	SJR	Relative index
		Flow	Stanislaus River at Goodwin Dam	Relative index

Table 3-4. Metrics for Evaluating Resource Management Areas

Resource Management Area		Geographic Area	Metric
Fisheries (cont.)	Temperature	Stanislaus River at Orange Blossom Bridge	Temperature differences
	Dissolved oxygen	SJR at DWSC	Percentage of periods (Feb-June) when WQO (5 mg/L) is predicted to be met
Energy	Energy generation	CVP, SWP	GWH
Economics	National Economic Development	United States	Net National Economic Development Benefits
	Regional Economic Development	Statewide	Output from agricultural production in Central Valley
		San Joaquin County	Output from agricultural production in CVPM Region 8
		Fresno and Kings counties	Output from agricultural production in CVPM Region 14

Key:
mg/L = milligram(s) per liter
CVP = Central Valley Project
CVPM = Central Valley Production Model
DWSC = Stockton Deep Water Ship Channel
GWH = gigawatt-hours
SJR = San Joaquin River
SOD = South of Delta
SWP = State Water Project
TAF = thousand acre-feet
WQO = water quality objective

and services. Effects in the NED account are to be expressed in monetary units.

- Environmental quality (EQ). The EQ account shows effects on the ecological, aesthetic, and cultural attributes of natural and cultural resources that cannot be measured in monetary terms. EQ effects are to be expressed in appropriate numeric or non-numeric units or terms.
- Regional economic development. The RED account shows the changes in the distribution of regional economic activity, which include the regional incidence of NED effects, income transfers, and employment effects. RED effects can be expressed in monetary units, other numeric units, or non-numeric terms.
- Other social effects (OSE). The OSE account shows effects from perspectives that are relevant to the planning process but not reflected in the other three accounts (e.g., urban and community impacts; life, health, and safety factors; displacement; long-term productivity; energy requirements and energy conservation). OSE effects can be expressed in monetary units, other numberic units, or non-numeric terms.

3.3 Guiding Principles

Guiding principles are derived from regional policies, practices, and conditions and must be adhered to in the plan formulation process. Guiding principles are the planning principles and guidelines identified in the P&Gs, other Federal planning regulations, and State and local policies. The guiding principles for the DMC Recirculation Project are:

- Alternative plans should be consistent with the identified planning constraints.
- A direct and significant geographical, operational, and physical dependency must exist between the major components of alternatives.
- Alternative plans should address, at a minimum, each of the identified primary planning objectives.
- Alternative plans should either avoid potential adverse impacts on environmental resources or include features to mitigate unavoidable impacts through enhanced designs, construction methods, and/or facilities operations.

Alternative plans should avoid unmitigated adverse impacts to hydrologic and/or hydraulic systems, such as water supply pumping and conveyance facilities, flood control works, or other significant water resource uses in the Study area.

- Alternative plans should avoid potential adverse impacts on present or historical cultural resources or include features to mitigate unavoidable impacts.
- Alternative plans are to be formulated and evaluated based on a 50-year analysis period.
- First costs for alternative plans are to reflect current prices and price levels, and annual costs are to include the current Federal discount rate and an allowance for interest during construction.
- Alternative plans should have a high certainty for achieving the intended benefits and not depend significantly on long-term actions for success.
- Alternative plans are to reflect the purposes, operations, and limitations of existing and without-project future projects and programs.

3.4 Planning Constraints

The scope of the plan formulation process is limited by basic constraints specific to the Study. Planning constraints guide the direction of the Study. Planning constraints include Congressional legislation (e.g., study authorization); existing water resources projects and programs; and constraints that may be specific to proposed locations (e.g., biological, cultural, and socioeconomic resources; hydrology; topography).

The specific planning constraints that apply to the DMC Recirculation Project Feasibility Study are as follows:

- **Study authorizations.** The Study is authorized by the CALFED Bay-Delta Authorization Act of 2004, which provides a directive for Reclamation to develop and initiate implementation of a program to meet all existing water quality standards and objectives for which the CVP has responsibility (see **Section 1.2).** The Study is part of Reclamation’s Program to Meet Standards (see **Section 1.8.1**).
- **Laws, regulations, and policies.** Laws, regulations, and policies that must be considered include, but are not limited to, water right decisions, operational plans and rules for Federal and State water supply facilities, NEPA, Fish and Wildlife Coordination Act, Clean Air Act, Clean Water Act, NHPA, Federal and California ESAs, CEQA, and CVPIA. Reclamation must also satisfy SWRCB requirements to evaluate the potential impacts of recirculating water from the DMC, including, but not limited to, changes in water composition, imprinting and fish entrainment, and impact on water deliveries.

- **CALFED ROD**. The CALFED ROD (CALFED 2000b) is a general framework for addressing the CALFED Bay-Delta Program and includes program goals, objectives, and projects intended primarily to benefit the Bay-Delta system, its tributaries, and areas that receive water supplies exported from the Delta. Formulation and evaluation of initial alternative plans, including a No-Action Alternative, will comply with the CALFED ROD and will not conflict with CALFED objectives, solution principles, or policies.

3.5 Agency and Public Outreach

The Study is addressing issues of interest and concern to stakeholders engaged in local and regional water resource planning as well as Federal and State agencies with regulatory and management responsibilities related to natural resources in the Study area. Successful completion of the Study requires involvement from a variety of agencies, stakeholders, and the public. The Study will provide opportunities for both stakeholder and public involvement and participation. This section briefly describes the management structure for the Study and the stakeholder and public outreach strategy.

3.5.1 Study Management Structure

Reclamation has established a Study management structure that consists primarily of a Project Management Team (PMT), Collaborative Interagency Team (CIT), Stakeholder and Public Outreach Team, and various technical teams. Reclamation is the lead Federal agency for NEPA compliance, and DWR is the lead State agency for CEQA compliance. Responsibilities for each team are summarized below.

Project Management Team

The PMT consists of a Project Manager from Reclamation, DWR, and the lead consultant, URS Corporation; an interdisciplinary team consisting of engineering, environmental resources, reservoir water operations, public involvement, and project support resources; the consultant team; and representatives from participating resource agencies. The PMT directs work performed by the CIT and technical teams, directs public involvement activities, coordinates general public input, and coordinates the results of the Study.

Collaborative Interagency Team

The CIT consists of representatives from the PMT and Federal and State agencies with regulatory and management responsibilities, such as the Service, National Marine Fisheries Service, the Corps, CDFG, SWRCB, and CVRWQCB. In addition, the San Francisco Bay RWQCB and the EPA may participate in the Study. The CIT is coordinated by the Project Managers and provides support to the PMT.

Stakeholder and Public Outreach Team

The Stakeholder and Public Outreach Team includes representatives from Reclamation, DWR, and the consultant team. This team initiates two distinct outreach efforts—one targeted to the needs of stakeholders and the other targeted to the general public.

Technical Teams

The primary technical focus areas for the Study are water quality, water supply and operations, fisheries, and benefits analysis. Representatives from the PMT and CIT form the technical teams to address these technical areas as needed. Additional technical teams address other environmental compliance issues.

3.5.2 Interagency Coordination

The Study management structure includes the active participation of numerous Federal and State agencies with regulatory responsibilities. In addition to coordinating Study efforts with these agencies, coordination will also take place with Cooperating Agencies in the environmental review process.

Cooperating Agencies

The Cooperating Agencies provide input from technical experts in environmental review on the development of the Study early and often. Reclamation is preparing agreements that identify roles and responsibilities for Cooperating Agencies. Representatives from Cooperating Agencies work with technical teams and technical work groups in the development of the Study. Coordination with Cooperating Agencies focuses on specific environmental issues such as water quality, water supply and operations, fisheries, and terrestrial biology.

3.5.3 Stakeholder and Public Involvement

The purpose of Stakeholder and Public Outreach Team is to identify and implement activities and opportunities to inform and engage stakeholders and agencies in the development of the Study. Stakeholder and agency involvement is designed to address issues of interest and concern to stakeholders and agencies engaged in local and regional water resource planning efforts. In addition, public involvement activities will inform the broader public, and their input is solicited.

The interactive components of the public involvement program focus on involving those with a stake in the outcome of the Study. Stakeholders in the

Study area bring a high level of experience and local knowledge to the process and likely will provide a variety of responses that will influence the Study process. Outreach components are designed to provide information and material to a broad group of interested parties. The outreach components are used to disseminate information widely, bring additional stakeholders and interested parties into the process, and enhance coordination with related water resources planning and management groups.

Public Involvement Goals

The public involvement goals are to:

- Identify and inform stakeholders, agencies, elected officials, community leaders, and members of the public who are likely to be interested in the Study and its potential approaches/solutions.
- Ensure that these audiences understand the mandate for the Study, technical considerations and constraints, and the development of the Study.
- Solicit and incorporate stakeholder and public input into the development of the Study.
- Develop and implement effective communication processes and tools.

3.5.4 Audiences and Participants

Audiences include Reclamation's water contractors, water agencies, environmental interests, and regulatory agencies that have jurisdiction related to aspects of the DMC Recirculation Project. Additional audiences will include elected officials, regional interests, community leaders, recreation, the media, and the broader public in the geographic area. A mailing list of stakeholders and interested persons has been developed to distribute information and meeting notices, as well as ensure that a broad range of interest groups are informed about the development of the DMC Recirculation Project. The mailing list will continue to be updated as interest in the Study grows.

Stakeholder Workshops

As previously mentioned, stakeholders bring a high level of experience and local knowledge to the process. Workshops have had—and will continue to have—a major role in engaging stakeholders in the overall Study process. A series of workshops have been held with future workshops to be scheduled at critical milestones in the Study (see **Table 3-5**). Workshops have been held to explain the results of efforts to date and to gain input for future Study efforts.

Table 3-5. Stakeholder Workshops to Date

Date/Location	Purpose
March 10, 2006 Modesto, California	Solicit stakeholder input on issues and concerns prior to preparing POS
November 17, 2006 Modesto, California	Provide Study update; engage stakeholders in the development of the Study
December 12, 2006 Modesto, California	Engage stakeholders in the development of alternatives to be considered in the Study
February 9, 2007 Modesto, California	Engage stakeholders in identification of baseline assumptions and evaluation criteria to be considered as part of the IAIR
March 10, 2008 Modesto, California	Present Preliminary Water Operations Modeling and Fisheries Technical Memorandum
April 28, 2009 Modesto, California	Present preliminary results from Plan Formulation

Key:
IAIR = Initial Alternatives Information Report
POS = Plan of Study

Public Scoping

Public scoping meetings were held in April 2007 (see **Table 3-6**) to solicit public, stakeholder, and agency input on the alternatives, concerns, and issues to be address in the EIS/EIR. A Notice of Intent to prepare an EIS was published in the *Federal Register* on March 30, 2007, and a Notice of Preparation of an EIR was filed with the California State Clearing House on March 28, 2007. The scoping meetings provided an introduction and overview of the DMC Recirculation Project; information on the planning process, alternatives development, and environmental resources; and opportunities for input.

A scoping report, consistent with Reclamation guidance and in compliance with NEPA requirements, will be prepared. It will describe agency and public comments received on the scope of the EIS/EIR, the Study's approach to the environmental review process, and responses to comments that will be addressed in the environmental document. Written comments received at the scoping meetings or submitted via letter, fax, and email during the comment period will be included in the scoping report.

Table 3-6. Public Scoping Meetings

Date/Time	Location
Monday, April 16, 2007 10 a.m. to 12 p.m.	Federal Building, 2800 Cottage Way, Cafeteria Rooms C-1001 and C-1002, Sacramento, California
Monday, April 16, 2007 6 p.m. to 8 p.m.	Miller and Lux Senior Center Building, 830 6th Street, Los Banos, California
Tuesday, April 17, 2007 6 p.m. to 8 p.m.	Modesto Centre Plaza, 100 I Street, Pistache Room Modesto, California

Briefings

Briefings have been and will be scheduled with elected officials and/or their staff to provide Study updates. The Stakeholder and Public Outreach Team, along with the PMT, coordinate the briefings as needed. Elected officials will also be kept informed of the development of the Study through the distribution of Study materials. Briefings may also be scheduled with other interested groups or organizations.

Informational Materials

Informational materials to be developed and distributed include:

- Briefing Packet: Briefing packets are developed periodically and distributed to elected officials, media, and interested persons to establish a base of information about the Study. The packets include facts sheets, graphics, and information about the public review process, a Study schedule, and contact information.
- Updates: A series of Study updates are developed at key milestones such as the release of the IAIR, PFR, EIS/EIR, and Feasibility Study Report.
- Websites: Two websites for the Study (one for each lead agency) contain background and current information, Study documents, a record of public and stakeholder meetings and materials, and updates. Input can be posted to the websites. The websites are:
  http://www.usbr.gov/mp/dmcrecirc/index.html
  http://baydeltaoffice.water.ca.gov/sdb/recirc/index_recirc.cfm

Chapter 4
Description of Alternative Plans

In this chapter, the six alternative plans that were selected for analysis in the PFR and the No-Action Alternative are described. The analysis of the alternative plans is presented in **Chapters 5** and **6**.

4.1 Overview of Alternative Plans

Table 4-1 is a summary of the six alternative plans.

Table 4-1. Plan Formulation Report Alternative Plans

Alt	Description	Delta Pumping Facilities	Delta Pumping Priority for Recirculation	Priority with New Melones Delta Operation
A1	Supplement Vernalis compliance using available Jones capacity	Jones	Low (no CVP/SWP or SOD impact)	Supplemental
A2	Enhance New Melones water supply and supplement Vernalis compliance using available Jones capacity	Jones	Low (no CVP/SWP or SOD impact)	Before
B1	Supplement Vernalis compliance using available Jones/Banks capacity	Jones/Banks	Low (no CVP/SWP or SOD impact)	Supplemental
B2	Enhance New Melones water supply and supplement Vernalis compliance using available Jones/Banks capacity	Jones/Banks	Low (no CVP/SWP or SOD impact)	Before
C	Limit reduction of CVP Delta export deliveries to enhance New Melones water supply and supplement Vernalis compliance using Jones/Banks capacity[1]	Jones/Banks	Low – for WQOs High – for flow objectives (no SWP impact)	Before
D	Reduce CVP Delta export deliveries to enhance New Melones water supply and supplement Vernalis compliance using Jones/Banks[1]	Jones/Banks	High (no SWP impact)	Before

Key:
Alt = alternative plan
Banks = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
Delta = Sacramento–San Joaquin River Delta
Jones = C.W. “Bill” Jones Pumping Plant
PFR = Plan Formulation Report
SOD = south of Delta
SWP = State Water Project
WQO = water quality objective

[1] Carried forward at the request of certain stakeholders and is consistent with the 2nd definition of excess capacity.

4.2 No-Action/No-Project Alternative

The No-Action/No-Project Alternative is required in any analysis of environmental effects under NEPA (the No-Action Alternative) and CEQA (the No-Project Alternative). Under the No-Action/No-Project Alternative, no recirculation would occur. For the NEPA analysis, the No-Action Alternative is used as the baseline in the comparison of the effects of the alternative plans. For the CEQA analysis, existing conditions at the time the Notice of Preparation was published (May 2007) are generally used as the baseline but may vary depending on the resource under analysis. **Sections 2.2 and 2.3** describe the No-Project and No-Action conditions considered in the PFR.

4.3 Elements Common to All Alternative Plans

One common element is the pathway for recirculation. Two pathways for the recirculation were considered: Newman Wasteway and Westley Wasteway.

Newman Wasteway is currently capable of providing the wider range of recirculation flows with little or no modification (see **Section 2.2.1, Conveyance Pathways**), as demonstrated in the 2004, 2007, and 2008 pilot studies (Reclamation 2005c, 2008b, 2009b [The 2008 Pilot Study is provided as **Appendix M**.]). However, lack of a lining in portions of Newman Wasteway has led to the development of habitat and to the mobilization of fine sediment during recirculation events, both of which have potential environmental impacts. During the pilot studies, periods of elevated turbidity were observed in the wasteway and downstream in the SJR. If it is necessary to reduce turbidity during recirculation, modifications to the unlined portion of Newman Wasteway will likely be necessary, potentially disturbing wetland habitat that has developed in the wasteway.

Westley Wasteway is not currently capable of discharging as much water to the SJR as Newman Wasteway without modifications at the outlet.

All the alternative plans may require improvements to wasteway conveyance facilities. In 2009, an appraisal-level engineering study of potential modifications to both wasteways was conducted to assist in the evaluation of the feasibility of such improvements (Reclamation 2009a). Options for improvements include stabilization of the unlined portion of Newman Wasteway to reduce elevated turbidity and construction of new conveyance facilities at the outlet of Westley Wasteway to allow passage of recirculation flows to SJR.

For the purposes of the water supply modeling and analysis, all the alternative plans assume the same discharge facility, namely Newman Wasteway, because for CalSim II modeling, both wasteways discharge into the same section of the model. From a water supply modeling perspective, the inclusion of only this single option in the alternative plan configurations should provide adequate results for the Study. Additionally, more detailed water quality modeling has been performed to provide more information on benefits to the SJR for alternatives using each pathway.

Use of DMC water for Vernalis water quality compliance suggests that, at a minimum, the quality of DMC water used for recirculation should be of equal or better quality than the objectives at Vernalis. Review of water quality data at Jones Pumping Plant indicates that EC can vary during the day approximately 200 µmhos/cm each day above and below the daily average. Vernalis within-day fluctuations do not exhibit the same fluctuation. To avoid contributing to a potential worsening of water quality within the SJR on a given day, recirculation for water quality would be restricted to periods when the mean DMC water quality is at least 200 µmhos/cm below the Vernalis WQO. This filter will also avoid the circumstance when DMC water quality is just below (i.e., better than) the WQO, whereby an unreasonably large volume of water may be required to dilute the upstream water and achieve the WQO at Vernalis. This assumption is described in **Appendix A** and the sensitivity of the performance of the alternative plans to this assumption is described in **Appendix A, Attachment A2**.

In the Study, water operations modeling using recirculation to achieve the primary objectives was conducted. Operations modeling results for the primary objectives were used to evaluate the effectiveness of recirculation in improving DO in the SJR and water quality and water levels in the interior south Delta. Also, water operations modeling sensitivity analysis was conducted on the ability to use recirculation to improve flow and water quality in the interior south Delta.

4.4 Alternative A1: CVP Compliance

Supplement Vernalis Compliance Using Available Jones Pumping Plant Capacity. This alternative plan uses only available capacity at Jones Pumping Plant to supplement explicit New Melones flow and water quality releases. No changes in water supply for either CVP Delta export or New Melones water contractors would occur.

4.5 Alternative A2: CVP Enhanced New Melones Storage

Enhance New Melones Storage and Supplement Vernalis Compliance Using Available Jones Pumping Plant Capacity. This alternative plan is similar to Alternative A1 except that recirculation water is released prior to explicit New Melones releases for Vernalis flow and water quality purposes. This release can result in reduced demand from New Melones for Delta releases (to the extent that recirculation water is available) and increased water for New Melones water users. Because only available capacity at Jones Pumping Plant is used, no changes in CVP Delta export water supply would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones Pumping Plant.

4.6 Alternative B1: CVP/SWP Compliance

Supplement Vernalis Compliance Using Available Jones/Banks Pumping Plant Capacity. This alternative plan is similar to Alternative A1 except that pumping from Banks Pumping Plant is added when capacity is available. Recirculation flow supplements New Melones releases (i.e., no changes in New Melones operations). No changes in water supply for either CVP Delta export or New Melones water contractors would occur.

4.7 Alternative B2: CVP/SWP Enhanced New Melones Storage

Enhance New Melones Storage and Supplement Vernalis Compliance Using Available Jones/Banks Pumping Plant Capacity. This alternative plan is similar to Alternative A2 except that pumping from Banks Pumping Plant is added when capacity is available. Water is released prior to explicit New Melones Delta releases, which may result in enhanced New Melones water supply. No major changes in Delta export water supply would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.

4.8 Alternative C: Limited SOD Supply/New Melones Storage Trade-off

Limit Reduction of CVP Delta Export Deliveries to Enhance New Melones Storage and Supplement Vernalis Compliance Using Available Jones/Banks Pumping Plant Capacity. Alternative C was carried forward at the request of certain stakeholders. It is based on the definition of "excess capacity" as the capacity in CVP facilities in excess of that needed to meet CVP environmental requirements. This alternative plan is similar to Alternative D except that recirculation water that could affect CVP Delta export deliveries would be used only to comply with Vernalis flow requirements in the SJR. Recirculation could occur for water quality compliance if it is determined to be available at Jones/Banks pumping plants without impact to deliveries. Recirculation flow would be released prior to explicit New Melones Delta releases to enhance New Melones water supply. Jones Pumping Plant would be used as needed to contribute to flow compliance and water supply benefits to New Melones. Reductions in CVP Delta export deliveries are anticipated but would be less than those under Alternative D. No major changes to SWP deliveries would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.

4.9 Alternative D: SOD Supply/New Melones Storage Trade-off

Reduced CVP Delta Export Deliveries to Enhance New Melones Storage and Supplement Vernalis Compliance Using Available Jones/Banks Pumping Plant Capacity. Alternative D was carried forward at the request of certain stakeholders. It is based on the definition of "excess capacity" as the capacity in CVP facilities in excess of that needed to meet CVP environmental requirements. This alternative plan would use recirculation as needed to attempt to provide compliance with Vernalis WQOs and enhance New Melones water supply. Recirculation water would be released prior to explicit New Melones Delta releases for flow objectives and WQOs resulting in additional water supply in New Melones. Reductions in CVP Delta export deliveries are anticipated. No major changes to SWP deliveries would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.

Table 4-2 shows the amount of recirculation that would occur under each alternative plan, the frequency of recirculation, and the change in use of the Jones and Banks pumping plants. The recirculation and pumping data in **Table 4-2** are based on modeled data from CalSim II, which is described in **Appendix A**.

Both the average annual total recirculation flows and the frequency of recirculation would increase under all six alternative plans. The flows and the frequency would be the lowest in Alterative A1 with progressively higher flows and frequency for each subsequent alternative. The annual total recirculation flows are predicted to vary substantially from year to year and from month to month (see **Appendix A**).

The volume of pumping at Jones Pumping Plant would be the same for Alternatives A1 and B1, higher under Alternative B2, then Alternative C, then Alternative D, and highest under Alternatives A2. Pumping at Banks Pumping Plant would not occur under Alternatives A1 and A2 and would increase under

Table 4-2. Alternative Plan Operational Characteristics

No-Action Alternative / Alternative Plans		Recirculation[1]			Pumping[1]	
		Total average recirculation (in TAF per year)	Years with recirculation (out of 82 years)	Periods with recirculation (out of 1,148 periods)	Average pumping at Jones (in TAF per year)[2]	Average pumping at Banks (in TAF per year)[2]
No-Action Alternative		0	0	0	2,423	3,528
Change Relative to No-Action Alternative, by Alternative Plan	A1	7.2	23	32	7.2	0
	A2	9.3	30	45	8.6	0
	B1	11.6	33	57	7.2	4.5
	B2	15.7	44	77	7.9	6.4
	C	28.2	54	124	7.9	6.5
	D	31.8	56	148	8.0	6.4

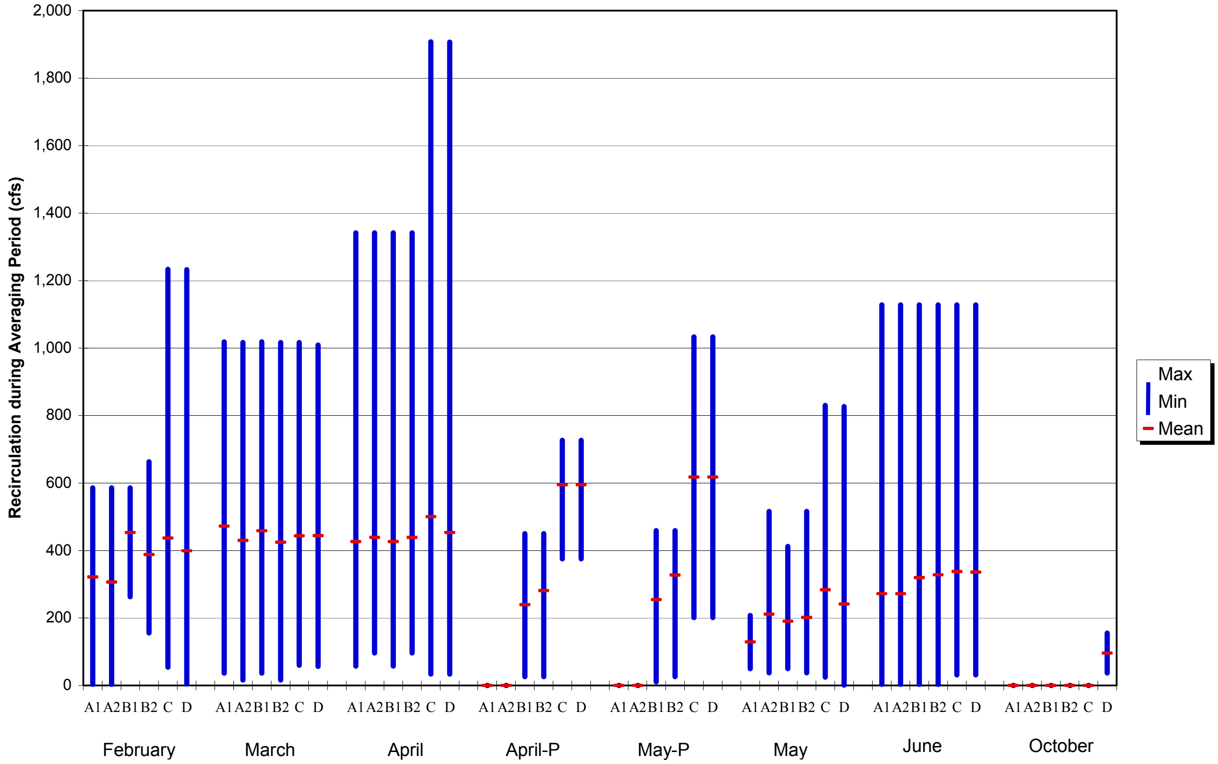
Source: CalSim II modeling using an 82-year simulation period with 14 time steps per year for a total of 1,148 periods.
[1] CVP/SWP operations based on pre-2007 operations.
[2] CVP/SWP average pumping evaluated over the 82-year CalSim II modeling period.

Key:

Banks = Harvey O. Banks Pumping Plant
Jones = C.W. “Bill” Jones Pumping Plant
TAF = thousand acre-feet

Alternative B1, B2, C, and D. Alternative D would result in the greatest amount of recirculation and pumping at both pumping plants.

Figure 4-1 shows how monthly recirculation flows would vary by alternative plan and by period for the periods during which recirculation is predicted to occur. Recirculation would occur principally from February through June with one occurrence in October. Flows would be highest in April regardless of alternative. Because of variable target flows from the Vernalis Adaptive Management Program, the greatest range in flows would occur in April, from approximately 20 to 1,900 cfs for Alternatives C and D. Average flows would be relatively consistent across all alternatives for March and April, but for other months, average flows would tend to be greater for Alternatives B1 and B2 (compared to Alternatives A1 and A2) and greatest for Alternatives C and D.



Note: Data only for recirculation periods are shown. Data provided by CalSim II for Future LOD over the 82-year modeling period (1922–2003). April-P = pulse flow period from April 16 through April 30; May-P = pulse flow period from May 1 through May 15.

Figure 4-1. Recirculation by Alternative Plan and Averaging Period

4.10 Summary of Construction, Operation, and Management Cost Estimates and Assumptions

The cost of the alternative plans in terms of construction (including wasteway improvement and mitigation costs), operation (excluding energy), and management would not be substantially different. The difference in costs would be attributed mainly to energy generation and consumption.

The evaluation of energy costs is described in **Appendix I**. **Table 4-3** shows the difference in net energy revenue (the difference in hydropower generation and project power use) by alternative plan relative to the No-Action Alternative, based on the evaluation. Because net energy costs correspond directly to energy generation and power costs from facility use, energy costs would increase relative to the No-Action Alternative under Alternatives A1, A2, B1, B2, and C during long-term conditions. During drought conditions, energy costs would increase under all six alternatives. Of the six alternatives, Alternative B2 would have the highest costs during both long-term and drought conditions. Alternative D would have lower costs than the No-Action Alternative under long-term conditions as a result of the reduction in CVP Delta export water deliveries, which results in less energy use to pump and store water in the SLR.

Construction costs associated with wasteway conveyance and modifications will be evaluated during preparation of the EIS/EIR and Feasibility Study Report.

Table 4-3. Predicted Effect on Average Annual Net Energy Revenue for the CVP and SWP Geographic Areas

No-Action Alternative / Alternative Plans		Net Energy Revenue: Average Conditions[1]	Net Energy Revenue: Dry Conditions[2]
No-Action Alternative		$231M	$154M
Change Relative to No-Action Alternative, by Alternative Plan	A1	–$203K	–$303K
	A2	–$213K	–$417K
	B1	–$292K	–$437K
	B2	–$313K	–$600K
	C	–$45K	–$306K
	D	$63K	–$70K

Notes:
[1] Average over Water Years 1922 to 2003
[2] Average over Water Years 1929 to 1934, 1976 to 1977, and 1987 to 1992 (14 of 82 water years or 17% of total)

Key:
CVP = Central Valley Project
K = thousand
M = million
SWP = State Water Project

Chapter 5
Comparison of Alternative Plans

This chapter provides a comparison of the alternative plans in terms of their ability to achieve planning objectives and their effects on natural resources. The alternative plans are also compared with respect to the four P&G accounts (the NED, EQ, RED, and OSE accounts).

5.1 Achieving Planning Objectives

The planning objectives for the Study are presented in **Section 1.6**. In the PFR, changes due to the project are compared to conditions under the No-Action Alternative. **Table 5-1** shows how the primary planning objectives for flow, EC, and reliance on New Melones are achieved. Other potential benefits for changes to DO and water level are also presented.

Flow was evaluated by estimating how often an alternative plan would meet the Bay/Delta Plan flow objective for the SJR at Vernalis. Flow was modeled using CalSim II, which is described in **Appendix A**. CalSim II uses a time increment equivalent to 14 periods per year over 82 years (1922 to 2003). Details of the flow analysis are provided in **Appendix F**.

EC was evaluated by estimating how often an alternative plan would meet the Basin Plan WQO in the SJR at Vernalis and in the south Delta as a potential benefit. EC in the SJR at Vernalis was modeled using CalSim II, which is described in **Appendix A**. EC in the south Delta was modeled using DSM2, which is described in **Appendix B**. DSM2 uses a daily time increment over 82 years. A more extensive evaluation of EC, including an analysis at each of the south Delta compliance sites, is provided in **Appendix F**.

Reliance on New Melones was evaluated by calculating the volume of releases from New Melones for each alternative plan. Releases include those for both water quality and flow and were calculated using CalSim II. CalSim II and the evaluation of New Melones releases are described in **Appendix A**.

DO was evaluated by estimating how often an alternative plan would meet the Basin Plan WQO in the Port of Stockton DWSC during February through June of representative hydrologic years. These representative periods reflect when recirculation was often predicted by CalSim II to occur under the future level of

Table 5-1. Predicted Effect of Recirculation on Planning Objectives

		Primary Planning Objective			Other Potential Benefit		
Objective		Flow	Electrical Conductivity	Reliance on New Melones	Dissolved Oxygen	Electrical Conductivity	Water Level
Geographic Area		SJR at Vernalis	SJR at Vernalis	New Melones	SJR at DWSC	Interior South Delta	SJR at Vernalis
Unit		Percentage of periods flow objective predicted to be met	Percentage of periods EC WQO predicted to be met[1]	Reductions in New Melones releases for water quality and flow (in TAF per year)	Percentage of periods (Feb-June) when WQO (5 mg/L) predicted to be met	Percentage of days EC WQO predicted to be met[2]	90th percentile change in average daily stage during recirculation, April-Aug (in feet)
No-Action Alternative		85.5%	98.2%[1]	14.7[3]	82.9%	98.1%	0
Change Relative to No-Action Alternative, by Alternative Plan	A1	2.2%	0.4%	0	—	—	—
	A2	2.0%	0.3%	2.1	—	—	—
	B1	3.6%	0.4%	0	8.6%	0.27%	1.0
	B2	3.3%	0.3%	3.8	8.6%	0.13%	1.0
	C[4]	6.8%	0.5%	5.3	—	—	—
	D[4]	6.8%	0.7%	8.1	14.3%	0.41%	1.2

Note:

[1] The EC WQO is always met with real-time operations.

[2] The SJR at Brandt Bridge was selected as a representative site of the interior south Delta compliance sites. Note Brandt Bridge is not necessarily reflective of Old River at Tracy Road Bridge, which is highly influenced by agricultural barrier operations and Delta return flows.

[3] No-Action Alternative represents releases rather than reductions.

[4] Alternatives C and D carried forward at the request of certain stakeholders and is consistent with the 2nd definition of excess capacity.

Key:

— = Not modeled
mg/L = milligram(s) per liter
DWSC = Deep Water Ship Channel
EC = electrical conductivity
SJR = San Joaquin River
TAF = thousand acre-feet
WQO = water quality objective

development (LOD). Thus, the evaluation covered 35 periods. DO in the DWSC was calculated using a fitted function relating DO to flow measured in the SJR at Stockton. This evaluation is described in **Appendix F**.

Water level, a potential benefit, was evaluated by estimating the change in average daily stage occurring during April through August agricultural season recirculation periods, as modeled by DSM2 for each alternative plan. DSM2 is described in **Appendix B**, while a more extensive evaluation of stage in both the SJR at Vernalis and the south Delta is provided in **Appendix F**. The 90th percentile value of the change in stage during agricultural season recirculation periods was used as a basis of comparison for alternatives. Changes in stage in the SJR at Vernalis were used as an indicator of the type of differences between alternatives that are expected, as this location is most directly affected by recirculation.

As expected, the Project's ability to meet planning objectives and potential benefits would increase with increasing amount of recirculation. The flow, EC, and DO objectives would be met more often under the Project than under the conditions of the No-Action Alternative and would be met increasingly more often with greater recirculation. Reliance on New Melones would remain the same as under the No-Action Alternative for Alternatives A1 and B1 but would decrease under the other four alternative plans.

Water level was evaluated by determining the 90th percentile value of the change in stage during agricultural season recirculation periods. The 90th percentile changes at Vernalis were between 1 and 1.2 feet. In the south Delta, 90th percentile changes were smaller, ranging from 0 to 0.2 feet. Water levels are generally of most concern during late summer, when SJR flow decreases. Recirculation would not occur during this period under any of the alternative plans.

At the request of certain stakeholders, additional water operations modeling analysis was conducted to assess whether recirculation could be used to achieve measures other than the planning objectives, as described in **Attachment A2 of Appendix A**. Two additional measures were evaluated: (1) meeting south Delta water quality standards and (2) achieving a minimum flow target at Vernalis during the April through August irrigation season.

Results of the modeling for south Delta water quality standards indicated that limited opportunities existed to use recirculation to help achieve these objectives at two of the three compliance stations (Brandt Bridge and Old River at Middle River). Use of recirculation to achieve standards at Old River at Tracy

Road Bridge Station could not be evaluated because of the lack of a relationship between water quality at Vernalis and the Tracy Road Bridge Station.

Results of the modeling for achieving a minimum flow target at Vernalis during the irrigation season indicated some opportunities to help achieve this measure using recirculation. The opportunities generally occurred during late summer months.

5.2 Water Supply

Table 5-2 shows how deliveries to the CVP Delta export and CVP Stanislaus delivery areas would change compared to the No-Action Alternative under each alternative plan.

Table 5-2. Predicted Effect of Recirculation on Water Supply

No-Action Alternative / Alternative Plans		CVP Contractor Deliveries in the Delta Export Area (in TAF per year)	CVP Stanislaus River Deliveries in the Stockton East Water District (in TAF per year)
No-Action Alternative		2,423	47.3
Change Relative to No-Action Alternative, by Alternative Plan	A1	0	0
	A2	–0.7	0.1
	B1	0	0
	B2	–1.5	0.1
	C	–13.9	0.3
	D	–17.6	0.4

Key:
CVP = Central Valley Project
TAF = thousand acre-feet

Water supply was evaluated by determining the annual volume of CVP Delta export and CVP Stanislaus delivery areas under each alternative plan. Deliveries data were provided by CalSim II, which is described in **Appendix A**.

Deliveries would remain the same as under the No-Action Alternative for Alternatives A1 and B1, but under the other four alternative plans, CVP deliveries to Delta export contractors would decrease while deliveries to the CVP Stanislaus contractors would increase. The most substantial difference from the conditions under the No-Action Alternative is the decrease in CVP Delta export deliveries under Alternatives C and D.

5.3 Water Quality

Table 5-3 shows how selected water quality parameters would change compared to the No-Action Alternative under each alternative plan.

Water quality was partially evaluated by estimating the effects of each alternative plan on drinking water quality. **Appendix G** contains an evaluation of how the alternatives would affect drinking water parameters. Of these parameters, bromide and chloride concentrations would be the most substantially affected, while TDS, dissolved organic carbon, and salt loads would not substantially change from those under the No-Action Alternative. High bromide is the primary drinking water quality issue in the Delta because of its contribution to the formation of disinfection byproducts from finished drinking water. The effects on bromide are presented in terms of changes in chloride because bromide concentrations are closely correlated to chloride concentrations. An increase or decrease of 5 mg/L or more in chloride was considered to be indicative of potential detriments or benefits, respectively, to drinking water (see **Appendix G**).

Turbidity was evaluated by estimating how often the Basin Plan WQOs would be violated under each alternative plan. TSS concentrations were modeled, as described in **Appendix D**, and then converted to turbidity using a linear relationship derived from measured data from the *San Joaquin River Watershed Surface Water Ambient Monitoring Program* (CVRWQCB 2008) and the 2007 Pilot Study (Reclamation 2008). TSS was modeled for 24 representative periods corresponding to periods when recirculation was predicted by CalSim II to occur. **Appendix F** describes the evaluation of turbidity in more detail, including analyses at several other locations along the SJR. The turbidity analysis in the SJR above the Merced River (6,500 feet) was selected as a representative location, as all locations that were analyzed exhibited a similar trend between alternative plans.

Water temperature was evaluated by estimating how often the Basin Plan WQO (no increases more than 5ºF) would be violated in the Stanislaus River at Orange Blossom Bridge under each alternative plan. Water temperature was modeled using HEC-5Q, which is described in **Appendix C**. The model uses a time increment of 6 hours over 24 years (1980 to 2003). A more extensive evaluation of water temperature, including analyses at the SJR at Vernalis and the Stanislaus River at Ripon, is provided in **Appendix F**. The analyses at Vernalis and Ripon did not exhibit as much variation in results between alternative plans and, thus, were not included in **Table 5-3**.

Table 5-3. Water Quality Results by Alternative Plan

Component	Geographic Area	Unit	No-Action Alter-native	Change Relative to No-Action Alternative, by Alternative Plan					
				A1	A2	B1	B2	C	D
Bromide as correlated to chloride	Jones Pumping Plant	Number of days (out of 29,950) chloride is increased by at least 5 mg/L	NA	—	—	6	30	—	234
		Number of days (out of 29,950) chloride is decreased by at least 5 mg/L	NA	—	—	93	116	—	155
	Clifton Court	Number of days (out of 29,950) chloride is increased by at least 5 mg/L	NA	—	—	0	0	—	182
	Clifton Court	Number of days (out of 29,950) chloride is decreased by at least 5 mg/L	NA	—	—	53	79	—	129
	Old River	Number of days (out of 29,950) chloride is increased by at least 5 mg/L	NA	—	—	0	0	—	68
		Number of days (out of 29,950) chloride is decreased by at least 5 mg/L	NA	—	—	9	9	—	66
	Rock Slough	Number of days (out of 29,950) chloride is increased by at least 5 mg/L	NA	—	—	0	5	—	31
		Number of days (out of 29,950) chloride is decreased by at least 5 mg/L	NA	—	—	8	8	—	93
	Antioch	Number of days (out of 29,950) chloride is increased by at least 5 mg/L	NA	—	—	4	160	—	132

Table 5-3. Water Quality Results by Alternative Plan

Component	Geographic Area	Unit	No-Action Alter-native	Change Relative to No-Action Alternative, by Alternative Plan					
				A1	A2	B1	B2	C	D
Bromide as correlated to chloride (cont.)	Antioch (cont.)	Number of days (out of 29,950) chloride is decreased by at least 5 mg/L	NA	—	—	13	93	—	1,696
Turbidity	SJR above Merced River (6,500 feet)	Number of periods (out of 24) predicted to be above the WQO in the SJR above Merced River (6,500 feet)[1]	NA	4	5	10	11	21	23
Temperature	Stanislaus River at Orange Blossom Bridge	Percentage of 6-hour periods for which the temperature is predicted to increase by more than 5ºF[2]	NA	—	0%	—	0.23%	0.19%	0.04%

Notes:

1 Values are for the alternative plan, not relative to the No-Action Alternative, and assume use of Newman Wasteway.

2 Values are for the alternative plan, not relative to the No-Action Alternative, because the narrative WQO for temperature for COLD or WARM waters is not to be increased more than 5°F above natural receiving water temperature.

Key:

— = Not modeled
ºF = degrees Fahrenheit
mg/L = milligram(s) per liter
NA = not applicable
SJR = San Joaquin River
WQO = water quality objective

In general, the effects on water quality would become increasingly detrimental with increases in recirculation. The number of days chloride concentrations at key drinking water intakes in the Delta (Jones, Clifton Court, Old River, Rock Slough, Antioch) would change by at least 5 mg/L would increase with increasing amounts of recirculation (i.e., from Alternatives B1, B2, and D). However, the ratio of days when chloride increases to days when chloride decreases would vary by location. Recirculation during periods of low flow may increase the portion of SJR source water at intakes, but decrease the amount of seawater intrusion. The SJR tends to have higher salinity than Sacramento River flow, but significantly less salinity than seawater. At Jones Pumping Plant and Clifton Court, chloride would more often increase than decrease by at least 5 mg/L. On the other hand, at Rock Slough and Antioch, chloride would more often decrease than increase.

Without improvements to Newman or Westley wasteways, the turbidity WQO would be violated more frequently as recirculation was increased because of mobilization of sediment from the unlined portion of either wasteway. All alternatives would include improvements to Newman Wasteway or Westley Wasteway. The turbidity effects would be decreased if Newman Wasteway sediment were stabilized or if a new outlet to Westley Wasteway were constructed and used.

Temperature in the Stanislaus River at Orange Blossom Bridge would rise as New Melones releases decreased, with the greatest effects under Alternative B2. However, the largest of the predicted temperature increases are still small and infrequent: the temperature would increase by more than 5ºF during 0.23% or less of the time and by more than 2ºF during 1.9% or less of the time for any alternative plan.

5.4 Fisheries

Table 5-4 shows how selected fisheries parameters would change compared to the No-Action Alternative under each alternative plan.

The weighted index of flows in the SJR at Vernalis is predicted to increase by 12% to 20% from conditions under the No-Action Alternative when recirculation is occurring, with the smallest changes occurring under Alternatives A1, A2, and B2 (**Table 5-4**). All alternative plans would provide additional habitat for fish when recirculation is occurring. The additional flow would assist juvenile salmonids during their emigration to the ocean. The increase in flow may also provide some improvements in habitat quality in the SJR. These flow changes, however, are not expected to provide substantial habitat improvements or to be consistent through time. Thus, the alternative

Table 5-4. Fisheries Results by Alternative Plan

Component	Geographic Area	Unit	No-Action Alter-native	Change Relative to No-Action Alternative, by Alternative Plan					
				A1	A2	B1	B2	C	D
Flow	SJR at Vernalis	Weighted Index	NA	14%	12%	19%	16%	20%	19%
Entrainment[1]	Delta	Weighted index for pelagic species: Delta smelt (*Hypomesus transpacificus)*	NA	7%	6%	13%	13%	6%	6%
		Weighted index for pelagic species: striped bass (*Morone saxatilis)*	NA	9%	8%	11%	11%	6%	5%
		Weighted index for pelagic species: longfin smelt (*Spirinchus thaleichthys)*	NA	4%	3%	10%	11%	5%	5%
		Weighted index for pelagic species: threadfin shad (*Dorosoma petenense)*	NA	9%	8%	13%	14%	7%	6%
		Weighted index for salmonid species: fall-run Chinook Salmon (*Oncorhynchus tshawytscha)*	NA	5%	5%	14%	16%	7%	7%
		Weighted index for salmonid species: late-fall-run Chinook salmon (*Oncorhynchus tshawytscha)*	NA	7%	6%	10%	10%	4%	4%
		Weighted index for salmonid species: winter-run Chinook salmon (*Oncorhynchus tshawytscha)*	NA	5%	5%	13%	13%	5%	5%
		Weighted index for salmonid species: spring-run Chinook salmon (*Oncorhynchus tshawytscha)*	NA	5%	5%	13%	16%	7%	7%
		Weighted index for salmonid species: steelhead (*Oncorhynchus mykiss)*	NA	7%	6%	13%	13%	6%	6%
		Weighted index for other species: American shad (*Alosa sapidissima)*	NA	3%	3%	11%	13%	6%	6%
		Weighted index for other species: splittail (*Pogonichthys macrolepidotus)*	NA	6%	5%	12%	11%	5%	5%

Table 5-4. Fisheries Results by Alternative Plan

Component	Geographic Area	Unit	No-Action Alter-native	Change Relative to No-Action Alternative, by Alternative Plan					
				A1	A2	B1	B2	C	D
Salmonid straying	SJR	Weighted index for proportion of Delta and Sacramento water in SJR below Merced River	NA	31%	33%	48%	50%	61%	60%
Flow	Stanislaus River at Goodwin Dam	Weighted index	NA	0%	–10%	0%	–11%	–12%	–15%
Temperature	Stanislaus River at Orange Blossom Bridge	90th percentile value of temperature where difference from the No-Action Alternative 90th percentile value of temperature is at least 0.9°F (critically dry year, Jan-Apr) (in °F)	56.9	—	0.2	—	0.2	0.2	1.1
Dissolved oxygen	SJR at DWSC	Percent of periods (Feb-June) when WQO (5 mg/L) is predicted to be met	82.9%	—	—	8.6%	8.6%	—	14.3%

Notes:

[1] Entrainment calculated compared to the No-Action Alternative; only for periods with recirculation.

Key:

— = Not modeled
ºF = degrees Fahrenheit
DWSC = Deep Water Ship Channel
NA = not available
SJR = San Joaquin River
WQO = water quality objective

plans may not provide substantial flow-related benefits to fisheries resources over time. Although all alternatives would provide increased flows over the No-Action Alternative when recirculation is occurring, the less than 8% difference in flow among alternatives is not substantial, and all alternatives are therefore considered to perform equivalently.

Fish entrainment in the Delta was evaluated by calculating the weighted index of entrainment under each alternative plan for each of the 11 species listed in **Table 5-4**. The species were selected in consultation with fisheries resource management agencies. The entrainment index is the product of volume of water pumped (provided by CalSim II) and salvage density (or loss) and was calculated on a monthly basis over 11 years (1993 to 2003). The index was weighted based on the frequency with which recirculation occurs under each alternative by water year type and month and the change in the index relative to the No-Action Alternative. Entrainment was calculated compared to the No-Action Alternative only for periods with recirculation. All alternatives would result in additional entrainment because of increases in pumping. The highest relative entrainment in the Delta would occur under Alternatives B1 and B2. **Appendix H** describes fish entrainment in more detail.

Salmonid straying in the SJR was evaluated qualitatively by determining the weighted index for the proportion of Delta and Sacramento River water in the SJR below the Merced River and at key locations in the Delta. Flows were provided by DSM2. Larger changes in the composition of source water indicate a higher likelihood of induced straying.[1] Only minor changes (less than 5%) were found for the Delta locations. In the SJR at Vernalis, the changes ranged from 14% to 20%. Directly below the Merced River, changes ranged from 31% to 61%, with the largest increases occurring under Alternatives C and D. These results indicate little potential for straying for fish that migrate up to Vernalis but some potential for straying for fish that migrate up to the Merced River. **Appendix H** describes salmonid straying in more detail.

In addition to entrainment, the evaluation of fisheries in the Delta included analyses of the following parameters (these parameters were not included in **Table 5-4** because they either did not vary substantially between alternative plans or the effects were related to entrainment and more directly estimated in the entrainment analysis):

[1] The presence of a large component of Sacramento River water in the SJR during the emigration season could impair the imprinting of SJR salmonids. Juvenile salmonids imprint on the sequence of olfactory chemical cues encountered in the river system as they migrate downstream. For instance, a salmon migrating out of the Merced River and down the SJR would encounter olfactory cues from the SJR and each tributary, in turn, including the Tuolumne and Stanislaus rivers, as it passes downstream. These sequences are then used in reverse order as an aid to navigation when the fish returns during its upstream migration.

- Delta outflow presented as a weighted index derived from data provided by CalSim II
- Combined exports presented as a weighted index derived from data provided by CalSim II for February through June (when recirculation would occur)
- Reverse flows[1] in Old River and Middle River presented as frequency of occurrence during various flow ranges (e.g., 0 to 2,000 cfs, 2,000 to 3,000 cfs) between January 1 and February 15, and as frequency of beneficial (decrease in number of days with reverse flows) and adverse changes (increase in number of days with reverse flows) between January 1 and April 15, derived from data provided by DSM2

In addition to salmonid straying, the evaluation of fisheries in the SJR (see **Appendix H**) included analyses of the following parameters (these parameters are not included in **Table 5-4** because they either did vary substantially between alternative plans or were not of as high concern as salmonid straying in the SJR):

- Temperature in the SJR at Vernalis presented as the temperature at which the difference in the 90th percentile value of temperature is at least 0.9°F from the No-Action Alternative for various seasons and water years when Chinook salmon and/or steelhead are migrating/emigrating, modeled temperatures provided by HEC-5Q
- Suspended sediment presented as severity of ill effects values derived from modeled TSS concentrations provided by the suspended sediment model

Flow was evaluated by determining the weighted index of flow in the Stanislaus River at Goodwin Dam under each alternative plan. Decreases in the weighted index indicate a reduction in the amount of suitable habitat available to certain fish species and life stages. Alternatives A2, B2, C, and D would result in decreased flows during recirculation periods of up to 15%. However, the change would not substantially alter habitat because water level changes would affect the margins of the River, which is generally where the least desirable habitat exists. **Appendix H** describes the flow evaluation in more detail.

Temperature was evaluated by first calculating the 90th percentile values of temperature (the temperature for which 90% of data points are less and 10% are

[1] Reverse flows (also known as upstream flows) occur in the southern Delta when in-Delta, SWP, and CVP exports are greater than the inflow from the SJR. When these conditions occur, water is drafted across the Delta from the Sacramento River and/or water can be drawn upstream from eastern Suisun Bay into the Delta, creating a reverse flow in the primary conveyance channels in the southern Delta (primarily Old and Middle rivers and their interconnecting channels). Reverse flows can impact resident and anadromous fish species by drawing them into the southern Delta and increasing the potential for their entrainment into the CVP and/or SWP southern Delta pumping facilities.

greater) by season in the Stanislaus River at Orange Blossom Bridge for each alternative plan. Then, the resulting temperatures that deviated from the No-Action Alternative 90th percentile values of temperature by at least 0.9°F were determined. A predicted change of at least 0.9°F in 90th percentile monthly water temperature was used to differentiate among alternatives for purposes of comparing alternatives in the PFR. This level of change was selected as a conservative estimate of the temperature changes that could affect salmonids. Modeled temperatures were provided by HEC-5Q, and the period of analysis was from January through April of a critically dry year, although a more extensive evaluation of temperature provided in **Appendix H** includes analyses for the Stanislaus River at Riverbank and other time periods. Orange Blossom Bridge was selected for the analysis because it provides the best fish-rearing habitat of the three locations that were evaluated and its effects are considered more important for fisheries. Recirculation had only a minimal effect on temperature in the Stanislaus River, with only a few occurrences when temperatures increased by greater than 0.9°F.

DO was evaluated using the same methods described above for the evaluation of planning objectives. Recirculation increased DO in SDWSC and increased the frequency that the objective was met by 8.6% and 14.3% during recirculation periods.

In summary, recirculation would have an adverse effect on fisheries primarily because of the effects of entrainment at the Jones and Banks pumping plants. The highest relative entrainment in the Delta would occur under Alternatives B1 and B2. Adverse effects on salmonid straying and higher temperature in the Stanislaus River at Orange Blossom Bridge increase with increasing amounts of recirculation, with the most substantial effects occurring under Alternative D. The reduction of flow in the Stanislaus River with regard to fish habitat is not considered to be substantial. Increases in flow at Vernalis are not expected to provide substantial habitat improvements or be consistent through time.

5.5 Energy

Table 5-5 shows how energy generation would change compared to the No-Action Alternative under each alternative plan.

Table 5-5. Energy Results by Alternative Plan

No-Action Alternative / Alternative Plans		Net energy generation for CVP and SWP facilities (in GWH)	
		Average Conditions[1]	**Dry Conditions**[2]
No-Action Alternative		3,396	2,242
Change Relative to the No-Action Alternative, by Alternative Plan	A1	–3.2	–4.9
	A2	–3.4	–6.8
	B1	–4.7	–7.2
	B2	–5.2	–10.0
	C	–1.0	–5.5
	D	0.6	–1.9

Notes:
[1] Average over Water Years 1922–2003
[2] Average over Water Years 1929–1934, 1976–1977, and 1987–1992 (14 of 82 water years or 17% of total)

Key:
CVP = Central Valley Project
GWH = gigawatt-hour(s)
SWP = State Water Project

Energy was evaluated by estimating how many GWH of energy would be generated by CVP and SWP facilities under each alternative plan. Net energy generation was calculated as the sum of energy generation from hydropower facilities and the energy usage from pumping operations. Energy generation was calculated for both long-term and drought conditions. The effects of the alternative plans on energy are evaluated more extensively in **Appendix I**, but net energy generation was selected as representative of the overall changes in energy. Energy costs for alternative plans are included and discussed under the economics evaluation in **Section 5.6**. Other parameters included in **Appendix I**, but not included in **Table 5-5**, were analyzed for both long-term and drought conditions:

- Total capacity of all facilities in megawatts
- Total energy generation of all facilities in GWH
- Total energy use of all facilities at load center in GWH
- Jones Pumping Plant energy use in GWH

- CVP Banks Pumping Plant energy use in GWH
- CVP San Luis Pumping Plant energy use in GWH
- CVP Dos Amigos Pumping Plant energy use in GWH
- Net energy costs in thousands of dollars

Because net energy costs correspond directly to energy generation and power costs from facility use, energy costs would increase from those of the No-Action Alternative during long-term conditions under Alternatives A1, A2, B1, B2, and C. During drought conditions, energy costs would increase under all six alternative plans. Of the six alternatives, Alternative B2 would have the highest costs during both long-term and drought conditions. Alternative D would have lower costs than the No-Action Alternative under long-term conditions as a result of the reduction in CVP Delta export water deliveries, which results in less energy use to pump and store water in the SLR.

5.6 Four Accounts of Potential Economic and Environmental Effects

The effects of the alternative plans are assessed using the four accounts described in the P&Gs (WRC 1983). These accounts were established to facilitate evaluation and display of alternative water resource plans.

5.6.1 National Economic Development Account

Table 5-6 shows how national economic parameters would change compared to the No-Action Alternative under each alternative plan.

Economic impacts on a national level were evaluated by calculating the net annual NED benefits for each alternative plan. The NED benefits of an alternative plan reflect changes in economic values associated with physical effects on natural resource management, and the NED costs of an alternative plan are based on the monetary outlays required to implement the alternative. Net benefits were assessed for both long-term and drought conditions. The parameters that could be quantified include agricultural water supply and hydroelectric energy impacts. A more extensive evaluation of NED, including an analysis of each resource area (e.g., fisheries, water supply, hydropower generation), is provided in **Appendix J**.

On a national level, economic losses relative to the No-Action Alternative tend to increase with recirculation, with Alternative D resulting in the greatest loss of net NED benefits for both average and dry water year conditions. Alternative A2 showed the greatest long-term NED benefits, though still negative.

Table 5-6. Predicted Effect on Average Annual Net National Economic Development Benefits

No-Action Alternative / Alternative Plans		Net NED Benefits	
		Average Conditions[1]	Dry Conditions[2]
No-Action Alternative		$2.7B	$2.6B
Change Relative to the No-Action Alternative, by Alternative Plan	A1	–$200K	–$300K
	A2	–$60K	–$1.4M
	B1	–$290K	–$440K
	B2	–$420K	–$1.4M
	C	–$990K	–$4.1M
	D	–$1.1M	–$8.6M

Notes:
[1] Average over Water Years 1922–2003
[2] Average over Water Years 1929–1934, 1976–1977, and 1987–1992 (14 of 82 water years or 17% of total)

Key:
B = billion
K = thousand
M = million
NED = National Economic Development

5.6.2 Regional Economic Development Account

Table 5-7 shows how regional economic parameters would change compared to the No-Action Alternative under each alternative plan.

On a regional level, the output from agricultural production in three different areas of analysis (statewide, San Joaquin County, and combined Fresno and Kings counties) was assessed for each alternative plan. The RED analysis focuses on changes in agricultural production and related regional economic impacts attributable to changes in surface water deliveries under each alternative. Outputs were determined for both long-term and drought conditions. A more extensive evaluation of RED, including total annual labor income and employment from agricultural production, is provided in **Appendix J**.

Table 5-7. Predicted Effect on Average Annual Regional Economic Development in Agricultural Production

		Central Valley		San Joaquin County, CVPM Region 8[1]		Fresno and Kings Counties, CVPM Region 14[2]	
		Average Conditions[3]	Dry Conditions[4]	Average Conditions[3]	Dry Conditions[4]	Average Conditions[3]	Dry Conditions[4]
No-Action Alternative		$22.5B	$21.6B	$1.2B	$1.2B	$1.5B	$771M
Change Relative to No-Action Alternative, by Alternative Plan	A1	0	0	0	0	0	0
	A2	$790K	–$8.1M	$140K	$210K	–$710K	–$7.7M
	B1	0	0	0	0	0	0
	B2	–$1.2M	–$6.9M	$220K	$290K	–$1.5M	–$7.7M
	C	–$13.1M	–$44.3M	$730K	$1.0M	–$14.0M	–$46.7M
	D	–$16.7M	–$96.5M	$740K	$1.3M	–$17.7M	–$100.5M

Notes:

1 Includes Sacramento County South of American River and San Joaquin County

2 Includes Westlands Water District

3 Average over Water Years 1922–2003

4 Average over Water Years 1929–1934, 1976–1977, and 1987–1992 (14 of 82 water years or 17% of total)

Key:

B = billion
CVPM = Central Valley Production Model
K = thousand
M = million

On a regional level (statewide, San Joaquin County, or Fresno and Kings counties), output from agricultural production would remain the same as under the No-Action Alternative for Alternatives A1 and B1. In general, output from agricultural production statewide and in Fresno and Kings counties would be less than output under the conditions of the No-Action Alternative, and the losses would increase with increased recirculation. Conversely, output from agricultural production in San Joaquin County would increase with recirculation due to increases in water deliveries to CVP Stanislaus contractors. However, these gains do not offset losses from other areas.

5.6.3 Environmental Quality Account

Implementation of the alternative plans may have beneficial or adverse effects on natural resources within the EQ account (water quality and fisheries).

Five water quality parameters were evaluated: EC, DO, bromide, turbidity, and temperature. EC and DO are both part of the planning objectives. Benefits in some water quality parameters (EC, DO) tend to be associated with adverse effects in other parameters (bromide, turbidity, temperature).

- As modeled using CalSim II and DSM2, all alternative plans showed a slight improvement (decrease) in EC in the SJR at Vernalis compared to the No-Action Alternative, and three of the alternative plans (B1, B2, and D) showed a slight improvement in the interior south Delta. At both of these locations, Alternative D resulted in the greatest improvement in EC.
- Alternatives B1, B2, and D showed improvement in DO in the Port of Stockton during February through June compared to the No-Action Alternative, a result that was estimated as a function of flow. Alternative D resulted in the greatest improvement (14.3 percent).
- Bromide (as correlated to chloride) would increase at most of the evaluated locations under Alternatives B1, B2, and D, with Alternative D showing the greatest increases. Bromide would not increase under Alternatives A1, A2, or C.
- Turbidity (as correlated to TSS) in the SJR above the Merced River would increase under all alternative plans, with the lowest increases shown under Alternative A1 and the greatest increase under Alternative D.
- As modeled using HEC-5Q, water temperature would increase by more than 5°F under Alternatives B2, C, and D, with Alternative B2 showing the most frequent increases.

Two aspects of fisheries were evaluated: entrainment and salmonid straying. All alternative plans had adverse effects on entrainment for at least 9 of 11 species considered. Alternatives B1 and B2 had greater adverse effects than the other plans. All alternative plans also had adverse effects on salmonid straying, with Alternatives B1, B2, C, and D having greater adverse effects than Alternatives A1 and A2.

5.6.4 Other Social Effects Account

Implementation of the alternative plans may have beneficial or adverse effects on resources within the OSE account. For example, Alternatives C and D would decrease CVP Delta exports and would further reduce the already limited agricultural water supply. These effects would adversely affect minority and economically disadvantaged groups that are employed in agriculture.

Chapter 6
Ranking of Alternative Plans and Recommendation of Alternative Plans for Further Study

The alternative plans were ranked based on the results of the comparison of the plans to each other (the comparison results are presented in **Chapter 5**). **Chapter 6** presents the ranking results and also the results of the comparison of the alternative plans to the four acceptance criteria that are described in the P&Gs—completeness, effectiveness, efficiency, and acceptability. Finally, recommended alternatives for further study are presented.

6.1 Ranking of Alternative Plans

For each unit in the ranking analysis (e.g., change in releases for New Melones Reservoir), a threshold was developed to indicate the degree to which a plan deviated from the No-Action Alternative and the other plans. If the unit value for an alternative plan deviated from the unit value under the No-Action Alternative by more than the threshold amount, the change compared to the No-Action Alternative was considered to be substantially adverse or beneficial depending on the nature of the unit. The threshold amount, determined by the Project Management Team (PMT) and the technical teams, was often a fraction of the No-Action Alternative value. Furthermore, if the unit value for an alternative plan deviated from those of other alternative plans by approximately the threshold amount or more, whether or not the other alternative plans were considered to change from the No-Action Alternative, the change compared to other alternative plans was considered to be substantially adverse or beneficial depending on the nature of the unit. If the unit value for an alternative plan did not increase or decrease from that of the No-Action Alternative by more than the threshold amount, the change was considered unsubstantial.

For example, in **Table 5-1**, the unit for reliance on New Melones ranges from 0 (Alternatives A1 and B1) to –8.1 (Alternative D) relative to a No-Action Alternative value of 0 thousand acre-feet (TAF). The ranking threshold was determined to be ±2 TAF; that is, an increase of 2 TAF in New Melones releases relative to the No-Action Alternative would be considered an adverse change, while a decrease of 2 TAF would be considered a beneficial change.

Thus, the changes in unit under Alternatives A1 and B1 compared to the No-Action Alternative were considered unsubstantial. The changes in unit under Alternatives A2, B2, C, and D compared to the No-Action Alternative were considered to be significantly beneficial because they all decreased from the No-Action Alternative by more than 2 TAF. Furthermore, because the changes under Alternatives C and D were considerably larger compared to Alternatives A1, A2, B1, and B2, Alternatives C and D were deemed to change significantly compared to other alternative plans.

After determining the degree to which an alternative plan deviated from the No-Action Alternative and the other alternative plans, a score was assigned to the alternative plan for each unit. The possible scores are summarized in **Table 6-1**.

Table 6-1. Ranking Criteria

Criteria	Ranking Score
Adverse change compared to other alternative plans	–2
Adverse change compared to the No-Action Alternative	–1
No change compared to the No-Action Alternative	0
Beneficial change compared to the No-Action Alternative	1
Beneficial change compared to other alternative plans	2

Continuing with reliance on New Melones as an example, Alternatives A1 and B1 were given a score of 0, Alternatives A2 and B2 were given a score of 1, and Alternatives C and D were given a score of 2.

After ranking each unit within a resource area, a weight was assigned to each unit. The overall ranking for a resource area was determined by calculating a weighted average. The PMT and technical team determined the weights using professional judgment. Higher weights were assigned for a given unit within the resource area if effects on that unit were deemed more important for the overall resource area. Considerations on weighting for each resource area are described below.

In achieving the planning objectives, meeting flow requirements at Vernalis was weighted the highest (0.3) while meeting the EC standards at Vernalis and in the interior south Delta had a combined weight of 0.2. Flow was given a higher weight because the percentage of time the flow standards was not achieved under the No-Action Alternative was higher (85.5%) than the percentage of time the EC standards were not met (97.1% and 98.2%), thereby providing a higher need for improvement for flow as compared to EC. Decreased reliance on New Melones and improvements in DO in the DWSC were weighted equally (0.2), because both are mentioned in the authorizing legislation. Improving water levels in the south Delta was weighted lower (0.1) because of the limited effect recirculation has at some south Delta locations and the lack of mention of south Delta water levels in the authorizing legislation.

For water supply, the evaluation was done for South of Delta Contractors and for CVP Stanislaus River Contractors. Each of these units was equally weighted to reflect the lack of a basis in favoring one location over another.

Water quality has three units reflecting affects on delta drinking water (bromide as chloride, shown in several locations within the Delta), turbidity in the SJR downstream of the Wasteway, and temperature compliance in the Stanislaus River. Effects on delta drinking water supply were given the most weight (0.5), and within the Delta locations that are larger diversion points (Jones Pumping Plant, Clifton Court Forebay) where given higher weights than only occasionally used locations such as Antioch. Turbidity and temperature were equally weighted as both are Basin Plan objectives, and there was no reason to favor one over another.

Fisheries had five units: entrainment, salmonid straying, flow, temperature, and dissolved oxygen. Entrainment was given the highest weight because of its potential to affect the greatest number of fish compared to other units. Specific entrainment analyses were conducted for a number of species. Special-status species were weighted higher than other species because effects to individuals must be considered, while effects to populations are considered for non-special-status species.

Energy generation was evaluated for both long-term and driest periods. Driest periods were weighted 0.2 while long-term was weighted 0.8. The lower weight for driest periods was assigned to reflect the less frequent occurrence of these periods (12 out of 82 years) and does provide more emphasis on the driest periods in the results as the driest periods are also included in the long-term evaluation.

For economics, the NED results were weighted equally to the RED results. Similar to the energy generation, NED results for long-term were weighted four time higher than NED results for the driest periods. RED analysis were presented for three geographic areas: statewide, San Joaquin County, and Fresno and King Counties. Each of these areas was weighted equally to avoid favoring one area over another.

Ranking thresholds, weights, and scores are shown in **Table 6-2** for each unit and resource area.

The overall ranking for achieving planning objectives is summarized in **Table 6-3**. Each alternative plan would result in a beneficial change compared to the No-Action Alternative in achieving planning objectives. Based on the overall ranking, Alternatives A1 and B1 would perform similarly, Alternatives A2 and B2 would perform similarly, and Alternatives C and D would be the most successful. As expected, planning objectives would be met with recirculation, and the degree to which they are met would increase with increased recirculation.

The overall rankings for each of the five resource areas are summarized in **Table 6-4**. The change in water supply would be the most adverse under Alternatives C and D with minor effects under the other alternative plans. The change in water quality would be adverse under all alternatives, but the most adverse changes would occur under Alternatives B2, C, and D. Fisheries would also experience adverse changes under all alternatives, with the most adverse changes occurring under Alternative B2. Energy would be adversely affected under Alternatives A2, B1, and B2. Economics would be adversely affected under Alternatives A2, B2, C, and D, with D resulting in the greatest changes compared to the No-Action Alternative.

Each resource area was weighted equally in determining the overall ranking for each alternative plan. Contrary to the overall ranking based on planning objectives, the overall ranking based on resources decreases as recirculation increases, with Alternative A1 being the least detrimental and Alternative D the most detrimental.

Table 6-2. Ranking of Alternative Plans for Individual Parameters and Resource Areas

Resource Area	Component	Geographic Area	Unit	Ranking Threshold	Ranking Score						Weight
					A1	A2	B1	B2	C	D	
Operations	Recirculation	Study Area	Total recirculation (in TAF per year)	Not applicable							
			Recirculation for flow (in TAF per year)								
			Recirculation for water quality (in TAF per year)								
			Years with recirculation (out of the 82 years)								
			Periods with recirculation (out of 1,148 periods)								
	Pumping	Jones Pumping Plant	Pumping at Jones (in TAF per year)								
		Banks Pumping Plant	Pumping at Banks (in TAF per year)								
Achieving Planning Objectives	Flow	SJR at Vernalis	Percentage of periods flow objective is predicted to be met	Increase of 2% beneficial, decrease of 2% adverse	1	1	1	1	2	2	0.30
	Electrical conductivity	SJR at Vernalis	Percentage of periods WQO is predicted to be met	Increase of 0.5% beneficial, decrease of 0.5% adverse	0	0	0	0	1	1	0.10
	Reliance on New Melones	New Melones	Change in New Melones releases for water quality and flow (in TAF per year)	Increase of 2 TAF adverse, decrease of 2 TAF beneficial	0	1	0	1	2	2	0.20
Other Potential Benefits	Dissolved oxygen	SJR at DWSC	Percentage of periods (Feb-June) when WQO (5 mg/L) is predicted to be met	Increase of 5% beneficial, decrease of 5% adverse	1	1	1	1	2	2	0.20
	Water level	SJR at Vernalis	90th percentile change in average daily stage during recirculation (April-Aug) (in feet)	Increase of greater than 1 foot beneficial, decrease of greater than 1 foot adverse	0	0	0	0	0	1	0.10
	Electrical conductivity	Interior south Delta (SJR at Brandt Bridge selected as representative)	Percentage of days WQO is predicted to be met	Increase of 0.5% beneficial, decrease of 0.5% adverse	0	0	0	0	0	0	0.10
				Overall Weighted Ranking Score	**0.5**	**0.7**	**0.5**	**0.7**	**1.5**	**1.6**	
Water Supply	CVP contractors deliveries	Delta export area	CVP deliveries (in TAF per year)	Increase of 2 TAF beneficial, decrease of 2 TAF adverse	0	0	0	0	–2	–2	0.50
	Stanislaus River deliveries	Stockton East Water District	Stanislaus River deliveries (in TAF per year)	Increase of 2 TAF beneficial, decrease of 2 TAF adverse	0	0	0	0	0	0	0.50
				Overall Weighted Ranking Score	**0.0**	**0.0**	**0.0**	**0.0**	**–1.0**	**–1.0**	
Water Quality	Bromide as correlated to chloride	Jones Pumping Plant	Number of days chloride is increased by at least 5 mg/L	Increase of 30 days adverse	0	0	0	–1	–2	–2	0.06
			Number of days chloride is decreased by at least 5 mg/L	Increase of 30 days beneficial	1	1	1	1	2	2	0.06
		Clifton Court	Number of days chloride is increased by at least 5 mg/L	Increase of 30 days adverse	0	0	0	0	–2	–2	0.06
			Number of days chloride is decreased by at least 5 mg/L	Increase of 30 days beneficial	1	1	1	1	2	2	0.06
		Old River	Number of days chloride is increased by at least 5 mg/L	Increase of 30 days adverse	0	0	0	0	–1	–1	0.06
			Number of days chloride is decreased by at least 5 mg/L	Increase of 30 days beneficial	0	0	0	0	1	1	0.06
		Rock Slough	Number of days chloride is increased by at least 5 mg/L	Increase of 30 days adverse	0	0	0	0	–1	-1	0.04
			Number of days chloride is decreased by at least 5 mg/L	Increase of 30 days beneficial	0	0	0	0	1	1	0.04

Table 6-2. Ranking of Alternative Plans for Individual Parameters and Resource Areas

Resource Area	Component	Geographic Area	Unit	Ranking Threshold	Ranking Score						Weight
					A1	A2	B1	B2	C	D	
Water Quality	Bromide as correlated to chloride (cont.)	Antioch	Number of days chloride is increased by at least 5 mg/L	Increase of 30 days adverse	0	0	0	-2	—	-2	0.03
			Number of days chloride is decreased by at least 5 mg/L	Increase of 30 days beneficial	0	0	0	1	2	2	0.03
				Contribution of Overall Weighted Ranking Score from Bromide	0.1	0.1	0.1	0.0	0.0	0.0	
	Turbidity	SJR above Merced River (6,500 feet)	Number of Periods (out of 24) predicted to be above the WQO in the SJR above Merced River (6,500 feet)[1]	2+ occurrences adverse	–1	–1	–2	–2	–2	-2	0.25
	Temperature	Stanislaus River at Orange Blossom Bridge	Percentage of 6-hour periods for which the temperature is predicted to increase by more than 5ºF[2]	Increase of 1% adverse, decrease of 1% beneficial	0	0	0	0	0	0	0.25
				Overall Weighted Ranking Score	**–0.1**	**–0.1**	**–0.4**	**–0.5**	**–0.5**	**-0.5**	
Fisheries	Entrainment	Delta	Weighted index for pelagic species: Delta smelt	Increase of 5% adverse, decrease of 5% beneficial	–1	–1	–2	–2	–1	-1	0.08
			Weighted index for pelagic species: striped bass		–1	–1	-2	-2	–1	–1	0.04
			Weighted index for pelagic species: longfin smelt		0	0	-2	-2	–1	–1	0.08
			Weighted index for pelagic species: threadfin shad		–1	–1	-2	-2	–1	–1	0.04
			Weighted index for salmonid species: fall-run Chinook salmon		–1	–1	-2	-2	–1	–1	0.04
			Weighted index for salmonid species: late fall-run Chinook salmon		–1	–1	-2	-2	0	0	0.04
			Weighted index for salmonid species: winter-run Chinook salmon		–1	–1	-2	-2	–1	–1	0.08
			Weighted index for salmonid species: spring-run Chinook salmon		–1	–1	-2	-2	–1	–1	0.08
			Weighted index for salmonid species: steelhead		–1	–1	-2	-2	–1	–1	0.08
			Weighted index for other species: American shad		0	0	-2	-2	–1	–1	0.04
			Weighted index for other species: splittail		–1	–1	-2	-2	–1	–1	0.04
	Salmonid Straying	SJR	Weighted index	Increase of 20% adverse, decrease of 20% beneficial	–1	–1	-2	-2	–2	–2	0.20
	Flow	Stanislaus River at Goodwin Dam	Weighted index	Increase of 10% beneficial, decrease of 10% adverse	0	–1	0	-1	–1	–1	0.10
	Temperature	Stanislaus River at Orange Blossom Bridge	Temperature where difference in the 10% exceedance temperature is greater than 0.9°F (critically dry year, Jan-Apr) (in °F)	Increase of 0.9°F adverse, decrease of 0.9°F beneficial	0	0	0	0	0	–1	0.05
	Dissolved oxygen	SJR at DWSC	Percentage of periods (Feb-June) when WQO (5 mg/L) is predicted to be met	Increase of 5% beneficial, decrease of 5% adverse	1	1	1	1	2	2	0.05
				Overall Weighted Ranking Score	**–0.2**	**–0.3**	**–0.5**	**–0.6**	**–0.5**	**–0.5**	

Table 6-2. Ranking of Alternative Plans for Individual Parameters and Resource Areas

Resource Area	Component	Geographic Area	Unit	Ranking Threshold	Ranking Score A1	A2	B1	B2	C	D	Weight
Energy	Energy generation	CVP, SWP	Long Term[3] (in GWH)	Increase of 5 GWH beneficial, decrease of 5 GWH adverse	0	0	0	-1	0	0	0.8
			Driest Periods[4] (in GWH)	Increase of 5 GWH beneficial, decrease of 5 GWH adverse	0	–1	–1	–2	–1	0	0.2
				Overall Weighted Ranking Score	**–0.0**	**–0.2**	**–0.2**	**–1.2**	**–0.2**	**0.0**	
Economics	National Economic Development	United States	Net NED benefits for an average water year[3] (in millions of dollars per year)	Increase of $1M beneficial, decrease of $1M adverse	0	0	0	0	0	–1	0.4
			Net NED Benefits for a dry water year[4] (in millions of dollars per year)	Increase of $1M beneficial, decrease of $1M adverse	0	–1	0	–1	–2	–2	0.1
	Regional Economic Development	Statewide	Output from Agricultural Production in Central Valley During Average Conditions[3] (in millions of dollars per year)	Increase of $10M beneficial, decrease of $10M adverse	0	0	0	0	–1	–1	0.13
			Output from Agricultural Production in Central Valley During Dry Conditions[4] (in millions of dollars per year)	Increase of $10M beneficial, decrease of $10M adverse	0	0	0	0	–2	–2	0.03
		San Joaquin County	Output from Agricultural Production in CVPM Region 8 During Average Conditions[3] (in millions of dollars per year)	Increase of $10M beneficial, decrease of $10M adverse	0	0	0	0	0	0	0.13
			Output from Agricultural Production in CVPM Region 8 During Dry Conditions[4] (in millions of dollars per year)	Increase of $10M beneficial, decrease of $10M adverse	0	0	0	0	0	0	0.03
		Fresno and King Counties	Output from Agricultural Production in CVPM Region 14 During Average Conditions[3] (in millions of dollars per year)	Increase of $10M beneficial, decrease of $10M adverse	0	0	0	0	–1	–1	0.13
			Output from Agricultural Production in CVPM Region 14 During Dry Conditions[4] (in millions of dollars per year)	Increase of $10M beneficial, decrease of $10M adverse	0	0	0	0	–2	–2	0.03
				Overall Weighted Ranking Score	**0.0**	**–0.1**	**0.0**	**–0.1**	**–0.6**	**–1.0**	

Notes:

Modeled periods vary depending on parameter, modeling methods, and applicable water quality criteria. See **Appendices A through I**.

Highlighted cells indicate estimated ranking values. In general, Alternatives A1 and A2 were estimated as equivalent to B1, B1 as equivalent to B2, C as equivalent to D.

1 Values are for the alternative plan, not relative to the No-Action Alternative, and assume use of Newman Wasteway.

2 Values are for the alternative plan, not relative to the No-Action Alternative, because the narrative WQO for temperature for cold or warm waters is not to be increased more than 5°F above natural receiving water temperature.

3 Average over Water Years 1922–2003.

4 Average over Water Years 1929-34, 1976-77, and 1987-92.

Key:

$M = million dollars
ºF = degrees Fahrenheit
mg/L = milligram(s) per liter
CVP = Central Valley Project
NA = not available or applicable
SJR = San Joaquin River
SWP = State Water Project
TAF = thousand acre-feet
WQO = water quality objective

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Table 6-3. Overall Weighted Ranking of Alternative Plans for Achieving Planning Objectives[1]

Alternative Plan	Overall Weighted Ranking Value for Planning Objectives
A1	0.5
A2	0.7
B1	0.5
B2	0.7
C	1.5
D	1.6

Table 6-4. Overall Weighted Ranking of Alternative Plans for Predicted Effect on Resource Areas[1]

Alternative Plan	Resource Area					Overall Ranking Value for Resource Areas
	Water Supply	Water Quality	Fisheries	Energy	Economics	
A1	0.0	–0.1	–0.2	0.0	0.0	–0.07
A2	0.0	–0.1	–0.3	–0.2	–0.1	–0.15
B1	0.0	–0.4	–0.5	–0.2	0.0	–0.22
B2	0.0	–0.5	–0.6	–1.2	–0.1	–0.47
C	–1.0	–0.5	–0.5	–0.2	–0.6	–0.56
D	–1.0	–0.5	–0.5	0.0	–1.0	–0.61
Weight	0.20	0.20	0.20	0.20	0.20	—

6.2 Acceptance Criteria

P&Gs provide a basis for comparison and selection of a proposed alternative plan. During the PFR Phase of the Study, a specific alternative plan does not need to be proposed but all alternative plans should be evaluated against each other to determine if they all need to be carried further in the Study. Acceptance criteria identified in the P&Gs are described below.

[1] Carried forward at the request of certain stakeholders and is consistent with the 2nd definition of excess capacity.

6.2.1 Completeness

Completeness is the extent to which an alternative plan provides and accounts for all necessary investments or actions by Reclamation, DWR, or others to ensure the realization of the planning objectives. Alternative plans that do not rely significantly on any other actions would be ranked high for completeness. All of the alternative plans are complete in that they include all necessary elements and do not rely on actions or investments by others.

6.2.2 Effectiveness

Effectiveness is the extent to which the alternative plan contributes to achieving the DMC Recirculation planning objectives as described in **Section 1.6**. Comparison of the effectiveness of each alternative plan is presented in the analysis of how well planning objectives are achieved and are presented in **Tables 5-1** and **6-3**.

6.2.3 Efficiency

Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the planning objectives, consistent with protection of the nation's environment. Analysis of NED Benefits and resource area impacts provides a indication of the efficiency of the alternatives.

6.2.4 Acceptability

Acceptability is the extent to which the alternative plans meet the requirements of applicable laws, regulations, and public policies. This criterion also assesses the degree of acceptance by State and local entities and the public. It considers compatibility with existing laws, regulations, and public policies. All alternative plans are designed to help meet regulations and obligations.

Impacts to resource areas are different for each alternative plan, with some alternative plans having larger potential impacts on fisheries and others having greater impacts on economics. Due to differences in the geographic areas benefited and impacted by the alternative plans, local entities will not likely be in favor of the same plan. All plans result in increased Delta pumping and have the potential to increase fish entrainment. Fisheries resource management agencies are likely to be concerned about any alternative that could increase stress on Delta fishes. As a result, overall acceptability of any one plan is difficult to generalize and will be evaluated in the EIS/EIR phase of the project in coordination with the appropriate regulators.

6.3 Findings

P&Gs define the NED Alternative Plan as an alternative that reasonably maximizes net national economic development benefits, consistent with the Federal objective. Other alternative plans can be developed to explore opportunities to address other Federal, State, local, and international concerns not fully addressed by the NED Alternative.

As shown in **Table 5-6**, net NED benefits for all six alternative plans are negative, indicating none of the plans provides a positive contribution to the economy. Alternative A1 has the least reduction in NED benefits during dry conditions, and Alternative A2 has the least reduction in NED benefits over the 82-year evaluation period. Alternatives C and D had the most negative NED benefits and the lowest ranking for environmental resources. Alternatives B1 and B2 ranked in the middle for meeting project goals, NED benefits, and environmental resources.

Because less water would be recirculated in Alternatives A1 and A2, these alternative plans have the best ranking for environmental resources but are the least effective in meeting the planning objectives.

All six alternative plans would increase Delta pumping, which could adversely affect Delta fisheries. Several programs currently under development are designed to mitigate the environmental impacts of the CVP and SWP in the Delta (e.g., Bay Delta Habitat Conservation Plan, Delta Habitat Conservation and Conveyance Program, reoperation of CVP/SWP to comply with current CVP/SWP operations Biological Opinions). Other programs currently under development (e.g., Real-Time Water Quality Management, San Joaquin River Restoration Program, Westside Drainage Management Program) include methods aimed at achieving more consistent compliance with water quality and flow objectives in the SJR. If successful, these programs may reduce the need for and impacts of recirculation.

6.4 Next Steps

Although the findings indicate that the project is not feasible, if further work were to be conducted on the project, the next steps in the feasibility study could include:

- Guidance from the Regional Water Quality Control Board and State Water Resources Control Board on the acceptability of short-term (less than 30-day) excursions above the 30-day average Vernalis salinity standard should be sought. Modeling indicates additional opportunities for recirculation may exist if these actions are allowed.

- Changes in CVP/SWP operations as a result of the current Biological Opinions could be incorporated into the water operations modeling to update existing and future conditions without the project.
- The San Joaquin River Restoration Water Management Program and the Real-Time Water Quality Management and efforts under the Program to Meet Standards would be incorporated into the Study assumptions.
- The potential for fish entrainment at the Delta pumping facilities would be re-evaluated based on the outcome of the Bay Delta Habitat Conservation Plan (and related activities). If a dual conveyance or isolated conveyance facility is implemented, recirculation opportunities and impacts would change.
- Recirculation could be more fully evaluated as a tool to assist in meeting minimum flow targets at Vernalis during the irrigation season, especially during periods when entrainment impacts at Delta pumping facilities are likely to be minimal.

The above actions would not be expected to significantly increase the net NED benefits; rather, they would serve to clarify the effects of recirculation activities on the system.

Chapter 7
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Chapter 8
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