Delta-Mendota Canal Recirculation Study

Final Report on Hydrologic Modeling

Prepared for

US Bureau of Reclamation
Mid-Pacific Region

By

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ACRONYMS – ABREVIATION

ANN	Artificial Neural Network
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta Estuary
Bay-Delta Accord	Principles for Agreement on Bay-Delta Standards between The State of California and the Federal Government
Banks Pumping Plant	Harvey O. Banks Pumping Plant
CALSIM2	California Simulation Model II
CCWD	Contra Costa Water District
CFS	cubicfoot per second
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
D-1641	Water Right Decision 1641
Delta	Sacramento – San Joaquin Delta
DFG	Department of Fish and Game
DMC	Delta-Mendota Canal
DSM2	Delta Simulation Model II
DWR	California Department of Water Resources
DWRSIM	SWP/CVP Simulation Model
EWA	Environmental Water Account
Exchange Contractors	San Joaquin River Exchange Contractors Water Authority
JPOD	joint point of diversion
LOD	Level of Development
LP	Linear Programming
M&I	Municipal and Industrial
Merced ID	Merced Irrigation District
MID	Modesto Irrigation District
MILP	Mixed Integer Linear Programming
NMFS	National Marine Fisheries Service
NOD	North-of-Delta
OID	Oakdale Irrigation District
POA	Plan of Action
Principles for Agreement	Principles for Agreement on Bay-Delta Standards between The State of California and the Federal Government
PROSIM	Project Simulation Model
Reclamation	Bureau of Reclamation
ROD	Record of Decision
SANJASM	San Joaquin River Simulation Model
SDWA	South Delta Water Agency
SJRA	San Joaquin River Agreement
SJRGA	San Joaquin River Group Association
SJR10	San Joaquin River mass balance water quality model
SJTA	San Joaquin Tributaries Association
SOD	South-of-Delta
SSJID	South San Joaquin Irrigation District
Study	Delta-Mendota Canal Recirculation Study
SWRCB	State Water Resources Control Board
TAF	thousand acre-foot
TID	Turlock Irrigation District
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
VAMP	Vernalis Adaptive Management Plan
WQCP	Water Quality Control Plan for San Francisco Bay/Sacramento-San Joaquin Delta Estuary May 1995

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CHAPTER 1. INTRODUCTION

STUDY PURPOSE

The Delta-Mendota Canal (DMC) Recirculation Study (Study) evaluates the benefits and impacts of recirculating water pumped from the Sacramento-San Joaquin Delta (Delta) through a series of the Central Valley Project (CVP) facilities to the San Joaquin River to meet flow objectives at Vernalis. The Study was performed to satisfy the requirements set forth by the State Water Resources Control Board (SWRCB) through its Water Right Decision 1641 (D-1641). CVP is owned and operated by the Bureau of Reclamation (Reclamation), and the recirculation-related facilities include the Tracy Pumping Plant, the DMC, the Newman Wasteway, and the San Luis Reservoir. Figure 1-1 shows the study area.

The Delta Mendota Canal (DMC) Recirculation study is an appraisal level study to be conducted in two phases. The first phase includes water supply and water quality modeling. The second phase includes fisheries studies, water and sediment sampling, a legal analysis, an economic analysis, public involvement, and the preparation of a final study report. The scope of the modeling effort was to provide sufficient information for Reclamation management to decide whether to proceed to the second phase of the project. If at the end of the appraisal study recirculation appears viable, then an extensive feasibility study, complete with environmental documentation, would be commenced. More detailed modeling to address unanswered questions from the appraisal study would also be conducted.

BACKGROUND

SWRCB D-1641

To provide ecosystem protection for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta), the State of California, federal agencies, and urban, agricultural, and environmental interest groups signed the “Principles for Agreement on Bay-Delta Standards Between the State of California and the Federal Government” (Principles for Agreement) on December 15, 1994. This agreement, lately referred to as the 1994 Bay-Delta Accord, stipulates water quality standards and operational constraints for facilities in the Delta, including minimum Delta outflows, minimum monthly average flows of San Joaquin River at Vernalis, and export limitations of CVP and the State Water Project (SWP). SWP is operated by the California Department of Water Resources (DWR). The 1994 Bay-Delta Accord was signed through the coordination of SWRCB, which also began a series of public proceedings to review then-existing water quality standards for the Delta.

In May 1995, SWRCB issued Resolution No. 95-24 to adopt the “Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary 95-1 WR May 1995 ” (1995 WQCP). Much of the 1994 Bay-Delta Accord coordinated actions package was included in the 1995 WQCP to establish water quality objectives to protect municipal and industrial, agricultural, and fish and wildlife beneficial uses in the Bay-Delta.

In June 1995, the San Joaquin Tributaries Association (SJTA) filed a lawsuit over SWRCB's adoption of the 1995 WQCP because of the lack of scientific information regarding flow objectives for the San Joaquin River and the lack of San Joaquin River stakeholder representation during negotiations of the objectives. To resolve this legal dispute, the San Joaquin River Group Authority (SJRGA)[1] proposed an alternative that provides a level of protection equivalent to the San Joaquin River flow objectives in the 1995 WQCP. With the collaborative effort of scientists from state and federal agencies and stakeholder groups, the Vernalis Adaptive Management Plan (VAMP) was then developed for the 31-day period of April and May pulse flow, as established by the San Joaquin River Technical and Management Committees.

The purpose of VAMP is to gather scientific information on the impact of flows and CVP/SWP export on the salmon smolts in the lower San Joaquin River during the pulse flow period. VAMP is implemented through the San Joaquin River Agreement (SJRA) over a 12-year period from 1999 through 2011. SJRA was signed by: the California Resources Agency parties[2], the United States Department of Interior parties[3], the SJRG parties[4], the CVP/SWP Export Interests parties[5], and the Environmental Community parties[6].

On July 1, 1998, SWRCB began a Bay-Delta Water Rights Hearing to appropriate the responsibilities of meeting these water quality objectives among water rights holders. The hearing is divided into eight phases; after the completion of Phases 1 through 7, including added Phases 2A and 2B, SWRCB adopted D-1641.

After completion of Phase 7 of the Bay-Delta Water Rights Hearing, SWRCB issued the D-1641 on December 29, 1999 (later revised on March 15, 2000), to implement the 1995 WQCP. DWR and Reclamation were held responsible for meeting flow and water quality standards until allocation of responsibility among other water users could be settled through the on-going Phase 8 negotiation process. This decision also recognizes SJRA and approves the implementation of VAMP flow objectives under the SJRA during the 31-day, April 15 through May 15, period for 12 years (1999 through 2011) to allow collection of additional scientific information for future references in revising flow and water quality standards at Vernalis.

[1] The member agencies of SJRGA are Modesto Irrigation District, Turlock Irrigation District, Merced Irrigation District, South San Joaquin Irrigation District, and Oakdale Irrigation District.
[2] DWR and California Department of Fish and Game (DFG)
[3] Reclamation and United States Fish and Wildlife Services
[4] SJRGA, the San Joaquin Exchange Contractors Water Authority, and its member agencies, Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water District, and Columbia Canal Company; the Friant Water Users Authority; and the City and County of San Francisco
[5] State Water Contractors, Kern County Water Agency, Tulare Lake Basin Water Storage District, Santa Clara Valley Water District, San Luis and Delta-Mendota Water Authority, Westlands Water District, and Metropolitan Water District of South California
[6] Natural Heritage Institute and the Bay Institute of San Francisco

D-1641 also amends the water right permits of Reclamation (CVP except New Melones Reservoir and Friant Unit) to allow operation of the joint point of diversion (JPOD). This amendment allows CVP, subject to permission of DWR, to divert or redivert water up to 10,350 cubic feet per second (CFS) at the Harvey O. Banks Pumping Plant (Banks Pumping Plant), a major export facility at the Delta owned and operated by DWR for SWP.

DMC Recirculation Study

During the Bay-Delta Water Right Hearing, Central Delta Water Agency and South Delta Water Agency (SDWA) opposed the allocation of responsibility proposed under SJRA. Instead, they recommended that no party other than Reclamation and DWR be allocated responsibility for meeting flow objectives in the southern Delta. SDWA also proposed that SWRCB implement flow objectives in the southern Delta by requiring DWR and Reclamation to release water pumped from the Delta into the San Joaquin River. The United States Fish and Wildlife Services (USFWS) witness testified that the proposal for recirculation required substantially more scientific evaluation and information regarding potential impacts to fishery resources.

As part of the terms and conditions for the amendment to permit use of the JPOD, SWRCB required Reclamation to prepare a Plan of Action (POA) to evaluate potential impacts of recirculating water from the DMC through the Newman Wasteway in consultation with National Marine Fisheries Service (NMFS), USFWS, California Department of Fish and Game (DFG), DWR, and SDWA. D-1641 also requires Reclamation to submit the POA to SWRCB for approval by October 1, 2000, and to initiate the study following SWRCB approval.

Study requirements set forth by D-1641 require analyses in various disciplines such as water supply, water quality, fishery, and engineering. Details of the derivation of the POA and the current Study are provided in Chapter 2.

HYDROLOGIC MODELING REPORT

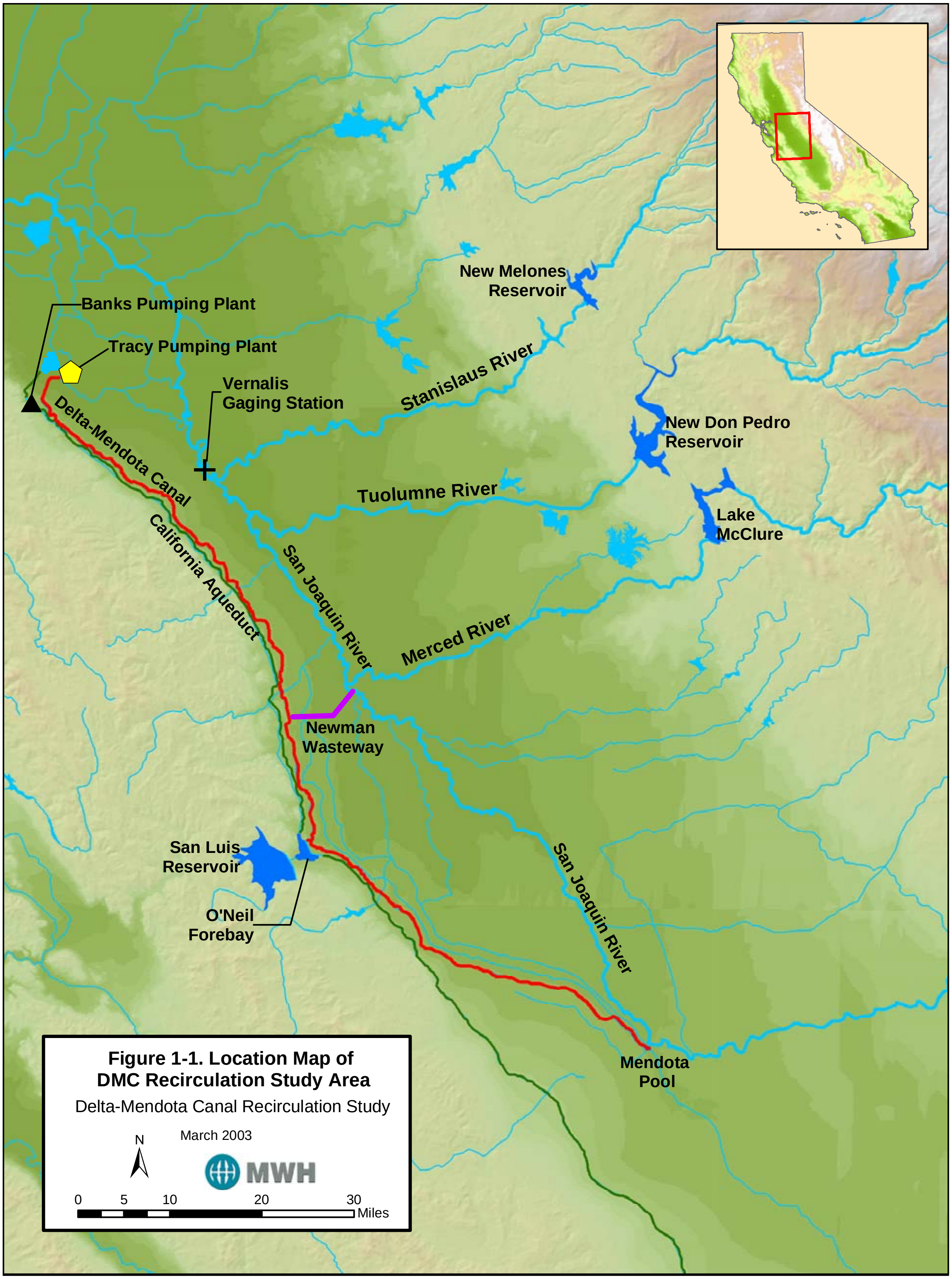
Purpose of this Report

The required studies in various disciplinary areas to satisfy the study requirements in D-1641 will be conducted in phases. The first phase of the Study focuses on hydrologic modeling analysis for water supply, and water quality modeling for the San Joaquin River and the Delta. This report summarizes hydrologic modeling results for the DMC recirculation study. The analysis identifies potential impacts on water supply due to implementation of DMC recirculation. Modeling results will be used as the basis for analyses in other disciplinary areas, including water quality sampling, fisheries, and engineering.

Report Organization

This report is divided into seven chapters. Chapter 1 provides background information for the study and the report. Chapter 2 summarizes development of the recirculation concept. Chapter 3 provides the methodology used for hydrologic analysis. Chapters 4 and 5 present the results of hydrologic analysis for Alternative 1 and Alternative 2, respectively. Chapter 6 summarizes the findings of the hydrologic and water supply evaluations. Chapter 7 provides the references used in this report.

Figure 1-1. Location Map of Delta-Mendota Canal Recirculation Study Area



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CHAPTER 2. DEVELOPMENT OF THE DMC RECIRCULATION CONCEPT

CONCEPT OF DMC RECIRCULATION

Recirculation uses water pumped at the CVP's Tracy Pumping Plant to augment flow in the San Joaquin River (Figure 2-1). Water is conveyed from the Tracy Pumping Plant by the DMC to milepost 54.38, where a portion is diverted to the Newman Wasteway and flows to the San Joaquin River near the San Joaquin/Merced River confluence. Once in the San Joaquin River the water returns to the Delta meeting Vernalis flow and water quality targets on the way.

The initiation of recirculation requires backfilling San Luis Reservoir water into the Newman Wasteway through operation of radial gates from Check Station 13 (near O'Neill Forebay) to Check Station 10 (near the Newman Wasteway). This initiation of recirculation is termed "priming the system." Once the recirculation operation has ended, the "priming" water is returned as soon as possible to the San Luis Reservoir CVP portion.

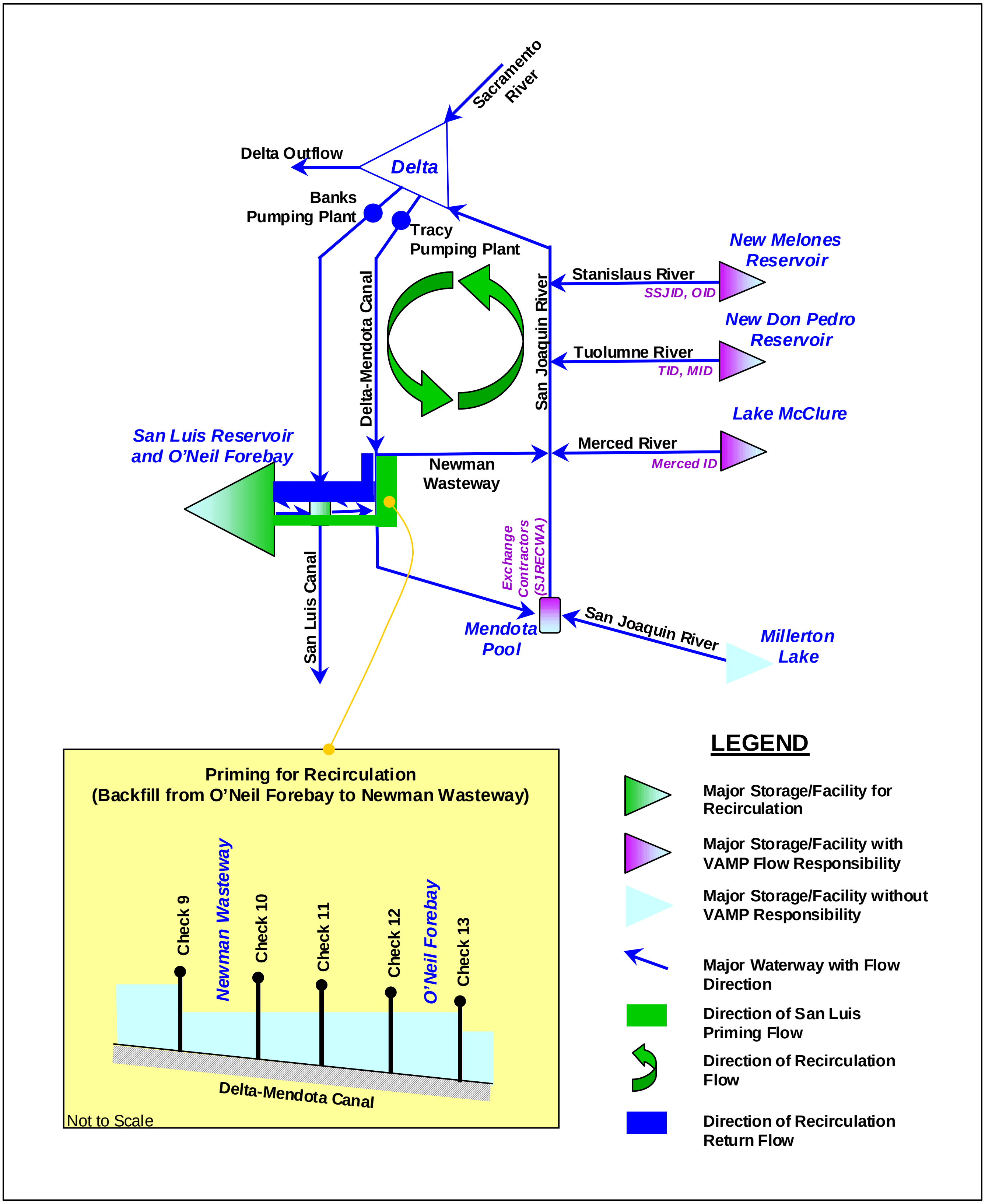
The Delta-Mendota Canal (Table 2-1), was built by Reclamation as part of the CVP to deliver Delta water diverted from Tracy Pumping Plant to the Mendota Pool. Water in the DMC can be stored in San Luis Reservoir through O'Neil Forebay. San Luis Reservoir can release water to DMC for downstream CVP deliveries.

The Newman Wasteway has a design flow rate of 4,300 CFS, and is primarily an unlined channel. It connects with the San Joaquin River at milepost 119.5. The Newman Wasteway is an emergency gateway used to release all DMC water into the San Joaquin River by gravity flow. However, discussions with the San Luis Delta Mendota Water Authority (SLDMWA, 2002) indicate that the actual flow rate of the Newman Wasteway may only be 1,500 cfs due to limited culvert capacity at the Highway 33 crossing.

Table 2-1. Delta-Mendota Canal Conveyance Capacity

Delta-Mendota Canal Reach	Conveyance Capacity (CFS)
From Tracy Pumping Plant to O'Neil Forebay	4,600 to 4,200
From O'Neil Forebay to Mendota Pool	3,500 to 3,200

Figure 2-1. Conceptual Representation of Delta-Mendota Canal Recirculation



History of the DMC Recirculation Concept

History of the DMC recirculation concept is briefly summarized in this section as a background for the current study conducted under the guidance of SWRCB as part of D-1641 implementation. Many previous studies considered recirculation as an option to meet flow objectives and to improve water quality in the lower San Joaquin River. However, results of these studies were not directly comparable due to differences in regulatory requirements, operation assumptions, base cases used for comparison, and the scale of recirculation. Therefore, results of previous studies are summarized qualitatively but not quantitatively.

1995 DMC Recirculation Appraisal Study by Reclamation

The concept of DMC recirculation was first proposed by SDWA in 1995 to meet the San Joaquin River flow requirements in the April-May pulse flow period per the 1994 Bay-Delta Accord. Potentially, recirculation would reduce demands on New Melones Reservoir during the spring pulse flow period, and could result in additional water available to meet water quality standards at Vernalis during summer months.

The appraisal study included the following assumptions:

1. Recirculation would be used for meeting April-May pulse flow requirements per the 1995 WQCP.
2. SWP would not wheel Delta water for CVP, with the exception of water for Cross Valley Contractors.
3. Increasing groundwater pumping would not be permitted.
4. System demand would be based on 1995 level of development.
5. Recirculation water would not be identified for usage only by federal facilities.

Four wasteways on the DMC are available to discharge water upstream of Vernalis: Westley Wasteway, Newman Wasteway, Volta Wasteway, and Firebaugh Wasteway. Their design flow rates are 4,400 CFS, 4,300 CFS, 5,000 CFS, and 3,300 CFS, respectively. However, these flow rates do not consider constrictions by bridge culverts, and actual flow capacity may be significantly less. The appraisal study does not specify which wasteway was considered in the analysis since the cost of channel modification was not included in this level of study.

The 1995 appraisal study was completed by using Project Simulation Model (PROSIM) for CVP operation and San Joaquin River Simulation Model (SANJASM) for operation in the San Joaquin River Basin. A report entitled "*DMC Recirculation Appraisal Study*" was completed in November 1995.

The appraisal study concludes that April-May pulse flow could be met by recirculation; however, impacts on salinity were unknown. In addition, recirculation would result in reduction of south-of-Delta (SOD) CVP delivery, while SWP storage would benefit slightly. The study also suggests that detailed studies to assess conveyance losses, environmental review, legal, and institutional considerations, and water quality impacts would be required for decision-making.

1997 DWRSIM Analysis of SWRCB Flow Alternative 6 by DWR

This analysis was conducted in response to a December 4, 1996, memorandum request from Victoria Whitney of SWRCB. The purpose of this analysis was to determine potential water supply impacts from diverting DMC water through Newman Wasteway to meet all flow objectives at Vernalis by using the SWP/CVP simulation model DWRSIM. A recirculation scenario, SWRCB Flow Alternative 6 (DWRSIM Simulation No. 485), was built upon the SWRCB Flow Alternative 2 (DWRSIM Simulation No. 468), which assumes the 1995 WQCP would be implemented through operations of CVP and SWP. However, the following addition assumptions were included in this recirculation scenario No. 485:

1. Recirculation would be used to meet flow objectives in the 1995 WQCP, including February–June and October minimum flows, and spring pulse flows. The San Joaquin River Agreement and the Vernalis Adaptive Management Plan would not be included in the simulation assumptions.

2. Incremental analysis for providing South Delta flow requirements by recirculation would be performed.

3. JPOD (wheeling) of CVP water through SWP facilities to CVP San Luis Reservoir would be permitted without adversely impacting SWP operations.

4. Meeting all flow objectives would have the highest priority. When DMC conveyance capacity was limiting, CVP deliveries would be subjected to cutback first.

The 1997 study suggests that using recirculation as a means to provide for South Delta flow requirements and flow objectives at Vernalis per the 1995 WQCP would result in reduced SOD CVP delivery, and a decrease in CVP storage. However, storage in New Melones would increase. Potential water quality impact was not discussed.

1998 SJRIO Studies of San Joaquin River Recirculation and Reoperation of Wetland Discharge and Tile Drainage by DWR, San Joaquin District

SJRIO, a mass balance water quality model for the San Joaquin River, was used to quantify the water quality impact of the following two water quality control actions in the San Joaquin River Basin:

- Recirculating water through the DMC to the San Joaquin River when additional water is required to meet the San Joaquin River spring pulse flow objectives from April 16 to May 15 per the 1995 WQCP.

- Reoperating tile drainage releases and/or wetland discharge from the Grassland watershed into the San Joaquin River. Tile drainage would be withheld in March and April, and released in May along with releases normally occurring in that month.

This 1998 study has no relationship to the previously mentioned 1997 study by DWR. The base case was defined by DWRSIM simulation No. 468A, in which it was assumed that the 1995 WQCP was implemented except flow and water quality objectives of the San Joaquin River at Vernalis. The operation of recirculation was not explicitly simulated because SJRIO simulated only the main stem of San Joaquin River. The required recirculation flow was then calculated to meet the 1995 WQCP flow objective at Vernalis.

The focus of this 1998 study was to find the combination effects of various levels of DMC recirculation and tile drainage release regulation. The study suggested that the reoperation of tile drainage releases would have a greater water quality benefit than recirculation. However, resulting water quality benefits from recirculation are not conclusive since the base case for comparison does not represent an alternative to recirculation, since flow and water quality objectives at Vernalis were not included.

Bay-Delta Hearings

The concept of DMC recirculation was discussed in the 1999 Bay-Delta Hearings. Testimony was heard on recirculation from SDWA, Reclamation, DWR, and SWRCB during the proceedings held in January through February 1999. This testimony indicated that there were still many unanswered questions on the benefits and impacts of recirculation.

CALFED Bay-Delta Program

The CALFED Bay-Delta program proposed initiating a study of recirculation in March 1999. In August 2000, CALFED agencies issued a Programmatic Record of Decision (ROD) in which the recirculation study was listed as an action item under the Water Quality Program to investigate impacts to the San Joaquin River.

SWRCB D-1641 and the DMC Recirculation Study

In addition to the request for Reclamation to prepare a POA for a DMC Recirculation Study, D-1641 also stipulates a set of study requirements that the Study should address.

Study Requirements

The following Study requirements are primarily based on Condition 2 of D-1641, the POA, and the SWRCB response letter regarding Reclamation:

a. Potential impacts of changes in water composition on Delta native fish and on imprinting of juvenile fall-run chinook salmon and steelhead in the San Joaquin River basin;

b. Potential effects of increased exports on in-Delta hydrodynamics and fish entrainment at the SWP and CVP export facilities;

c. Potential effects of salt and contaminant loading in the San Joaquin basin due to recirculation of water through the Newman Wasteway;

d. Impacts on water deliveries to exchange contractors and other contractors receiving water from the DMC, the State Aqueduct, and San Luis Reservoir;

e. The capacity of the physical facilities to implement recirculation. A description of any needed structural/channel modifications, a cost estimate, and a determination of potential conserved water over other alternatives to meet Delta flow and VAMP requirements shall be provided; and

f. Potential for improvements in water quality in the San Joaquin River as a result of recirculation.

Plan of Action

On December 15, 2000, Reclamation submitted a "Plan of Action, Recirculation Feasibility Study November 6, 2000" to SWRCB to comply with the Condition 2 of D-1641. The POA provides a framework for the Study, including eight tasks listed in Table 2-2, to address different issues raised in D-1641. After Task 3 is accomplished, if the practice of recirculation has shown no improvement to San Joaquin River flow and water quality, water savings, or has adverse effects on various aspects, DMC Recirculation Study would be concluded without implementing the remaining tasks.

Table 2-2. POA Tasks and Related D-1641 Issues

Task	Tasks per Plan of Action	Addresses Issues in Condition 2 of D-1641
1	Alternatives formulation This task consists of defining the characteristics and assumptions of the No-Action Base Condition and the various alternatives. The evaluation of alternatives will be compared to the Base Condition.	a, b, c, d, e, f
2	Alternatives modeling including water supply and water quality analysis CALSIM will be used for the surface water analysis and provide input into DSM2, and DSM2 for water quality analysis.	a, b, c, d, e, f
3	Fish and wildlife evaluation on fisheries, wetlands, and contaminants The fisheries agencies will evaluate the impact of South of Delta operations, and contaminants from Newman Wasteway on aquatic species.	a, b, c, f
4	Water and sediment sampling and laboratory analysis	c, f
5	Review of water rights, agreements, permits, and other legal issues	b, d, e
6	Economic analysis	a, b, c, d, e, f
7	Public involvement	a, b, c, d, e, f
8	Preparation of final study report	a, b, c, d, e, f

SWRCB Approval of the POA

On March 21, 2001, an SWRCB letter to Reclamation approved the POA. SWRCB accepted the general tasks and timelines for completing the POA tasks with additional comments and directions on implementation. SWRCB's comments on the POA, as well as the specific elements to be included in the Base Condition for the Study, include the following:

1. The 1995 level hydrology and the SWP and CVP demand specified in the "Baseline Operation Criteria" are adequate.

2. The studies must comply with all objectives of the 1995 Bay-Delta Water Quality Control Plan, with the exception of the Vernalis salinity objective, which may be violated under specified conditions.

3. The studies must comply with all provisions of the winter run chinook salmon and the Delta smelt Biological Opinions, including the export restrictions.

4. The studies must adhere to the CVPIA section 3406 (b)(2) Delta actions.

5. The studies must incorporate the Trinity River flows specified in the Trinity Record of Decision.

6. The studies must use the new long-term Yuba River flows set forth in the February 16, 2001, draft Yuba River decision.

7. The studies may make full use of Joint Point of Diversion in accordance with D-1641.

8. Pumping at Banks Pumping Plant shall be constrained in accordance with the 1981 U.S. Army Corps of Engineers criteria (Public Notes 5820A), except that the studies may make use of the extra 500 CFS of pumping at Banks during July, August and September.

9. The studies may make use of Export/Inflow flexing in accordance with Table 3, footnotes 18 and 20, when feasible.

10. New Melones Reservoir shall be operated in accordance with the Interim Operation Plan. The channel capacity limitation of 1,500 CFS shall be imposed on the Stanislaus River Agreement.

11. VAMP shall be operated in all years. VAMP flows shall be met by releases from Don Pedro and Exchequer reservoirs in accordance with the SJRA.

12. The head of Old River barrier shall be in place during the April-May pulse flow period except when flows exceed its hydraulic capacity. The interior agricultural barriers may be used as needed to counteract the effects of the head of Old River.

In addition, the SWRCB letter contained the following remark:

> *"Page 6 of the Plan (Plan of Action) contains the statement, "All studies are based on an objective of no net loss of water supply to the SWP and CVP". While this may be a desirable goal, it should not be the primary objective of the study; D-1641 clearly does not establish this as a requirement of the study. The objective of the study is to determine whether significant benefits can be achieved by recirculation, while at the same time complying with all relevant regulatory conditions. If there are significant water supply impacts, then other methods for achieving the Vernalis flow objectives, such as the San Joaquin River Agreement, may be more desirable."*

In the course of developing the modeling assumptions in 2002, the Bureau of Reclamation approached the SWRCB on further clarification of the preceding remark. In numerous conversations with the SWRCB, the Bureau was instructed to model all recirculation alternatives subject to the existing regulatory framework. Current export restrictions were not to be relaxed or modified for any of the alternatives.

CHAPTER 3. STUDY FRAMEWORK FOR HYDROLOGIC ANALYSIS

The study framework for hydrologic (water supply) analysis discussed in this chapter is divided into four areas:

- Scope of hydrologic analysis
- Selected operation model for planning purposes
- Definition of Base Condition and alternatives
- Methodology for impact assessment

A description of hydrologic and water supply conditions in Base Condition is also provided in this chapter.

SCOPE OF HYDROLOGIC ANALYSIS

The purpose of the hydrologic analysis is to identify potential water supply impacts due to implementation of DMC recirculation, and to provide basic information for further analyses in other disciplinary areas. Table 3-1 shows a list of issues in D-1641 that the Study should address, and notes whether these issues were addressed in the hydrologic analysis.

Table 3-1. Issues in Condition 2 of D-1641 and Scope of Hydrologic Analysis

	Issues that the Study Should Address per Condition 2 of D-1641	Included in Scope of Hydrologic Analysis?
a	Potential impacts of changes in water composition on Delta native fish and on imprinting of juvenile fall-run chinook salmon and steelhead in the San Joaquin basin.	No
b	Potential effects of increased exports on in-Delta hydrodynamics and fish entrainment at SWP and CVP export facilities.	No
c	Potential effects of salt and contaminant loading in the San Joaquin basin due to recirculation of water through the Newman Wasteway.	No
D	Impacts on water deliveries to Exchange Contractors and other contractors receiving water from the DMC, State Aqueduct, and San Luis Reservoir.	Yes
e	Capacity of physical facilities to implement recirculation. A description of any needed structural/channel modifications, a cost estimate, and a determination of potential conserved water over other alternatives to meet Delta flow and VAMP requirements shall be provided.	Hydrologic modeling assumes the Newman Wasteway can flow at its design capacity (4,300 cfs).
f	Potential for improvements in water quality in the San Joaquin River as a result of recirculation.	No

Operation Model for Planning Purposes: CALSIM2

Hydrologic analysis for the Study was accomplished using the California Simulation Model II (CALSIM2), a hydrologic planning model that has replaced Reclamation's PROSIM and DWR's DWRSIM. CALSIM2 is a general-purpose planning simulation model under development by Reclamation and DWR to simulate operations of California's water resources system, specifically the CVP and SWP. On a monthly time-step, CALSIM2 utilizes optimization techniques to route water through a network. A linear programming (LP)/mixed integer linear programming (MILP) solver determines an optimal set of decisions for each time period with a given set of weights and system constraints. A key component for specification of the physical and operational constraints is the WRESL language, through which the model user can describe the physical system (e.g., dams, reservoirs, channels, pumping plants), operational rules (e.g., flood-control diagrams, minimum flows, delivery requirements), and priorities for allocating water to different uses.

CALSIM2's geographic coverage includes the valley floor drainage area of the Sacramento and San Joaquin Rivers, the upper Trinity River, San Joaquin Valley, Tulare Basin, and southern California areas served by CVP and SWP. Although the focus of CALSIM2 is on major CVP and SWP facilities, operations of many other facilities are included to varying degrees. Operations in the upper watersheds are generally represented by inflows to major storage facilities (i.e., the integration of upstream operations is not dynamic).

The latest release of CALSIM2 Benchmark Studies is dated September 30, 2002. These benchmark studies were developed under the oversight of the CALFED/DWR/Reclamation Technical Coordination Team. The benchmark studies were developed for both 2001 and 2020 Levels of Development (LOD), each with use of Contra Costa Water District's (CCWD) G-Model and DWR's Artificial Neural Network (ANN) model for modeling Delta flow-salinity relationships.

A set of common assumptions consistent with ongoing and foreseeable CALSIM2 applications was incorporated into the current release. However, many identified enhancements are being implemented through an ongoing process. Most statewide planning efforts using CALSIM2 will require their own unique baseline simulations. Assumptions related to CVPIA 3406(b)(2) and CALFED's Environmental Water Account are under review and are subject to refinement as these adaptive management programs continue to mature. Refer to the draft Benchmark Studies Assumptions produced by the CALSIM2 development team for additional details in major assumptions used in the model (http://modeling.water.ca.gov/).

Definition of Base Condition and Alternatives

Through continued consultation with the SWRCB, the Study has defined a Base Condition and two recirculation alternatives that satisfy SWRCB's requirements, as described below. In addition, fundamental guidelines for the Study are to observe current applicable water rights, laws, regulations (including CVP and SWP pumping restrictions), contracts, and other operation principles and guidelines.

- **Base Condition** — The Base Condition is based on the CALSIM2 September 2002 Benchmark Study for 2001 level of development (ANN version). The Base Condition satisfies the study requirements listed in Condition 2 of D-1641, and study requirements listed in SWRCB's March 21, 2000, letter. Since the beginning of the Study in 2002, the Base Condition has been refined through continued consultation with SWRCB. Table 3-2 shows that the current Study adequately includes all requested elements in the base condition.

- **Alternative 1 (VAMP Recirculation)** — For this alternative, DMC recirculation would be used to supplement the San Joaquin River flow at Vernalis with up to 110 thousand acre-feet (TAF) per year during the 31-day pulse flow period (April 15 through May 15). The intent of Alternative 1 is to provide complete relief of the Exchange Contractors and tributary reservoirs (New Melones, New Don Pedro, and Lake McClure) responsibility for meeting the VAMP flow requirements.

- **Alternative 2 (February-June Vernalis Minimum Flow Recirculation)** — For this alternative, DMC recirculation would be used to supplement the San Joaquin River flow at Vernalis during February through June, with the exclusion of the 31-day pulse flow period (April 15 through May 15), to meet minimum flow objectives set forth in the 1995 WQCP. However, recirculation is only intended to supplement the Vernalis flow deficiency after releases from New Melones Reservoir per the 1996 Interim Operation Agreement. In addition, the possibility of supplementing San Joaquin River flows during October pulse or attraction flows was also investigated.

METHODOLOGY FOR IMPACT ASSESSMENT

Potential impacts of DMC recirculation will be assessed through comparing CALSIM2 results for the Base Condition and Alternatives 1 and 2. Outputs of CALSIM2 also will provide basic information for analyses in other disciplinary areas such as water quality[7] and fisheries.

The impact assessment focuses on the following major areas:

- North-of-Delta (NOD) CVP operation (reservoir storage and delivery)

- NOD SWP operation (reservoir storage)

[7] One current study component will model water quality in the San Joaquin River and the Delta by using Delta Simulation Model II (DSM2). Results will be reported in a separate volume. Due to the advanced model resolution of DSM2, the data linkage between CALSIM and DSM2-SJR has been developed; more details can be found in "Technical Memorandum on Linking CALSIM and DSM2-SJR for Delta-Mendota Canal Recirculation Study," dated August 2002.

- Delta operation (Delta outflow and export pumping)
- SOD CVP operation (reservoir storage and delivery)
- SOD SWP operation (reservoir storage and delivery)
- San Joaquin River eastside tributary reservoir operation (New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure)

The impact assessment also will include the variation of potential impacts for different hydrologic year types, and in representative drought periods. In this report, only summary tables and figures are presented; detailed tabulation of simulation results is provided in the appendices.

Table 3-2.
Necessary Elements in Base Condition per SWRCB March 21, 2001 Letter and Their Inclusion Status in the Study

	Elements for Base Condition Modeling per SWRCB March 21, 2001 Letter	Included in this Study?
1	The 1995 level hydrology and the SWP and CVP demand specified in the "Baseline Operation Criteria" are adequate.	Demands for 2001 level of development are used.
2	The studies must comply with all objectives of the 1995 Bay-Delta Water Quality Control Plan, with the exception of the Vernalis salinity objective, which may be violated under specified conditions.	Yes
3	The studies must comply with all provisions of the winter run chinook salmon and the Delta smelt Biological Opinions, including the export restrictions.	Yes
4	The studies must adhere to the CVPIA section 3406 (b)(2) Delta actions.	Yes
5	The studies must incorporate the Trinity River flows specified in the Trinity Record of Decision.	Yes
6	The studies must use the new long-term Yuba River flows set forth in the February 16, 2001, draft Yuba River decision.	Yes[1]
7	The studies may make full use of Joint Point of Diversion in accordance with D-1641.	Yes
8	Pumping at Banks Pumping Plant shall be constrained in accordance with the 1981 U.S. Army Corps of Engineers criteria (Public Notes 5820A), except that the studies may make use of the extra 500 CFS of pumping at Banks during July, August and September.	Yes
9	The studies may make use of Export/Inflow flexing in accordance with Table 3, footnotes 18 and 20, when feasible.	No[2]
10	New Melones Reservoir shall be operated in accordance with the Interim Operation Plan. The channel capacity limitation of 1,500 CFS shall be imposed on the Stanislaus River Agreement.	Yes
11	VAMP shall be operated in all years. VAMP flows shall be met by releases from Don Pedro and Exchequer reservoirs in accordance with the SJRA.	No[3]
12	The head of Old River barrier shall be in place during the April-May pulse flow period except when flows exceed its hydraulic capacity. The interior agricultural barriers may be used as needed to counteract the effects of the head of Old River.	Yes

[1] Currently, there is no available simulation for the fully implemented Decision 1644. During a discussion on May 13, 2002, SWRCB (Nick Wilcox) agreed to use simulation results presented in the 2000 Lower Yuba River Hearing for existing conditions with the proposed instream flow requirements in the 1996 Draft Decision as a surrogate. The Yuba River flow is an input to the CALSIM2 model and would remain unchanged in alternative evaluation; thus, using the surrogate flow as model input would not impact study findings.

[2] The use of Delta export/inflow flexing will not be modeled in CALSIM2 as per the discussion with the SWRCB (Nick Wilcox) on May 13, 2002. Delta export/inflow flexing involves real-time decisions involving fisheries that cannot be modeled in CALSIM2.

[3] Don Pedro, Exchequer and the exchange contractors will be relieved of their VAMP flow requirements by recirculation as per the discussion with the SWRCB (Nick Wilcox) on May 13, 2002.

HYDROLOGIC AND WATER SUPPLY CONDITIONS FOR BASE CONDITION

The Base Condition used in this Study is the system condition defined in the CALSIM2 Benchmark Study for 2001 LOD dated September 30, 2002, with only one exception for Yuba River inflow (described below). The complete list of CALSIM2 Benchmark Study assumptions is provided in Appendix A. Highlights of assumptions directly relevant to this Study include the implementation of the following:

- SWRCB D-1485 and D-1641
- 1986 Coordination Operations Agreement between CVP and SWP
- 1997 New Melones Interim Operations Plan
- 1987 Agreement on Instream Flow Requirements below Goodwin Dam between Reclamation and DFG
- San Joaquin River Agreement
- 1993 Winter Run Biological Opinion issued by NMFS
- 1995 Delta Smelt Biological Opinion issued by USFWS
- CVPIA, Section 3406(b)(2)
- JPOD
- Environmental Water Account (EWA).

Per SWRCB's request, Yuba River inflow in the September 2002 CALSIM2 Benchmark Study was modified to be more consistent with D-1644[8]. Since Yuba River inflow is a boundary condition of CALSIM2, variation of this inflow will not affect the Study (Revised Yuba River inflow is consistently used in the Base Condition and alternatives, and impact assessments are based on differences in CALSIM2 result between alternatives and the Base Condition.)

Hydrologic and water supply conditions in the Base Condition are summarized in the remainder of this chapter for different San Joaquin Valley water year types[9]. For consistency and easy comparison, Chapters 4 and 5 summarize Alternative 1 and 2 results, respectively, and are organized similarly (storage, deliveries, export and JPOD, Delta inflow and outflow, flows at recirculation control points, and eastside tributary reservoir releases are discussed in all three of these chapters).

[8] A SWRCB water right order issued in 2001 for the instream flow requirements in the Lower Yuba River.
[9] San Joaquin Valley water year types are: wet (W), above normal (AN), below normal (BN), dry (D), and critical (C).

Storage

This report focuses on the following major storage facilities: San Luis Reservoir, New Melones Reservoir, New Don Pedro Reservoir, Lake McClure, NOD CVP storage, and NOD SWP storage (Table 3-3).

San Luis Reservoir is jointly owned and operated by CVP and SWP as the major SOD storage (CVP San Luis and SWP San Luis). It receives water pumped from the Delta and regulates delivery to CVP and SWP water users. Tables 3-4 and 3-5 show end-of-month storage in these two portions of San Luis Reservoir by year type. For recirculation, CVP San Luis will provide flow for recirculation if necessary, and SWP portion will not.

New Melones Reservoir was built by USACE in 1978 for flood control, water conservation, and water quality purposes. It is operated by Reclamation under the 1997 New Melones Interim Operations Plan. Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID) have senior water rights on Stanislaus River aggregating 908.3 CFS of natural flow diversion. Per D-1641, New Melones Reservoir is responsible for meeting water quality and flow objectives at Vernalis. Due to the SJRA (described in Chapter 5), the responsibility of meeting Vernalis flow objectives during the spring pulse flow period is also shared by New Don Pedro Reservoir, Lake McClure, and exchange contractors. Table 3-6 shows end-of-month storage of New Melones Reservoir by year type.

New Don Pedro Dam was constructed by the City and County of San Francisco, Hetch Hetchy Water and Power, Turlock Irrigation District (TID), and Modesto Irrigation District (MID). It is operated by TID. Besides supplying water to City of San Francisco, TID, and MID, New Don Pedro Reservoir also provides flood control and hydropower generation. Under SJRA, New Don Pedro Reservoir contributes flow to meet spring pulse flow objectives in San Joaquin River at Vernalis. Table 3-7 shows end-of-month storage of New Don Pedro Reservoir by year type.

Lake McClure, located behind the New Exchequer Dam, is owned and operated by Merced Irrigation District (Merced ID) for water supply and hydropower generation. Most agricultural needs of eastern Merced County are met through diversion from Lake McClure. Under the SJRA, Lake McClure contributes flow to meet spring pulse flow objectives in the San Joaquin River at Vernalis. Table 3-8 shows end-of-month storage of Lake McClure by year type.

Tables 3-9 and 3-10 show end-of-month storage in major NOD CVP and SWP storages by year type. Although recirculation occurs in south of Delta, storage of these reservoirs could be affected.

Table 3-3. Major Storage Facilities and Their Corresponding Capacity in TAF

Storage Facilities	Capacity (TAF)
San Luis Reservoir CVP Portion	972
San Luis Reservoir SWP Portion	1,067
San Joaquin River Basin	
New Melones Reservoir	2,420
New Don Pedro Reservoir	2,030
Lake McClure	1,024
North-of-Delta CVP Total Storage	5,800
Whiskeytown Lake	240
Shasta Lake	4,552
Keswick Reservoir	24
Folsom Lake	975
Lake Natomas	9
North-of-Delta SWP Total Storage	3,570
Lake Oroville	3,558
Thermalito Forebay	12

Deliveries and Exports

Total NOD and SOD deliveries by CVP and SWP simulated in the Base Condition are summarized by year type in Tables 3-11 through 3-13. When possible, SWP also provides interruptible supplies or Article 21 water to its contractors south of Delta (Table 3-14). Interruptible supplies are only made available when the Delta is in excess condition, San Luis Reservoir is full, and additional pumping capacity at Banks Pumping Plant is available.

Tracy Pumping Plant (Table 3-15) and Banks Pumping Plant (Table 3-16) are the export facilities for CVP and SWP SOD deliveries, respectively. Operations of these pumps are subject to their physical capacity and a series of regulations, including 1995 WQCP, 1981 USACE criteria, biological opinions, CVP-SWP Coordinated Operation Agreement, and SJRA during the spring pulse flow period.

Tracy Pumping Plant has six pumps with individual capacities of 800 to 990 CFS; the plant has a total capacity of up to 4,600 CFS. Water pumped at the Tracy Pumping Plant is stored in San Luis Reservoir or delivered to project water contractors directly through DMC. The nominal conveyance capacity of DMC is 4,600 CFS.

Banks Pumping Plant has a capacity of 10,350 CFS; the U.S. Army Corps of Engineers. However, in compliance with the 1981 Public Notice 5820A ("Four Pumps Agreement") issued by USACE, pumping rate is constrained at 6,680 CFS from March 16 through December 14. During December 15 to March 15, pumping is limited to 6,680 CFS plus one-third of the total flow at Vernalis when Vernalis flow exceeding 1,000 CFS. Water pumped at the Banks Pumping Plant is stored in San Luis Reservoir or delivered to water users directly through the California Aqueduct, South Bay Aqueduct, and Coastal Aqueduct.

In the Base Condition and both alternatives, operation of JPOD is assumed. That is, Banks Pumping Plant is enabled to wheel water for CVP when unused capacity exists, and vice versa. However, Banks Pumping Plant wheeling for CVP is more realistic because of the limited pumping capacity at Tracy Pumping Plant compared with CVP SOD demands. After Banks Pumping Plant fulfills the SWP export (Table 3-17), its unused capacity will divert Delta water for CVP (Table 3-18) to San Luis Reservoir.

The maximum Delta export/inflow ratio (Table 3-19) stipulated in the 1995 WQCP imposes additional limitations on CVP and SWP exports. When additional export through CVP and SWP pumps is considered, these ratios require additional Delta inflow to protect the Delta ecosystem. This additional water is commonly called carriage water. The same rule applies to recirculation because recirculated water will be pumped at Tracy Pumping Plant and is considered part of the CVP export.

Delta Inflow and Outflow

Delta inflow (Table 3-20) is the total of inflows from Sacramento River, Mokelumne River, Yolo Bypass, San Joaquin River, and Marsh Creek. It is a result of upstream reservoir operation. Delta outflow (Table 3-21) is equal to Delta inflow minus the total of net Delta consumptive use and Delta exports. Delta inflow and outflow provide the quantitative indicator of Delta condition. Delta inflow and outflow conditions are crucial to Delta Estuary fishery and wildlife resources.

Flows at Recirculation Control Points

Flow conditions are only reported at two recirculation control points, the San Joaquin River at Vernalis and Newman Wasteway.

The San Joaquin River at Vernalis is an important location for the 1995 WQCP because its flow and water quality objectives control the operations of major tributary reservoirs. The location is near the south end of the legal Delta. Table 3-22 summarizes flow at this location for the Base Condition by year type.

Newman Wasteway, which is not used in the Base Condition, is considered to be the pathway to move water from DMC to the San Joaquin River for recirculation purposes.

Eastside Tributary Reservoir Releases

Eastside tributary reservoir releases are summarized in Tables 3-23 through 3-25, showing releases from Goodwin Dam on Stanislaus River (Table 3-23), New Don Pedro Reservoir on Tuolumne River (Table 3-24), and Lake McClure on Merced River (Table 3-25). These releases are performed for various purposes, including but not limited to, VAMP flow per SJRA, water quality, minimum instream flow, and fishery needs. Since water stored in these reservoirs is generally of higher quality than Delta water, the change in occurrence of these releases can impact downstream San Joaquin River water quality.

Table 3-4. End-of-Month Storage of San Luis Reservoir (CVP Portion) by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	315	429	570	694	793	879	865	729	589	447	337	456
AN	412	525	671	798	870	914	866	685	470	287	188	249
BN	241	351	509	647	764	836	779	572	352	193	112	164
D	440	567	699	787	822	844	783	642	438	254	161	208
C	259	318	441	587	657	699	629	513	359	219	132	152
All Year Types	328	431	570	697	777	834	787	634	454	295	200	264

Table 3-5. End-of-Month Storage of San Luis Reservoir (SWP Portion) by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	348	395	528	731	914	982	882	690	705	551	536	643
AN	420	473	529	725	857	934	801	570	435	289	233	272
BN	390	409	473	649	737	819	708	478	387	262	216	272
D	595	622	723	892	866	872	733	549	361	259	193	175
C	290	253	303	463	543	582	478	404	344	250	204	191
All Year Types	393	415	499	682	785	842	727	548	470	343	301	341

Table 3-6. End-of-Month Storage of New Melones Reservoir by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	1,343	1,361	1,422	1,536	1,660	1,767	1,802	1,947	2,077	2,032	1,933	1,828
AN	1,195	1,231	1,286	1,344	1,432	1,505	1,502	1,595	1,670	1,585	1,483	1,387
BN	1,408	1,423	1,442	1,466	1,510	1,569	1,539	1,555	1,606	1,518	1,415	1,314
D	1,571	1,586	1,605	1,626	1,648	1,683	1,631	1,549	1,501	1,375	1,260	1,159
C	1,055	1,067	1,081	1,093	1,114	1,143	1,104	1,029	992	899	822	756
All Year Types	1,297	1,316	1,352	1,404	1,470	1,535	1,523	1,554	1,597	1,515	1,417	1,323

Table 3-7. End-of-Month Storage of New Don Pedro Reservoir by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	1,355	1,336	1,444	1,545	1,629	1,656	1,669	1,791	1,990	1,969	1,845	1,736
AN	1,264	1,274	1,349	1,414	1,546	1,585	1,607	1,656	1,776	1,673	1,534	1,452
BN	1,289	1,263	1,280	1,313	1,394	1,472	1,502	1,539	1,583	1,474	1,334	1,258
D	1,469	1,435	1,447	1,473	1,532	1,567	1,589	1,583	1,526	1,401	1,284	1,226
C	1,197	1,166	1,175	1,193	1,228	1,267	1,270	1,247	1,194	1,094	1,002	953
All Year Types	1,309	1,290	1,340	1,394	1,472	1,513	1,530	1,573	1,638	1,554	1,432	1,355

Table 3-8. End-of-Month Storage of Lake McClure by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	442	448	503	580	636	708	800	949	1,016	974	888	812
AN	396	420	450	480	545	595	647	773	811	720	625	563
BN	422	423	431	440	474	493	509	576	586	491	403	343
D	515	517	524	535	551	562	557	556	505	389	296	243
C	331	327	327	328	340	353	369	378	340	278	233	202
All Year Types	417	422	446	476	514	551	592	670	681	605	525	468

Table 3-9. End-of-Month Storage of North-of-Delta CVP Reservoirs by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	3,197	3,306	3,637	3,964	4,139	4,611	5,300	5,621	5,454	4,915	4,454	4,101
AN	3,100	3,166	3,325	3,671	3,990	4,485	4,924	5,100	4,754	4,039	3,638	3,371
BN	3,396	3,477	3,563	3,789	4,238	4,665	5,198	5,358	5,065	4,352	3,941	3,685
D	3,564	3,515	3,568	3,769	4,030	4,458	4,584	4,447	3,998	3,323	2,907	2,817
C	2,762	2,730	2,836	2,987	3,302	3,755	3,803	3,605	3,185	2,566	2,177	2,081
All Year Types	3,171	3,212	3,379	3,636	3,927	4,385	4,775	4,859	4,539	3,899	3,481	3,257

Table 3-10. End-of-Month Storage of North-of-Delta SWP Reservoirs by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	1,899	2,070	2,352	2,655	2,894	3,140	3,165	3,182	3,181	2,930	2,567	2,533
AN	1,882	2,074	2,329	2,555	2,732	2,845	2,816	2,767	2,602	2,207	1,877	1,840
BN	1,893	2,058	2,296	2,499	2,663	2,770	2,728	2,585	2,368	2,013	1,771	1,730
D	2,259	2,438	2,650	2,808	2,863	2,896	2,851	2,676	2,362	1,931	1,656	1,621
C	1,586	1,686	1,855	2,043	2,130	2,205	2,138	1,980	1,753	1,453	1,242	1,213
All Year Types	1,880	2,040	2,274	2,499	2,653	2,781	2,754	2,664	2,500	2,166	1,876	1,841

Table 3-11. South-of-Delta CVP Total Deliveries by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	179	105	84	99	122	149	187	294	422	484	404	238	2,768
AN	168	97	74	83	103	143	173	272	394	449	378	228	2,562
B	181	106	86	101	124	140	174	270	393	447	359	229	2,609
D	183	108	88	105	128	134	162	244	351	396	333	214	2,445
C	161	91	65	69	87	101	124	179	245	271	236	173	1,802
All Year Types	174	101	79	91	112	133	165	253	362	411	344	217	2,442

Note: South-of-Delta CVP total deliveries exclude Cross Valley Canal deliveries.

Table 3-12. North-of-Delta CVP Total Deliveries by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	42	17	9	5	4	5	214	369	460	479	421	194	2,218
AN	40	17	9	5	4	10	273	373	455	471	415	195	2,266
BN	53	17	9	5	5	13	275	360	457	476	414	191	2,275
D	59	18	9	5	7	34	309	377	438	451	393	168	2,268
C	57	20	9	5	7	27	278	326	392	408	356	159	2,043
All Year Types	49	18	9	5	5	16	264	360	440	457	400	182	2,206

Table 3-13. South-of-Delta SWP Total Deliveries by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	233	201	181	113	147	183	233	304	394	430	426	317	3,163
AN	227	195	176	104	139	192	252	346	438	462	448	336	3,312
BN	227	196	179	100	126	164	232	327	413	435	420	317	3,136
D	232	200	183	118	149	173	221	304	385	403	388	295	3,050
C	190	162	150	59	73	91	140	188	237	249	239	183	1,960
All Year Types	221	190	173	98	126	160	214	290	369	393	382	288	2,906

Table 3-14. SWP Interruptible Deliveries by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0	0	9	20	54	92	26	2	0	0	0	0	203
AN	0	0	7	35	55	92	8	0	0	0	0	0	197
BN	0	0	4	17	14	55	1	0	0	0	0	1	94
D	0	7	15	54	66	40	0	0	0	0	0	0	181
C	0	0	0	1	9	20	0	0	0	0	0	0	30
All Year Types	0	1	7	23	40	62	9	0	0	0	0	0	143

Table 3-15. CVP Tracy Pumping Plant Export by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	242	217	213	201	205	210	127	76	169	270	279	266	2,475
AN	219	209	201	192	161	191	126	90	163	257	274	264	2,347
BN	236	215	240	236	221	214	122	73	158	271	267	265	2,519
D	263	229	219	189	165	158	106	110	130	208	215	246	2,237
C	213	151	186	211	152	141	56	68	82	126	138	194	1,720
All Year Types	233	202	210	205	181	184	108	82	141	227	235	246	2,256

Table 3-16. SWP Banks Pumping Plant Total Export by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	296	282	370	386	420	391	182	122	337	341	413	414	3,955
AN	285	276	268	390	351	383	149	121	251	329	380	369	3,552
BN	271	252	302	324	274	340	143	101	264	350	370	360	3,351
D	346	296	353	377	216	237	101	122	169	359	352	285	3,213
C	207	131	222	265	190	176	50	109	85	287	173	165	2,060
All Year Types	278	245	304	349	302	311	128	115	228	331	338	322	3,251

Table 3-17. SWP Banks Pumping Plant Export for SWP by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	267	268	355	370	406	365	182	122	337	257	398	376	3,702
AN	258	265	250	375	350	383	149	121	243	280	362	323	3,358
BN	247	237	275	322	253	323	143	101	261	285	338	327	3,113
D	322	250	343	368	210	237	101	122	165	277	305	260	2,960
C	190	125	220	263	186	172	50	109	79	136	156	159	1,846
All Year Types	253	228	290	339	292	300	128	115	224	242	314	293	3,021

Table 3-18. SWP Banks Pumping Plant Export for CVP Wheeling by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	26	12	11	9	7	11	0	0	0	66	8	13	164
AN	24	9	16	7	0	0	0	0	0	24	5	46	132
BN	20	14	18	0	21	9	0	0	0	36	13	27	159
D	23	46	6	4	3	0	0	0	0	27	9	25	143
C	15	5	2	2	4	4	0	0	0	24	5	5	66
All Year Types	22	16	11	5	7	5	0	0	0	38	8	22	132

Table 3-19. Delta Export/Inflow Ratio by Year Type (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.56	0.47	0.30	0.20	0.14	0.15	0.11	0.08	0.26	0.42	0.60	0.56
AN	0.51	0.47	0.32	0.27	0.18	0.26	0.16	0.15	0.33	0.43	0.59	0.65
BN	0.55	0.53	0.48	0.42	0.27	0.25	0.17	0.13	0.35	0.45	0.59	0.63
D	0.56	0.54	0.53	0.46	0.28	0.29	0.19	0.22	0.31	0.46	0.53	0.62
C	0.52	0.40	0.48	0.50	0.31	0.24	0.13	0.17	0.21	0.41	0.35	0.54
All Year Types	0.54	0.47	0.41	0.35	0.23	0.23	0.15	0.14	0.29	0.43	0.53	0.59

Note: Delta export used in this calculation is the total exports at SWP Banks Pumping Plant and CVP Tracy Pumping Plant.
Delta inflow is the total of inflows from Sacramento River, Mokelumne River, Yolo Bypass, San Joaquin River, and Marsh Creek.

Table 3-20. Delta Inflow by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	964	1,196	2,880	4,925	5,885	5,450	3,543	2,985	2,214	1,466	1,149	1,243	33,899
AN	1,063	1,386	2,694	3,418	3,540	2,558	2,176	1,527	1,240	1,372	1,099	979	23,053
BN	932	861	1,345	1,876	2,078	2,583	1,547	1,448	1,223	1,374	1,070	997	17,334
D	1,116	997	1,076	1,308	1,687	1,396	1,068	1,058	956	1,199	1,023	845	13,729
C	783	665	846	952	1,071	1,266	806	1,054	726	974	787	651	10,582
All Year Types	961	1,031	1,874	2,719	3,122	2,896	1,980	1,739	1,349	1,285	1,028	962	20,946

Note: Delta inflow is the total of inflows from Sacramento River, Mokelumne River, Yolo Bypass, San Joaquin River, and Marsh Creek.

Table 3-21. Delta Outflow by Year Type in TAF (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	349	650	2,303	4,519	5,372	4,889	3,179	2,638	1,443	566	261	446	26,615
AN	487	858	2,232	2,940	3,105	1,956	1,820	1,161	547	487	248	230	16,071
BN	344	342	779	1,340	1,611	1,992	1,186	1,133	534	455	243	263	10,221
D	420	420	453	774	1,306	954	747	658	373	332	271	214	6,923
C	280	326	382	494	734	898	577	720	289	265	289	189	5,443
All Year Types	370	533	1,339	2,247	2,690	2,383	1,654	1,389	708	431	263	283	14,290

Table 3-22. San Joaquin River Flow at Vernalis by Year Type in CFS (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	3,040	1,955	3,785	7,583	11,722	12,659	10,878	11,337	11,157	9,786	10,074	3,802	2,064	2,633
AN	3,424	2,559	4,191	5,642	6,981	5,806	4,994	7,013	6,899	3,650	2,493	2,021	1,881	1,848
BN	2,766	1,710	2,041	2,350	3,085	3,341	3,202	5,604	5,363	2,638	2,017	1,790	1,706	1,649
D	3,660	1,663	1,807	1,864	2,624	2,463	2,193	4,336	4,025	1,905	1,616	1,525	1,314	1,387
C	2,096	1,410	1,550	1,872	1,997	1,860	1,479	2,666	2,496	1,408	1,495	1,289	942	1,123
All Year Types	2,955	1,867	2,788	4,237	5,890	5,910	5,119	6,610	6,415	4,410	4,141	2,236	1,611	1,802

Table 3-23. Stanislaus River Flow Below Goodwin Dam by Year Type in CFS (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	778	391	451	594	746	1,081	1,240	1,419	1,432	1,323	1,160	593	460	383
AN	940	485	633	736	739	425	811	1,223	1,329	879	391	340	375	259
BN	783	299	320	337	332	231	609	1,192	1,301	679	358	385	418	263
D	1,029	338	349	378	521	216	461	1,126	1,245	735	678	796	643	385
C	387	245	245	203	203	147	335	642	731	368	581	592	385	249
All Year Types	762	354	404	461	524	480	738	1,130	1,209	834	681	541	448	310

Table 3-24. Tuolumne River Flow Below New Don Pedro Reservoir by Year Type in CFS (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	1,097	960	1,156	2,478	3,575	4,616	4,647	4,915	4,494	3,351	5,066	4,003	2,680	2,419
AN	1,068	1,138	1,531	1,749	1,950	2,695	2,956	4,035	4,235	2,523	2,755	2,923	2,660	1,785
BN	1,022	927	991	728	753	1,722	2,527	3,333	3,461	2,239	2,331	2,601	2,558	1,603
D	1,212	986	895	453	544	1,422	2,086	2,583	2,812	1,967	2,262	2,334	2,170	1,370
C	804	727	659	330	314	752	1,499	1,809	2,119	1,721	1,821	1,917	1,733	1,094
All Year Types	1,032	941	1,052	1,275	1,628	2,444	2,898	3,454	3,500	2,444	3,039	2,857	2,372	1,715

Table 3-25. Merced River Flow Below Exchequer Dam (Lake McClure) by Year Type in CFS (Base Condition)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	929	215	438	758	1,621	1,642	1,722	1,777	3,629	3,435	4,145	2,460	1,770	1,406
AN	1,144	267	546	675	783	719	1,474	1,869	2,874	2,106	2,124	2,171	1,695	1,108
BN	865	238	202	305	321	719	1,499	2,306	2,599	2,020	2,087	2,097	1,552	1,052
D	1,362	224	197	171	336	675	1,486	2,254	2,508	2,030	2,120	2,113	1,534	942
C	632	171	117	169	186	474	992	1,308	1,565	1,338	1,416	1,297	887	558
All Year Types	960	221	313	450	739	911	1,442	1,851	2,694	2,276	2,516	2,038	1,491	1,035

CHAPTER 4. ALTERNATIVE 1 (VAMP RECIRCULATION)

ALTERNATIVE DESCRIPTION

Alternative 1 assumes recirculation will be used to supplement the San Joaquin River flow at Vernalis during the 31-day pulse flow period (April 15 through May 15). The intent of Alternative 1 is to provide complete relief of the responsibility of Exchange Contractors and tributary reservoirs (New Melones, New Don Pedro, and Lake McClure) for meeting VAMP flow requirements.

Alternative 1 includes the same assumptions as the Base Condition, except:

1. Recirculation will provide VAMP flow of up to 110 TAF per year during the April 15 to May 15 pulse flow period per SJRA. Recirculation flows are from Delta exports of the Tracy Pumping Plant and, in some years, CVP San Luis releases (boost flows). This action will relieve New Melones Reservoir, New Don Pedro Reservoir, Lake McClure, and the Exchange Contractors from VAMP flow responsibility. It was assumed that fulfilling the SJRA has a higher priority than delivering water to CVP water contractors. Boost flows would be required in years when Tracy export restrictions prevent the pumping of the total VAMP flow.

2. A storage release from CVP San Luis Reservoir is required to initiate, or “prime”, the recirculation process.

SAN JOAQUIN RIVER AGREEMENT

VAMP flows, capped at 110 TAF per year, are guaranteed water supplies from SJRGA members used to achieve Target Flow per SJRA during the 31-day April-May pulse flow period.

During the 31-day spring pulse flow period, often between mid-April and mid-May, most juvenile anadromous fish migrate out tributaries, through the Delta, and into the Pacific Ocean to complete their life cycles. Timing of the pulse flow coincides with the peak period of time when naturally spawned smolts migrate out of the San Joaquin River Basin. SJRA provides water to enhance instream flows for fish migration and a methodology to establish flows. The 31-day out-migration target flow is mostly equivalent to the single-step Target Flow determined from the existing flow (Table 4-1) except in times of wet or dry hydrologic conditions. The difference between the target flow and existing flow is known as the VAMP flow, which is capped at 110 TAF.

Existing flow consists of forecasted flows in the San Joaquin River at Vernalis during the pulse flow period that would exist in the absence of VAMP or water acquisitions, including, but not limited to the following:

1. Tributary minimum in stream flows pursuant to Davis-Grunsky, Federal Energy Regulatory Commission, or other agency orders existing on the date of the SJRA

2. Water quality or scheduled fishery releases from New Melones Reservoir, and as provided in the contingent upon New Melones Operations

3. Flood flow releases from any non-Federal storage facility required to be made during the pulse flow period pursuant to its operating protocol with the U.S. Army Corps of Engineers in effect when SJRA is executed

4. Uncontrolled spills not otherwise recaptured pursuant to water right accretions (less natural depletions) to the system

5. Local runoff

Under wet conditions (when the sum of the 60-20-20 Indicator (Table 4-2) of the current year and the previous year is 7 or greater), an annual 31-day out-migration flow target will be the Target Flow that is one level higher than that established by the single-step Target Flow. This is known as the double-step Target Flow. If achieving the double-step Target Flow requires more water than 110 TAF, Reclamation will pursue additional water from willing sellers.

Under dry conditions (that is during years when the sum of the 60-20-20 Indicator of the current year and previous 2 years is 4 or less), SJRGA's members will not be required to provide water above existing flow.

Per SJRA, CVP and SWP shall limit their combined export rate during the pulse flow period (Table 4-3). The combined export rate is the SWP Clifton Court Forebay (minus actual Byron-Bethany Irrigation District diversions from Clifton Court Forebay) and the export rate of the CVP Tracy Pumping Plant. The parties of the SJRA agree that the export limits are consistent with existing biological opinions.

According to the SJRA, SJRGA members who guarantee to provide annual VAMP flow of up to 110 TAF (Table 4-4) include the following:

1. Merced ID from Merced River

2. OID/SSJID from Stanislaus River

3. Exchange Contractors from San Joaquin River

4. MID/TID from Tuolumne River

Per SJRA, Reclamation agrees to operate the New Melones Reservoir consistent with Reclamation's 1997 New Melones Interim Plan of Operations until the long-term plan is developed. Annual water allocations of the Interim Plan of Operations and its distribution of the fishery releases (Table 4-5) during the pulse flow period are critical to the amount of water provided by SJRGA's members.

Recirculation is intended to substitute water provided from SJRGA members with water exported from Tracy Pumping Plant and/or the boost flows from the CVP portion of San

Luis Reservoir for April 15 to May 15. SJRA export limits are applicable to this alternative.

Table 4-1. Single-Step Target Flow

Existing Flow (CFS)	Target Flow (CFS)
0 – 1,999	2,000
2,000 – 3,199	3,200
3,200 – 4,449	4,450
4,450 – 5,699	5,700
5,700 – 6,999	7,000
7,000 or greater	Existing Flow

Source: SJRA

Table 4-2. 60-20-20 Indicator for VAMP

San Joaquin Valley Water Year Type	Acronym for this Report	60-20-20 Indicator
Wet	W	5
Above Normal	AN	4
Below Normal	BN	3
Dry	D	2
Critical	C	1

Source: SJRA

Table 4-3. CVP and SWP Combined Export Limits During the Pulse Flow Period

Export Limits (CFS)	Vernalis Target Flow (CFS)				
	2,000	3,200	4,450	5,700	7,000
1,500	**X**	**X**	**X**		**X**
2,250				**X**	
3,000					**X**

Note: The export limit for 7,000 CFS Vernlalis Target Flow alternates between 1,500 and 3,000 CFS every high year.

Table 4-4. Hierarchy for the Provision of the VAMP Flow in TAF

Entity (In Order of Providing Flow)	River	Reservoir	First 50 TAF	Next 23 TAF	Next 17 TAF	Next 20 TAF	Total 110 TAF
Merced ID	Merced	Lake McClure	25	11.5	8.5	10	55
OID/SSJID	Stanislaus	New Melones and Turlock	10	4.6	3.4	4	22
Exchange Contractors	San Joaquin	-	5	2.3	1.7	2	11
MID/TID	Tuolumne	New Don Pedro	10	4.6	3.4	4	22

Source: Modified from Table 2.1-1 of Meeting Flow Objectives for the San Joaquin River Agreement, 1999-2010, Final Environmental Impact Statement/Environment Impact Report (EIS/EIR).
Note: The flow shown in the table is for EIS/EIR analysis. The San Joaquin River Technical Committee will determine best management of flow releases during the pulse flow period to achieve target flows.

Table 4-5. Annual Water Allocation of New Melones Reservoir Based on the 1996 Interim Plan of Operations in TAF

Annual Water Supply Categories	End-of-February New Melones Reservoir Storage plus March-September Forecast (TAF)	Fishery	Water Quality (Maximum Salinity Requirement at Vernalis)	D-1641 Minimum Flow Requirements at Vernalis	Water Supply
Low	0 – 1,400	0 – 98	0 – 70	0	0
Medium – Low	1,400 – 2,000	98 – 125	70 – 80	0	0
Medium	2,000 – 2,500	125 – 345	80 – 175	0	0 – 59
Medium – High	2,500 – 3,000	345 – 467	175 – 250	75	90
High	3,000 – 6,000	467	250	75	90

SUMMARY OF ALTERNATIVE 1 RESULTS

The impact of Alternative 1 on various components of each San Joaquin Valley water year type is tabulated in two ways: average changes and average percentage changes from the Base Condition. For example, the statistics for wet years are calculated as follows:

$$\text{Average Change} = \frac{\sum_{i=1}^{N}\left(Alternative1_i - Base_i\right)}{\text{Total Number of Wet Years}}$$

$$\text{Average Percentage Change} = \frac{\sum_{i=1}^{N}\left[\left(Alternative1_i - Base_i\right)\Big/ Base_i\right]}{\text{Total Number of Wet Years}}$$

Note that for some components, the average change and average percentage change for the same year type and time have different signs because of the way average percentage change is defined.

It is important to distinguish the actual impacts to the system caused by an alternative from changes that are beyond the resolution of the model to calculate. Therefore, a 1-percent or 5.0 TAF threshold has been designated for this study. Changes between an alternative and the base condition that are less than 1-percent or 5.0 TAF are **not** considered impacts due to Recirculation.

VAMP Flow

Annual VAMP flow from recirculation is from zero to 110 TAF; the annual average is 44 TAF (Figure 4-1). The CALSIM2 result for VAMP flow during the pulse flow period is divided into two periods: April VAMP flows for the April 15 to 30 period, and May VAMP flows for the May 1 and 15 period. Recirculation moves water from DMC and CVP San Luis through Newman Wasteway to San Joaquin River for VAMP flow.

The average April VAMP flows (Table 4-6) in below normal and dry years have the largest magnitudes: 37 TAF (1,170 CFS) and 35 TAF (1,094 CFS), respectively. Average April VAMP flows are 21 and 25 percentage of the average San Joaquin River flow at Vernalis after VAMP flow augmentation. VAMP flow is required every year for both year types (Table 4-7).

Average May VAMP flows (Table 4-8) are high in above normal, below normal, and dry years: 42 TAF (1,418 CFS), 43 TAF (1,453 CFS), and 34 TAF (1,145 CFS). Average May VAMP flows are 21, 27 and 28.5 percentage of the average San Joaquin River flow at Vernalis after VAMP flow augmentation. Among those years with May VAMP flows, some have experienced VAMP flow shortages because total VAMP flow is capped at 110 TAF. May VAMP flows are required for every below normal and dry year (Table 4-9).

Impacts on Storage

For Alternative 1, there is no obvious change in the Base Condition for average CVP end-of-September total storage (CVP San Luis and NOD CVP reservoirs) and average SWP end-of-August total storage (SWP San Luis and NOD SWP reservoirs). The former decreased by 8 TAF while the latter increased by 1 TAF. However, the average eastside tributary end-of-September total storage (New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure) increased by 100 TAF (Figure 4-3).

Recirculation has reduced long-term average April and May end-of-month storage for CVP San Luis by 4.1 TAF (Table 4-10). Since VAMP flow has a higher priority, less Tracy Pumping Plant capacity is available for diversion to CVP San Luis for storage. This reduction in end-of-month storage has a ripple effect and attenuated through time. The long-term end-of-month CVP San Luis storage percentage changes in summer (June –3.0 percent, and July –4.4 percent, August –3.5 percent) are more obvious. This difference is because summer storage is generally low for the Base Condition, and CVP San Luis releases for high summer water demand draw storage down.

Long-term average March through June end-of-month SWP San Luis storage is reduced by recirculation, ranging from –1.4 to –3.6 TAF (Table 4-11); the average percentage change is small, varying from -0.1 percent to –0.6 percent. For the rest of the period, there is an increase in the average end-of-month storage ranging from 0.5 to 5.1 TAF.

The average end-of-month storage for New Melones Reservoir (Table 4-12) has been increased (varying from 22 to 29 TAF) every month for each year type. This increase is because recirculation provides VAMP flows released from New Melones Reservoir for the Base Condition. Both New Don Pedro Reservoir (Table 4-13) and Lake McClure (Table 4-14) show this impact; their average end-of-month storage increase range from 10 to 16 TAF, and 40 to 63 TAF, respectively. However, Lake McClure has the biggest end-of-month storage increase, as it was responsible for half of the total VAMP flow for the Base condition.

The long-term average end-of-month storage for NOD CVP reservoirs (Table 4-15) decreased, ranging from –2 to –7 TAF; however, the percentage change is relatively small (less than 0.5%).

The long-term average of NOD SWP reservoirs, end-of-month storage (Table 4-16) increased (between 0.6 to 4.5 TAF) except during July to September (between –0.2 to –2.8 TAF). The percentage change is relatively small (less than 0.5 percent).

Impacts on Deliveries and Exports

The long-term average of SOD CVP total annual deliveries (Table 4-17) decreased by 43.5 TAF, which is equivalent to the amount of recirculation flow. The largest reductions were 14 TAF in April and 20 TAF in May; the changes are about 8 percent of the Base Condition. This decrease is a consequence of utilizing a portion of Tracy Pumping Plant capacity for recirculation as VAMP flow has a higher priority than deliveries.

The long-term average of NOD CVP total deliveries (Table 4-18) was subject to a small reduction from April to July (1.8 TAF in total or –0.1 percent). The long-term average of SOD SWP total annual deliveries (Table 4-19) increased by 5.1 TAF (0.3 percent). For SWP interruptible deliveries (Table 4-20), the long-term annual average increased by 1.6 TAF (1.8 percent). The changes for NOD CVP total deliveries, SOD SWP total deliveries, and SWP interruptible deliveries are all below 1% or the 5.0 TAF threshold and are therefore not considered impacted by recirculation.

Recirculation increased average annual total Delta exports: 7.1 TAF at Tracy Pumping Plant (Table 4-21) and 5.2 TAF at Banks Pumping Plant (Table 4-22). However, corresponding increases in percentage was only 0.3 percent and 0.1 percent respectively.

Regarding the Banks Pumping Plant, the long-term average annual export for SWP (Table 4-23) increased by 7.7 TAF (0.2%) but CVP wheeling (Table 4-24) decreased by 2.5 TAF. The increase in Banks pumping and decrease in CVP wheeling are below the 1% and 5.0 TAF threshold respectively.

There is no significant impact on the Delta export/inflow ratio (Table 4-25) as both Delta inflow and outflow increased.

Impacts on Delta Inflow and Outflow

The long-term annual average Delta inflow and outflow (Tables 4-26 and 4-27) have been increased by 40 TAF (0.2 percent) and 27.7 TAF (0.2 percent), respectively; the greatest average increases occur in wet years.

Impacts on Flows at Recirculation Control Points

The long-term monthly average flow of the San Joaquin River at Vernalis (Table 4-28) increased, especially in October. This increase is because recirculation increased the storage of the eastside-tributary reservoirs, particularly Lake McClure, thereby, providing higher October releases for flood control and/or tributary instream flows.

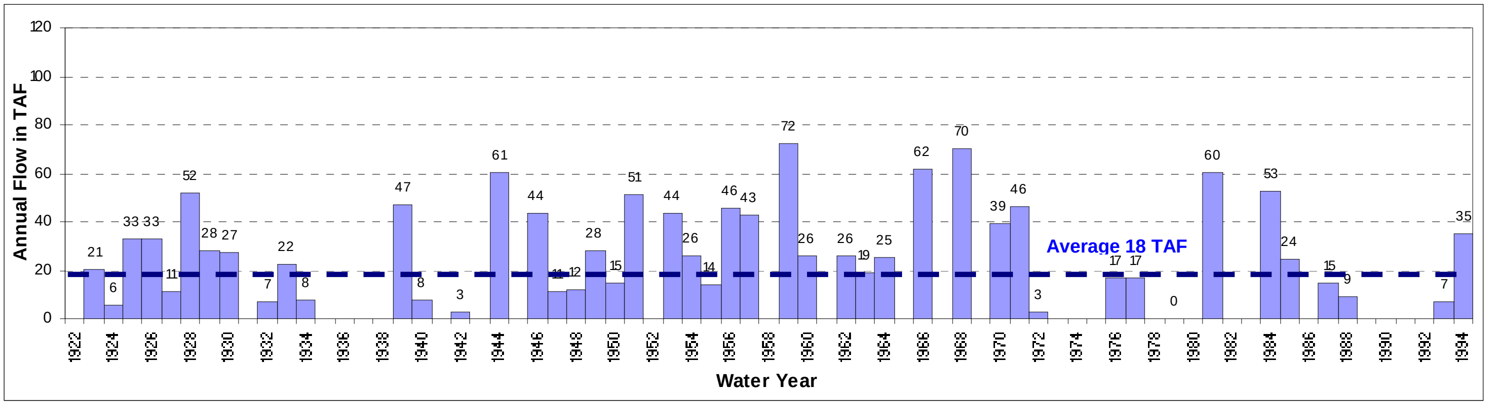
Flow only exists in the Newman Wasteway during the pulse flow period whenever VAMP flow is provided by recirculation (Table 4-29). The magnitude of Newman Wasteway flow is same as the VAMP flow through recirculation. Maximum April VAMP flows and May VAMP flows through Newman Wasteway throughout the 73 hydrologic simulation years are 2,274 CFS and 2,228 CFS, respectively.

Impacts on Eastside Tributary Reservoir Releases

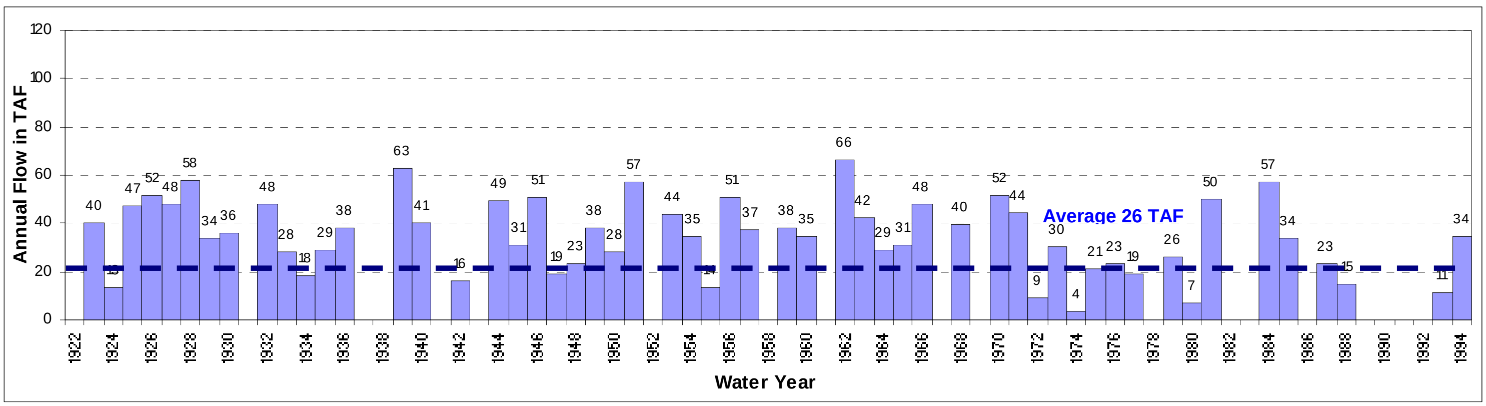
During the April and May pulse flow period, the long-term average of river flow below Goodwin Dam (Table 4-30), New Don Pedro Reservoir (Table 4-31), and Lake McClure (Table 4-32) declined at different degrees. Reductions in April 15-31 and May 1-15 are 7 and 80 CFS (0.7 percent and 8.3 percent), 46 and 175 CFS (1.4 percent and 5.1 percent), and 399 and 402 CFS (18.8 percent and 15.6 percent), respectively. However, for the rest of the time period, long-term averages of these reservoir releases increased. Lake McClure release increments are the largest among them.

Figure 4-1. Recirculation Flow of Alternative 1 in TAF

(a) April 15-31



(b) May 1-15



(c) Annual Total

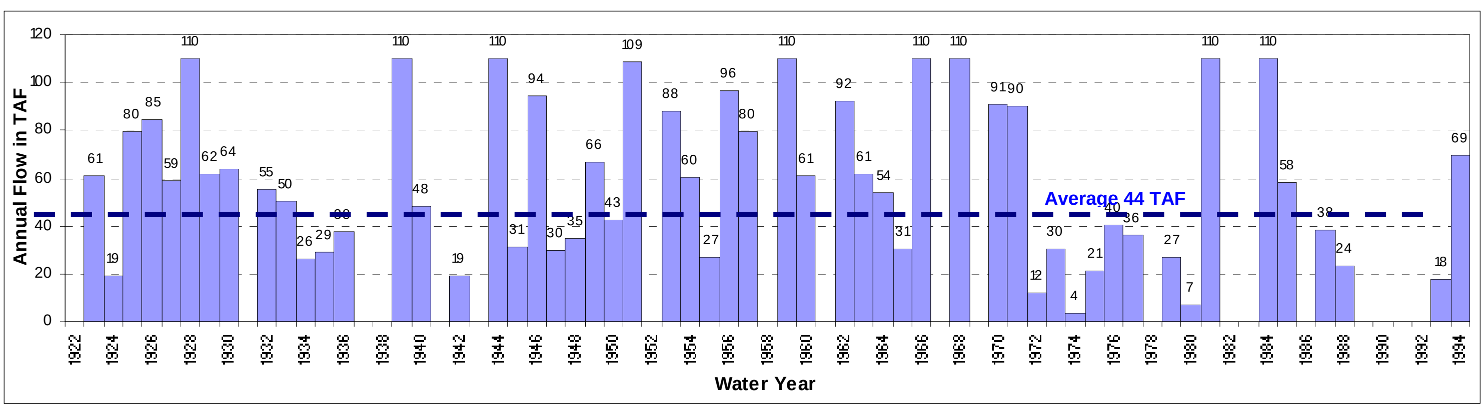
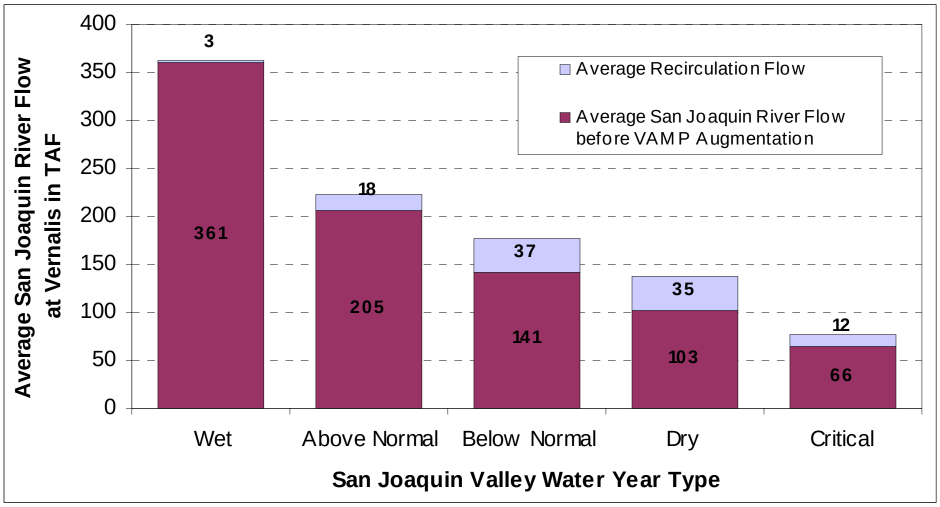


Figure 4-2. Composition of Average Flow at Vernalis in TAF

(a) April 15-31



(b) May 1-15

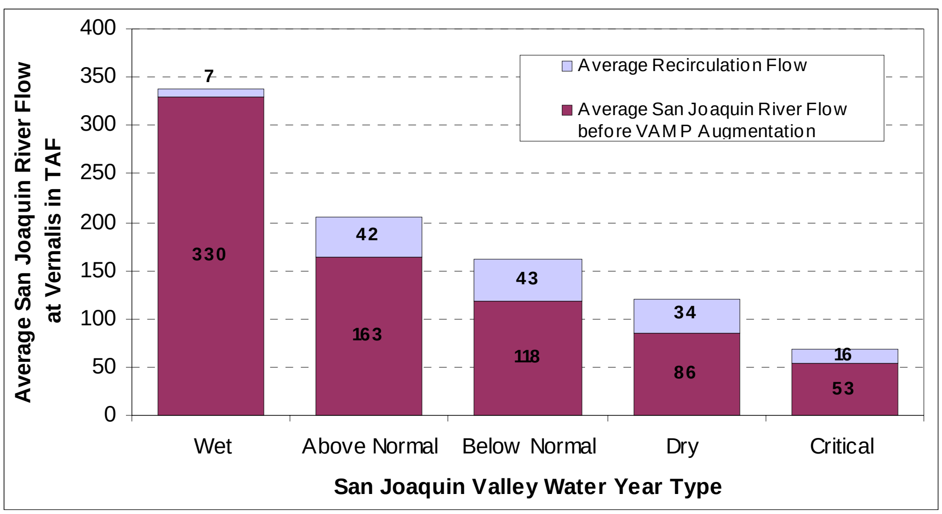
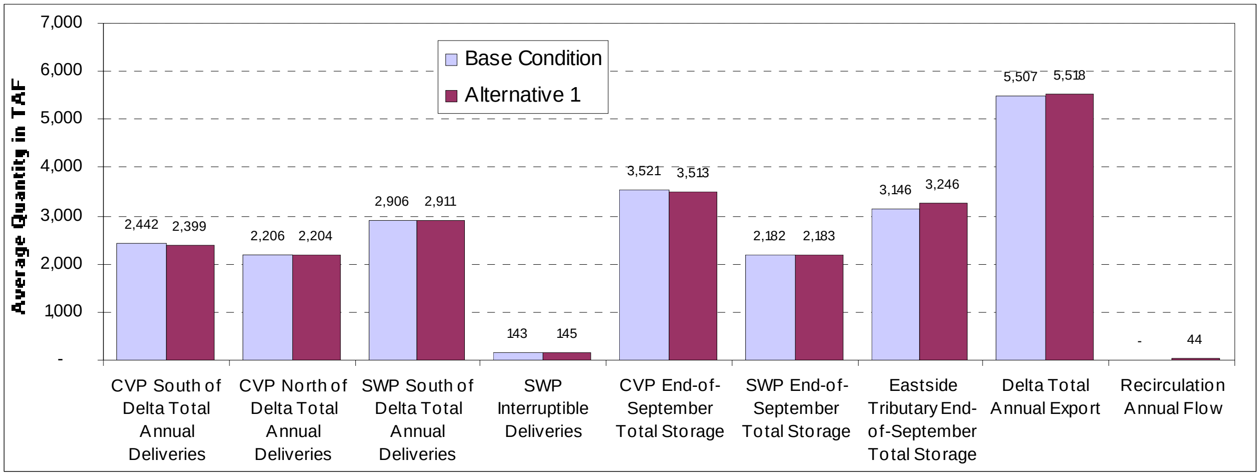
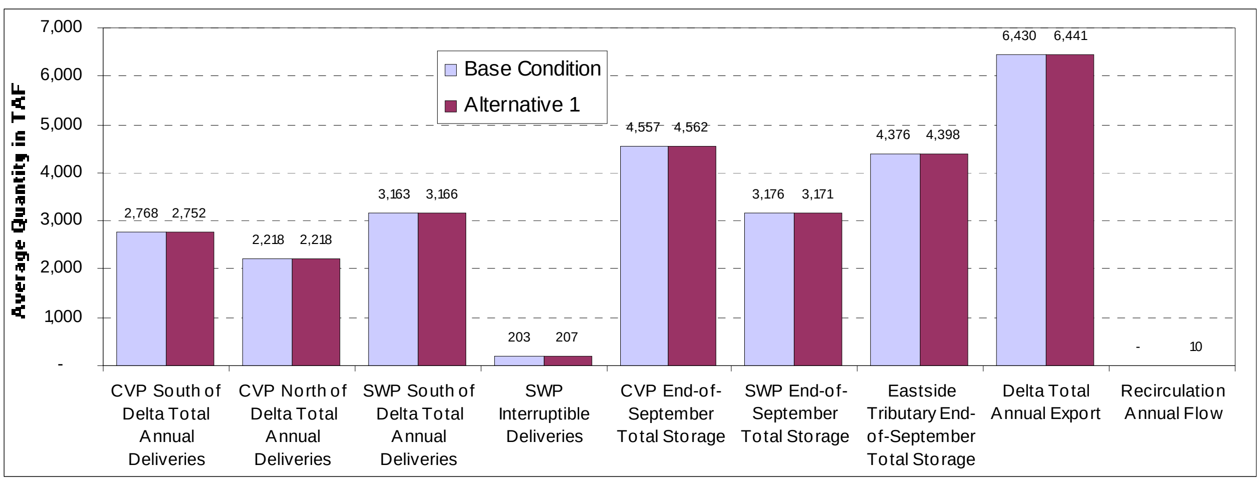


Figure 4-3. Comparison of Selective Water Supply Components between Base Condition and Alternative 1

(a) Average of All Year Types



(b) Average of Wet Years



(c) Average of Above Normal Years

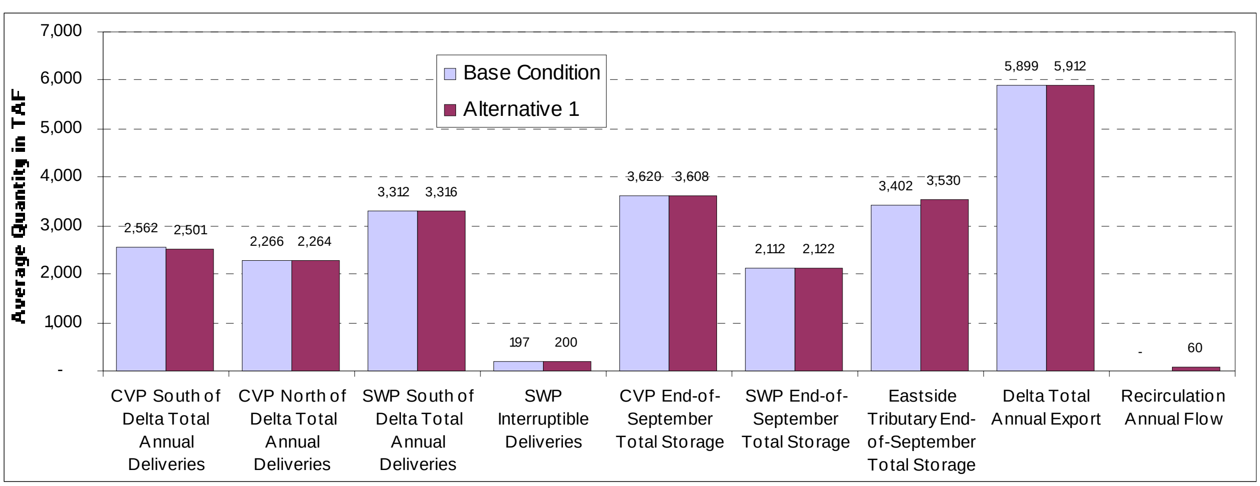
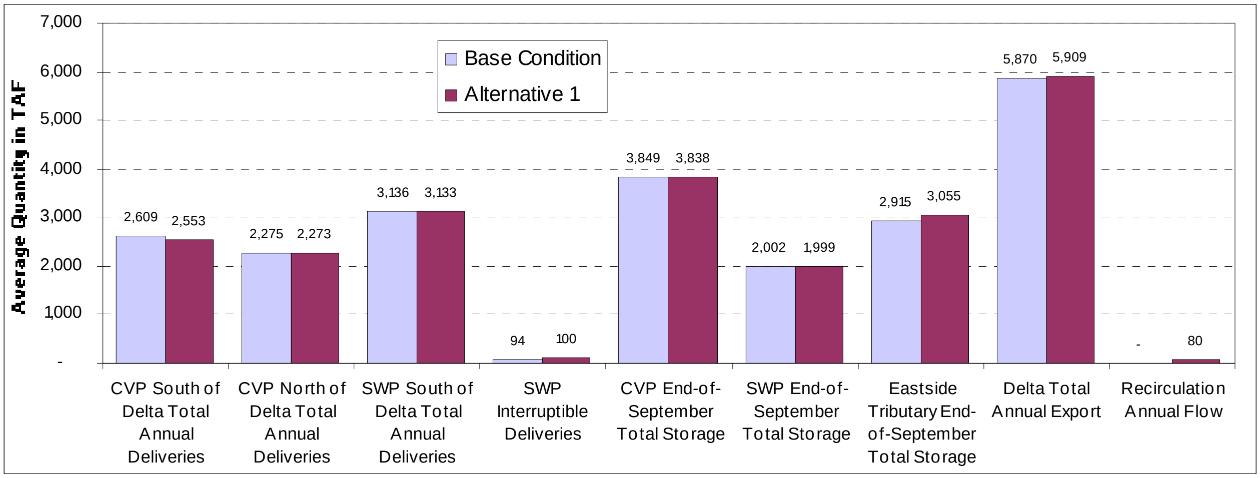
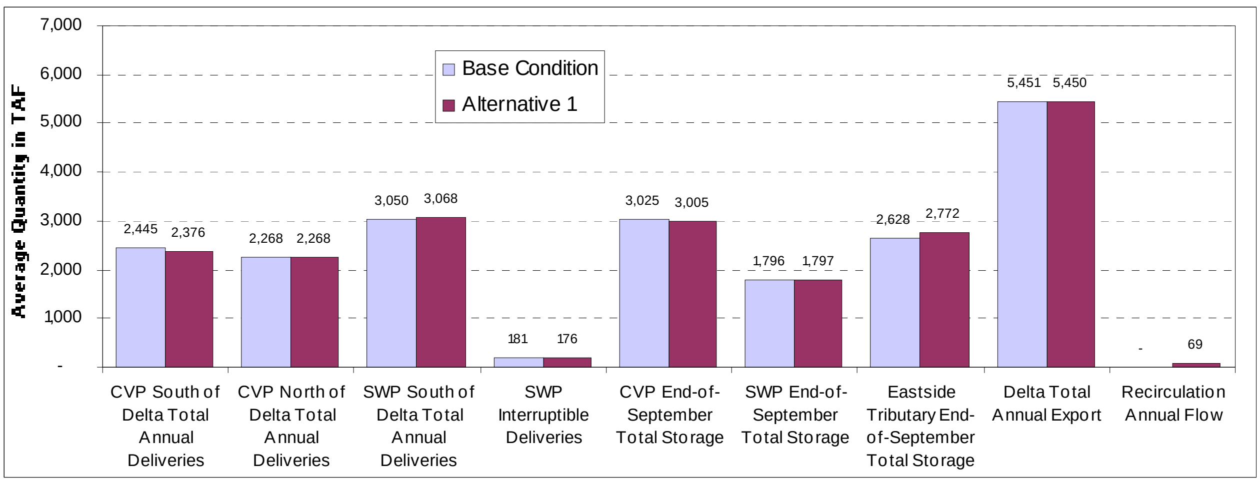


Figure 4-3. (Continued)

(d) Average of Below Normal Years



(e) Average of Dry Years



(f) Average of Critical Years

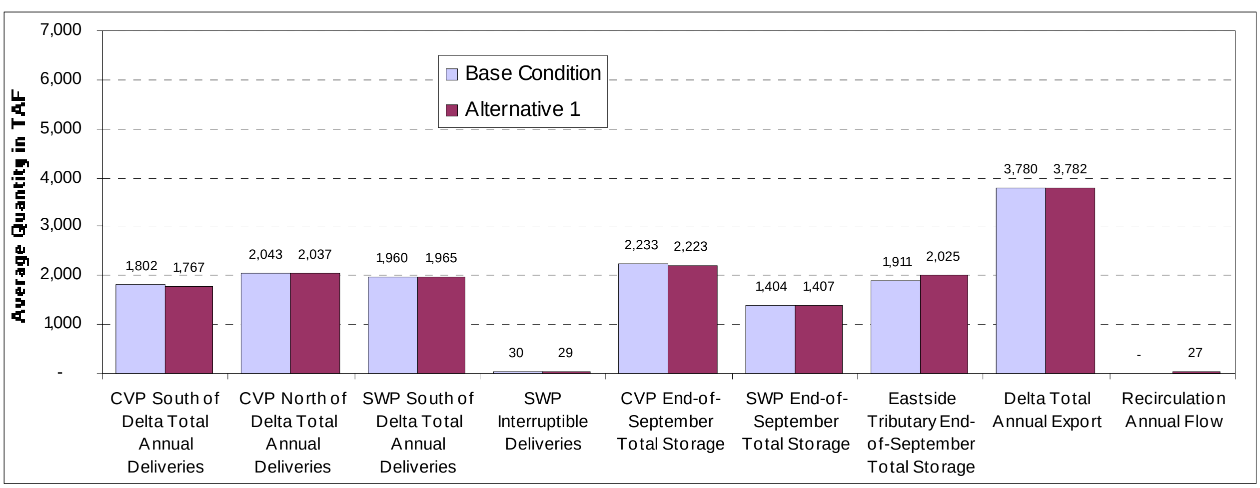


Table 4-6. Average of San Joaquin River Flow at Vernalis during April 15 through 30 (Alternative 1)

(a) In CFS

San Joaquin Valley Water Year Type	Before VAMP Flow Augmentation	VAMP Flow Deficiency	Flow Augmentation through Recirculation	After VAMP Flow Augmentation	VAMP Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	11,361	-88	88	11,448	0
AN	6,471	-569	569	7,037	0
BN	4,434	-1,170	1,170	5,598	0
D	3,243	-1,094	1,094	4,331	0
C	2,066	-370	370	2,436	0

(b) In TAF

San Joaquin Valley Water Year Type	Before VAMP Flow Augmentation	VAMP Flow Deficiency	Flow Augmentation through Recirculation	After VAMP Flow Augmentation	VAMP Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	361	-3	3	363	0
AN	205	-18	18	223	0
BN	141	-37	37	178	0
D	103	-35	35	137	0
C	66	-12	12	77	0

Table 4-7. Summary of Components Used in Recirculation during April 15 through 30 (Alternative 1)

	Average Flow (TAF)				Total Number of Years			
San Joaquin Valley Water Year Type	Diversion from DMC	Boost Flow from San Luis Reservoir (CVP Portion)	Total Flow Augmentation through Recirculation	VAMP Flow Shortage	San Joaquin Valley Water Year Type	With Diversion from DMC	With Boost Flow from San Luis Reservoir (CVP Portion)	With VAMP Flow Shortage
W	1	2	3	0	20	3	1	0
AN	11	7	18	0	14	10	6	0
BN	23	14	37	0	12	12	8	0
D	19	16	35	0	11	11	7	0
C	9	3	12	0	16	10	4	0

Table 4-8. Average of San Joaquin River Flow at Vernalis during May 1 - 15 (Alternative 1)

(a) In CFS

San Joaquin Valley Water Year Type	Before VAMP Flow Augmentation	VAMP Flow Deficiency	Flow Augmentation Through Recirculation	After VAMP Flow Augmentation	VAMP Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	11,096	-236	236	11,332	0
AN	5,481	-1,426	1,418	6,890	-8
BN	3,954	-1,650	1,453	5,395	-197
D	2,880	-1,456	1,145	4,016	-311
C	1,784	-527	527	2,306	0

(b) In TAF

San Joaquin Valley Water Year Type	Before VAMP Flow Augmentation	VAMP Flow Deficiency	Flow Augmentation through Recirculation	After VAMP Flow Augmentation	VAMP Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	330	-7	7	337	0
AN	163	-42	42	205	-0*
BN	118	-49	43	161	-6*
D	86	-43	34	119	-9*
C	53	-16	16	69	0

Table 4-9. Summary of Components Used in Recirculation from May 1 - 15 (Alternative 1)

	Average Flow (TAF)				Total Number of Years			
San Joaquin Valley Water Year Type	Diversion from DMC	Boost Flow from San Luis Reservoir (CVP Portion)	Total Flow Augmentation Through Recirculation	VAMP Flow Shortage	San Joaquin Valley Water Year Type	With Diversion from DMC	With Boost Flow from San Luis Reservoir (CVP Portion)	With VAMP Flow Shortage
W	5	2	7	0	20	7	3	0
AN	20	22	42	-0	14	14	12	1
BN	17	26	43	-6	12	12	12	3
D	16	18	34	-9	11	11	11	4
C	10	6	16	0	16	10	6	0

Table 4-10. Average Changes in End-of-Month Storage for San Luis Reservoir (CVP Portion) from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-5.2	-2.5	-3.7	-1.9	-3.5	-3.4	-7.2	-4.9	-5.4	-6.1	-3.6	6.2
AN	-12.2	-14.3	-26.1	-16.9	-11.1	-1.2	-11.7	-18.0	-18.3	-14.6	-10.9	-9.9
BN	8.7	7.3	7.5	6.2	-3.7	-5.9	-22.3	-25.6	-23.9	-21.3	-6.4	-6.5
D	-5.5	0.3	0.9	10.5	13.8	11.8	-9.8	-31.7	-30.0	-25.0	-19.2	-21.8
C	-1.7	3.1	0.0	3.8	3.3	2.5	-2.7	-4.8	2.5	4.1	1.3	1.9
All Year Types	-3.5	-1.5	-4.7	-0.3	-0.9	0.2	-9.9	-14.9	-12.9	-10.8	-6.8	-4.1

(b) In Percentage Change

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-2.5%	-0.5%	-0.5%	-0.2%	-0.3%	-0.2%	-0.6%	-0.5%	-1.0%	-1.9%	-2.1%	2.6%
AN	-4.5%	-3.7%	-4.2%	-2.3%	-1.2%	-0.1%	-1.3%	-2.4%	-3.5%	-4.0%	-4.0%	-2.3%
BN	2.2%	2.0%	1.1%	0.8%	-0.3%	-0.6%	-2.7%	-4.1%	-6.3%	-10.0%	-5.4%	-4.4%
D	0.6%	0.5%	0.5%	1.8%	1.9%	1.5%	-0.8%	-4.1%	-6.5%	-11.4%	-8.8%	-8.3%
C	0.0%	2.5%	0.4%	0.7%	0.5%	0.0%	-1.5%	-3.4%	-0.2%	0.9%	0.3%	1.3%
All Year Types	-1.1%	0.1%	-0.6%	0.1%	0.0%	0.0%	-1.3%	-2.6%	-3.0%	-4.4%	-3.5%	-1.4%

Table 4-11. Average Changes in End-of-Month Storage for San Luis Reservoir (SWP Portion) for Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	6.2	2.8	11.5	1.9	0.1	-0.2	-7.6	-7.7	-0.7	13.6	12.7	6.2
AN	7.0	4.8	-3.0	8.6	5.7	5.4	-0.1	-0.5	-9.4	-12.3	-10.8	-0.2
BN	18.0	20.5	22.0	1.9	8.5	0.4	5.5	11.0	7.7	4.5	3.8	3.7
D	-6.9	-13.2	-12.1	-7.6	-7.1	-11.7	-13.6	-15.7	-11.9	-5.6	7.1	-5.1
C	0.7	-2.0	-2.9	-3.6	0.1	-3.1	-6.4	-6.8	-5.1	-2.3	-2.1	-2.2
All Year Types	5.1	2.6	3.7	0.5	1.5	-1.4	-4.6	-4.3	-3.6	0.8	2.6	1.0

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	1.8%	0.7%	2.8%	0.2%	0.0%	0.0%	-0.8%	-1.1%	0.2%	3.3%	3.2%	1.3%
AN	2.6%	0.8%	-0.8%	0.8%	0.8%	0.6%	0.1%	0.2%	0.0%	-4.0%	-3.4%	0.2%
BN	3.3%	3.4%	3.7%	0.2%	1.1%	0.0%	0.7%	2.2%	3.3%	3.3%	3.7%	3.0%
D	-0.6%	-1.2%	-0.9%	-0.6%	-0.7%	-1.3%	-1.7%	-2.4%	-3.1%	-0.7%	3.5%	-1.9%
C	0.0%	-1.0%	-1.2%	-1.1%	-0.5%	-0.7%	-1.2%	-1.5%	-0.9%	-0.5%	-0.5%	-0.4%
All Year Types	1.4%	0.5%	0.8%	-0.1%	0.1%	-0.2%	-0.6%	-0.6%	-0.1%	0.4%	1.3%	0.5%

Table 4-12. Average Changes in End-of-Month Storage for New Melones Reservoir from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	27.5	26.2	25.9	25.7	23.6	17.4	17.3	16.4	15.5	16.3	16.0	15.4
AN	25.2	23.3	26.4	24.7	24.0	23.0	26.0	34.8	34.6	34.2	33.8	33.3
BN	26.8	26.6	26.4	26.1	24.6	25.5	30.2	40.4	39.5	39.0	38.5	38.1
D	29.0	28.1	27.1	25.6	25.5	25.1	28.9	38.2	40.7	40.3	37.5	35.3
C	21.9	21.6	20.7	18.9	20.6	21.6	22.4	26.9	24.6	26.5	25.3	24.6
All Year Types	25.9	25.0	25.1	24.1	23.5	21.9	23.9	29.4	28.9	29.3	28.4	27.6

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	2.5%	2.4%	2.2%	1.9%	1.5%	1.1%	1.1%	0.9%	0.8%	0.8%	0.9%	0.9%
AN	3.2%	2.9%	3.1%	2.9%	2.5%	2.2%	2.4%	2.6%	2.4%	2.5%	2.6%	2.8%
BN	2.2%	2.1%	2.1%	2.0%	1.8%	1.8%	2.1%	2.8%	2.6%	2.7%	2.9%	3.1%
D	2.2%	2.2%	2.1%	1.9%	1.9%	1.8%	2.1%	2.8%	3.0%	3.2%	3.3%	3.3%
C	2.5%	2.4%	2.3%	2.0%	2.1%	2.2%	2.3%	2.9%	2.7%	3.4%	3.7%	4.0%
All Year Types	2.6%	2.4%	2.4%	2.1%	1.9%	1.8%	1.9%	2.3%	2.1%	2.4%	2.5%	2.7%

Table 4-13. Average Changes in End-of-Month Storage for New Don Pedro Reservoir from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	11.1	11.1	8.0	5.0	1.8	0.0	0.3	0.7	0.0	0.0	0.0	0.0
AN	22.4	22.4	19.8	19.8	16.7	15.8	14.4	21.8	21.7	21.6	21.5	21.5
BN	13.8	13.7	13.7	13.7	12.3	9.6	12.6	23.7	23.7	23.6	23.4	23.4
D	18.4	18.4	18.4	18.4	17.7	15.7	19.4	27.5	27.4	27.3	27.1	27.1
C	13.3	13.3	13.3	13.3	13.3	13.3	13.3	15.9	15.8	15.7	15.7	15.6
All Year Types	15.3	15.3	13.9	13.1	11.3	9.9	10.7	15.9	15.7	15.6	15.5	15.5

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.9%	0.9%	0.6%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	2.5%	2.4%	2.1%	1.9%	1.3%	1.2%	1.0%	1.4%	1.3%	1.4%	1.5%	1.6%
BN	1.3%	1.4%	1.3%	1.3%	1.1%	0.8%	0.9%	1.6%	1.6%	1.7%	1.9%	2.0%
D	1.4%	1.4%	1.4%	1.4%	1.3%	1.1%	1.3%	1.8%	1.9%	2.0%	2.2%	2.3%
C	1.2%	1.3%	1.2%	1.2%	1.1%	1.1%	1.1%	1.3%	1.4%	1.6%	1.7%	1.8%
All Year Types	1.4%	1.4%	1.3%	1.1%	0.9%	0.8%	0.8%	1.1%	1.1%	1.2%	1.3%	1.4%

Table 4-14. Average Changes in End-of-Month Storage for Lake McClure from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	41.5	41.3	36.5	28.6	13.8	11.8	11.5	13.7	6.6	6.5	6.5	6.5
AN	56.6	56.6	56.1	52.3	39.6	39.6	52.0	74.6	74.3	73.9	73.5	73.2
BN	38.6	38.4	38.4	38.5	38.5	38.4	63.9	80.9	80.5	80.1	79.7	78.6
D	52.7	52.7	50.4	48.7	48.4	48.4	72.6	86.6	86.1	85.6	85.1	81.7
C	69.1	69.1	69.2	69.2	69.3	69.2	79.0	85.5	85.0	81.9	78.3	73.7
All Year Types	51.7	51.6	49.8	46.7	40.2	39.6	51.9	63.1	60.9	60.0	59.0	57.2

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	18.9%	17.9%	10.4%	6.3%	2.6%	2.0%	1.6%	1.6%	0.7%	0.8%	0.8%	0.9%
AN	30.6%	27.2%	23.4%	18.9%	12.1%	10.7%	11.5%	11.5%	10.3%	11.6%	13.2%	14.6%
BN	16.5%	16.5%	16.2%	15.2%	11.4%	10.9%	15.1%	15.8%	15.5%	18.9%	23.8%	29.0%
D	13.1%	13.0%	12.4%	11.8%	11.1%	11.0%	16.0%	17.9%	19.0%	25.3%	35.5%	42.1%
C	34.7%	35.7%	35.8%	35.8%	34.7%	34.6%	35.0%	35.3%	38.5%	42.2%	43.8%	45.0%
All Year Types	23.3%	22.6%	19.7%	17.5%	14.2%	13.6%	15.2%	15.7%	16.0%	18.6%	21.6%	24.0%

Table 4-15. Average Changes in End-of-Month Storage for NOD CVP Reservoirs from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-2.3	-9.3	-1.2	-2.4	-1.0	-0.5	-0.1	0.1	-0.1	1.4	-1.5	-1.5
AN	-7.9	-5.6	-5.7	-4.3	-3.4	-4.7	-5.6	-5.3	-4.8	-3.7	-0.2	-2.5
BN	12.6	12.3	12.3	11.0	14.8	9.2	8.0	2.3	-4.5	2.1	-1.6	-4.5
D	-0.4	0.2	0.8	-0.3	-1.2	-2.9	-4.0	-4.6	-4.3	-8.7	6.5	1.3
C	-13.6	-15.3	-15.5	-14.2	-14.3	-12.2	-11.3	-10.9	-20.3	-20.4	-13.2	-12.3
All Year Types	-3.1	-4.9	-2.7	-2.8	-1.8	-2.6	-2.9	-3.7	-6.8	-5.8	-2.6	-4.1

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-0.1%	-0.3%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
AN	-0.3%	-0.2%	-0.1%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.1%
BN	0.4%	0.4%	0.4%	0.3%	0.4%	0.2%	0.2%	0.0%	-0.1%	0.0%	-0.1%	-0.2%
D	0.0%	-0.1%	-0.2%	-0.3%	-0.3%	-0.2%	-0.2%	-0.2%	-0.2%	-0.4%	0.2%	0.0%
C	-0.6%	-0.6%	-0.6%	-0.5%	-0.4%	-0.3%	-0.3%	-0.3%	-0.7%	-1.1%	-0.8%	-0.6%
All Year Types	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%	-0.3%	-0.2%	-0.2%

Table 4-16. Average Changes in End-of-Month Storage for NOD SWP Reservoirs from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-2.2	1.0	1.8	1.6	4.4	3.4	1.9	2.0	1.5	-13.9	-12.0	-11.5
AN	1.4	4.4	4.6	4.7	4.8	4.4	4.4	4.5	4.4	5.6	3.1	9.7
BN	-8.1	-12.0	-12.6	-3.8	-3.1	-4.6	-4.6	-4.9	-8.7	-7.0	-13.2	-7.0
D	11.9	13.8	13.8	13.7	13.6	13.8	14.1	15.7	12.1	10.2	5.9	6.4
C	2.3	5.4	5.1	5.1	4.1	4.0	4.0	4.5	4.9	4.4	5.4	5.6
All Year Types	0.6	2.4	2.5	3.9	4.5	4.0	3.6	4.0	2.7	-1.4	-2.8	-0.2

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.1%	0.4%	0.4%	0.2%	0.2%	0.1%	0.1%	0.1%	0.0%	-0.4%	-0.4%	-0.4%
AN	0.5%	0.7%	0.7%	0.5%	0.4%	0.3%	0.2%	0.2%	0.2%	0.3%	0.2%	0.6%
BN	-0.2%	-0.5%	-0.5%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%	-0.3%	-0.7%	-0.3%
D	0.7%	0.8%	0.8%	0.8%	0.7%	0.6%	0.6%	0.7%	0.6%	0.6%	0.4%	0.5%
C	0.2%	0.4%	0.3%	0.3%	0.2%	0.2%	0.2%	0.3%	0.4%	0.5%	0.7%	0.8%
All Year Types	0.2%	0.4%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.0%	0.2%

Table 4-17. Average Changes in South-of-Delta CVP Total Deliveries from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.1	0.1	0.1	0.1	0.1	-0.2	-3.0	-10.5	-0.4	-0.4	-1.7	-0.1	-16.0
AN	0.4	0.3	0.4	0.6	0.7	-1.0	-17.2	-39.4	-1.4	-1.7	-2.4	-0.4	-61.3
BN	-0.5	-0.4	-0.6	-0.9	-1.0	0.2	-24.5	-23.1	0.7	-3.0	-3.6	0.3	-56.5
D	-0.9	-0.7	-1.0	-1.6	-1.9	0.4	-21.5	-16.7	-3.6	-5.3	-14.8	-1.0	-68.7
C	-0.4	-0.3	-0.4	-0.6	-0.7	-0.6	-10.1	-13.0	-3.4	-2.3	-2.8	-0.6	-35.2
All Year Types	-0.2	-0.2	-0.2	-0.4	-0.5	-0.3	-13.6	-19.6	-1.5	-2.2	-4.4	-0.4	-43.5

Note: South of Delta CVP Total Deliveries excludes the Cross Valley Canal deliveries.

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0%	0.1%	0.1%	0.1%	0.1%	-0.2%	-1.6%	-3.4%	-0.1%	-0.1%	-0.4%	-0.1%	-0.6%
AN	0.2%	0.3%	0.4%	0.6%	0.5%	-0.7%	-9.7%	-14.4%	-0.3%	-0.4%	-0.6%	-0.2%	-2.4%
BN	-0.3%	-0.4%	-0.7%	-0.9%	-0.8%	0.2%	-14.1%	-8.8%	0.1%	-0.8%	-1.0%	0.1%	-2.3%
D	-0.5%	-0.7%	-1.2%	-1.7%	-1.6%	0.3%	-13.1%	-7.4%	-0.7%	-1.0%	-3.7%	-0.4%	-2.7%
C	-0.3%	-0.4%	-0.7%	-1.3%	-1.1%	-0.6%	-8.2%	-7.9%	-1.6%	-0.9%	-1.1%	-0.4%	-2.0%
All Year Types	-0.1%	-0.2%	-0.3%	-0.5%	-0.5%	-0.2%	-8.4%	-8.0%	-0.5%	-0.6%	-1.2%	-0.2%	-1.8%

Table 4-18. Average Changes in North-of-Delta CVP Total Deliveries from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-0.3	-0.4	-0.4	-0.3	-0.1	-1.7
BN	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.4	-0.5	-0.2	-0.1	-1.6
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.4
C	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.3	-0.4	-0.2	-4.3	-0.1	-5.7
All Year Types	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-1.0	0.0	-1.8

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.1%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	-0.1%	-0.1%	0.0%	0.0%	-0.1%
D	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-1.4%	-0.1%	-0.3%
All Year Types	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	-0.3%	0.0%	-0.1%

Table 4-19. Average Changes in South-of-Delta SWP Total Deliveries from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.2	0.2	0.2	0.2	0.0	0.2	0.2	0.3	0.4	0.5	0.6	0.3	3.4
AN	0.4	0.4	0.3	0.1	0.2	0.4	0.4	0.4	0.5	0.5	0.5	0.4	4.4
BN	0.4	0.3	0.3	0.0	0.0	-0.1	-0.2	-0.6	-0.8	-0.8	-0.8	-0.6	-2.8
D	0.2	0.2	0.2	0.1	1.2	1.4	1.9	2.1	2.7	2.8	2.8	2.1	17.5
C	0.6	0.6	0.6	0.0	0.1	0.2	0.3	0.5	0.6	0.6	0.6	0.6	5.2
All Year Types	0.3	0.3	0.3	0.1	0.2	0.4	0.5	0.5	0.6	0.7	0.7	0.5	5.1

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0%	0.1%	0.1%	0.3%	0.0%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
AN	0.3%	0.3%	0.3%	0.1%	0.2%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
BN	0.2%	0.2%	0.3%	0.0%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
D	0.2%	0.2%	0.2%	0.2%	1.4%	1.3%	1.2%	0.9%	0.9%	0.9%	1.0%	1.0%	0.8%
C	0.4%	0.5%	0.5%	0.0%	0.1%	0.3%	0.2%	0.3%	0.3%	0.3%	0.3%	0.4%	0.3%
All Year Types	0.2%	0.3%	0.3%	0.1%	0.3%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%

Table 4-20. Average Changes in SWP Interruptible Deliveries from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0	0.0	0.0	-0.4	4.1	-0.1	0.3	-0.1	0.0	0.0	0.0	0.0	3.8
AN	0.0	0.0	0.0	2.3	-1.8	1.0	0.9	0.0	0.0	0.0	0.0	0.0	2.5
BN	0.0	0.0	0.0	4.2	1.8	0.0	0.1	0.0	0.0	0.0	0.0	0.0	6.1
D	0.0	0.0	-0.1	-4.3	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.7
C	0.0	0.0	0.0	1.9	-3.3	0.5	0.0	0.0	0.0	0.0	0.0	-0.1	-1.0
All Year Types	0.0	0.0	0.0	0.8	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	1.6

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0%	0.0%	0.0%	-0.2%	71.4%	-0.2%	-0.1%	-0.3%	0.0%	0.0%	0.0%	0.0%	1.7%
AN	0.0%	0.0%	0.0%	2.4%	-3.1%	12.3%	9.2%	0.0%	0.0%	0.0%	0.0%	0.0%	10.8%
BN	0.0%	0.0%	0.0%	5.4%	22.9%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
D	0.0%	0.0%	-0.2%	-8.6%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-2.6%
C	0.0%	0.0%	0.0%	19.8%	-10.7%	5.9%	0.0%	0.0%	0.0%	0.0%	0.0%	-6.2%	-3.3%
All Year Types	0.0%	0.0%	0.0%	4.3%	20.3%	3.6%	2%	0%	0.0%	0.0%	0.0%	-1.4%	1.8%

N/A: Divided by number of zero value.

Table 4-21. Average Changes in CVP Tracy Pumping Plant Export from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1.9	2.5	0.2	0.0	-1.1	0.4	-3.3	0.0	0.1	3.2	0.0	0.0	3.9
AN	-2.4	-1.8	-11.8	9.8	6.4	7.5	-5.5	0.9	0.1	0.6	1.1	0.0	5.0
BN	0.5	-1.4	-0.7	-2.2	-5.9	-0.7	5.0	14.9	5.4	0.9	4.0	-0.1	19.9
D	0.4	5.5	-0.3	8.8	0.4	-1.6	0.0	-6.5	1.4	2.4	-4.5	-2.4	3.6
C	1.5	4.4	-3.3	3.2	-0.2	-1.6	0.1	0.0	2.9	0.1	-2.5	1.1	5.6
All Year Types	0.5	1.9	-3.1	3.5	0.0	0.8	-1.1	1.6	1.8	1.5	-0.4	-0.1	7.1

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.8%	3.0%	0.2%	0.0%	-0.6%	0.1%	-2.0%	0.0%	0.1%	1.5%	0.0%	0.0%	0.2%
AN	-1.0%	-1.3%	-5.0%	6.7%	6.1%	4.5%	-3.3%	7.9%	0.1%	0.2%	0.5%	0.0%	0.1%
BN	-0.1%	0.1%	-0.4%	-1.0%	-2.5%	-0.4%	7.5%	21.5%	4.4%	0.3%	1.9%	0.0%	0.8%
D	0.2%	8.4%	-0.2%	4.3%	0.2%	-0.6%	0.0%	-5.5%	1.5%	1.5%	-1.6%	-1.4%	0.4%
C	0.6%	5.0%	-2.9%	1.9%	-0.6%	-2.8%	0.1%	0.0%	3.5%	-0.3%	-0.5%	0.7%	0.4%
All Year Types	0.2%	3.0%	-1.6%	2.2%	0.5%	0.1%	0.1%	4.2%	1.8%	0.7%	0.1%	-0.1%	0.3%

Table 4-22. Average Changes in SWP Banks Pumping Plant Total Export from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	3.8	-2.3	7.6	-8.2	0.9	0.5	-6.8	0.0	1.7	9.7	0.4	0.0	7.4
AN	5.9	-1.6	-7.1	13.9	-2.3	2.0	-5.0	0.0	0.3	-0.4	2.3	0.2	8.3
BN	13.2	5.9	1.9	-9.4	0.9	-10.1	5.0	4.9	-0.7	2.0	4.2	0.9	18.6
D	-4.3	-6.5	0.8	-1.6	0.8	-3.6	0.0	0.0	3.4	1.3	-1.6	6.7	-4.5
C	0.9	-1.0	-0.4	1.1	-0.6	-2.6	-2.9	0.0	4.6	-2.9	-0.3	0.3	-3.7
All Year Types	3.9	-1.2	1.1	-1.1	-0.1	-2.2	-2.6	0.8	2.0	2.4	1.0	1.3	5.2

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1.6%	-1.3%	2.4%	-1.6%	0.2%	0.3%	-3.8%	0.0%	1.4%	4.1%	0.1%	0.0%	0.2%
AN	4.7%	-1.4%	1.2%	5.1%	-2.4%	0.5%	-2.4%	0.0%	0.1%	-0.3%	0.6%	0.0%	0.2%
BN	4.4%	2.6%	1.2%	-3.4%	-0.9%	-2.3%	7.5%	7.1%	0.3%	0.6%	-1.3%	0.4%	0.4%
D	-0.9%	-3.6%	0.3%	-0.6%	0.6%	-1.5%	0.0%	0.0%	2.1%	0.2%	0.1%	4.8%	-0.2%
C	-0.3%	2.5%	-0.6%	0.4%	0.2%	-1.2%	-3.2%	0.0%	25.9%	-1.4%	2.6%	0.3%	-0.1%
All Year Types	1.8%	-0.2%	1.0%	0.0%	-0.4%	-0.7%	-0.9%	1.2%	6.4%	0.9%	0.5%	0.9%	0.1%

Table 4-23. Average Changes in SWP Banks Pumping Plant Export for SWP from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	3.3	-2.9	8.9	-9.5	1.1	1.2	-6.8	0.0	1.7	14.9	-0.1	0.2	12.1
AN	6.6	-1.9	-7.3	13.9	-3.2	0.6	-5.0	0.0	0.1	0.1	2.9	-1.4	5.4
BN	12.0	2.9	1.8	-15.9	5.9	-5.9	5.0	4.9	0.9	-0.4	-1.4	-0.1	9.8
D	0.9	-6.2	0.8	-0.7	2.7	-3.6	0.0	0.0	0.5	5.3	12.5	4.7	16.9
C	1.1	-2.0	-0.2	1.1	0.4	-2.6	-2.9	0.0	0.6	0.8	-0.2	0.5	-3.5
All Year Types	4.5	-2.1	1.4	-2.4	1.2	-1.6	-2.6	0.8	0.9	5.0	2.2	0.6	7.7

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1.4%	-1.5%	3.0%	-1.8%	0.3%	0.6%	-3.8%	0.0%	1.3%	12.1%	0.0%	0.1%	0.3%
AN	4.9%	-1.5%	1.3%	5.1%	-2.6%	0.1%	-2.4%	0.0%	0.1%	0.0%	0.8%	-0.4%	0.1%
BN	4.4%	1.2%	1.2%	-4.7%	2.5%	-1.6%	7.5%	7.1%	1.2%	0.6%	-0.3%	0.1%	0.2%
D	0.6%	-3.5%	0.3%	-0.4%	1.1%	-1.5%	0.0%	0.0%	0.6%	1.8%	20.0%	4.2%	0.6%
C	-0.2%	2.2%	-0.5%	0.4%	0.6%	-1.2%	-3.2%	0.0%	0.5%	0.5%	0.0%	0.3%	-0.2%
All Year Types	2.1%	-0.5%	1.2%	-0.3%	0.3%	-0.5%	-0.9%	1.2%	0.8%	3.8%	3.1%	0.7%	0.2%

Table 4-24. Average Changes in SWP Banks Pumping Plant Export for CVP Wheeling from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0	0.9	-1.3	1.4	-0.1	0.0	0.0	0.0	0.0	-5.8	0.1	-0.2	-4.9
AN	-0.8	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	-0.3	1.6	1.1
BN	0.7	1.1	0.1	3.2	-4.9	-0.9	0.0	0.0	0.0	-1.9	2.0	1.0	0.3
D	-4.3	-0.2	-0.1	-0.8	-0.9	0.0	0.0	0.0	0.0	-1.8	-1.1	0.4	-8.9
C	-0.2	1.1	-0.2	0.0	-1.0	0.0	0.0	0.0	1.6	-1.7	0.2	-0.1	-0.3
All Year Types	-0.7	0.7	-0.3	0.8	-1.2	-0.1	0.0	0.0	0.4	-2.5	0.2	0.5	-2.5

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-3%	-5.5%	-4.5%	-2.4%	-0.1%	0.0%	0.0%	0.0%	0.0%	-13.7%	0.2%	-0.2%	-3.2%
AN	-2%	0.7%	-9.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	-7.4%	7.0%	-2.0%
BN	-1.1%	0.6%	26.9%	0.0%	-21.1%	-2.1%	0.0%	0.0%	0.0%	-2.1%	-2.5%	3.3%	-1.3%
D	-5.7%	-9.5%	-1.7%	-5.2%	-2.8%	0.0%	0.0%	0.0%	0.0%	-1.4%	-2.2%	0.7%	-6.0%
C	0%	58.0%	-0.7%	0.0%	-3.5%	0.0%	0.0%	0.0%	0.0%	-8.2%	1.6%	-0.2%	2.6%
All Year Types	-2.3%	9.4%	1.2%	-1.4%	-4.7%	-0.3%	0.0%	0.0%	0.0%	-5.9%	-1.7%	1.9%	-1.8%

Table 4-25. Average Changes in Delta Export/Inflow Ratio from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
AN	0.00	0.00	-0.02	0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
BN	0.00	0.00	0.00	-0.01	0.00	-0.01	0.01	0.01	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00
C	0.00	0.01	-0.01	0.00	0.00	-0.01	0.00	0.00	0.01	0.00	0.00	0.00
All Year Types	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Delta Export is the total exports at SWP Banks Pumping Plant and CVP Tracy Pumping Plant.

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.0%	0.0%	-1.6%	0.0%	0.0%	0.0%	-3.3%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.5%	0.0%	0.0%	0.0%	0.0%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
C	0.0%	0.0%	-2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	4.6%	0.0%	0.0%	0.0%
All Year Types	0.0%	0.0%	-0.8%	0.0%	0.0%	0.0%	0.6%	0.0%	1.0%	0.0%	0.0%	0.0%

Table 4-26. Average Changes in Delta Inflow from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.5	2.4	-0.9	15.1	17.4	10.7	2.8	4.7	9.4	12.5	1.3	0.3	76.3
AN	1.7	-5.3	3.1	9.6	16.5	2.5	3.7	0.8	0.4	-1.8	3.3	0.2	34.6
BN	18.6	4.7	1.0	-7.2	-2.8	10.1	2.0	8.2	11.1	-4.5	9.8	1.0	52.0
D	0.3	0.3	2.7	4.5	2.2	3.8	1.0	-0.2	3.1	3.9	-6.3	4.8	20.2
C	4.2	-0.7	1.0	-0.9	1.1	-1.9	-2.2	0.0	7.2	-2.9	-2.3	1.5	4.1
All Year Types	4.5	0.3	1.1	5.3	8.1	5.2	1.5	2.8	6.5	2.3	1.1	1.4	40.0

Note: Delta Inflow is the total of inflows from Sacramento River, Mokelumne River, Yolo Bypass, San Joaquin River, and Marsh Creek.

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.2%	0.2%	0.0%	0.2%	0.4%	0.2%	0.1%	0.2%	0.6%	1.0%	0.1%	0.0%	0.2%
AN	0.2%	-0.4%	0.0%	0.2%	0.6%	0.1%	0.2%	0.0%	0.0%	-0.1%	0.3%	0.0%	0.2%
BN	2.3%	0.5%	0.0%	-0.7%	-0.1%	0.2%	0.1%	0.5%	1.0%	-0.4%	0.9%	0.1%	0.3%
D	-0.2%	0.0%	0.3%	0.4%	0.2%	0.2%	0.1%	0.0%	0.4%	0.3%	-0.6%	0.7%	0.1%
C	0.6%	-0.2%	0.2%	-0.1%	0.1%	-0.2%	-0.3%	0.0%	1.2%	-0.3%	-0.3%	0.2%	0.0%
All Year Types	0.6%	0.0%	0.1%	0.0%	0.2%	0.1%	0.0%	0.1%	0.7%	0.2%	0.1%	0.2%	0.2%

Table 4-27. Average Changes in Delta Outflow from Base Condition by Year Type (Alternative 1)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-5.1	2.2	-8.7	23.2	17.6	9.8	12.9	4.7	7.5	-0.3	0.8	0.3	64.9
AN	-1.8	-1.9	21.9	-14.2	12.4	-7.1	14.1	-0.1	-0.1	-2.0	-0.2	0.1	21.2
BN	4.9	0.2	-0.2	4.4	2.2	20.9	-8.1	-11.6	6.4	-7.4	1.6	0.2	13.5
D	4.1	1.3	2.3	-2.8	1.0	8.9	1.0	6.3	-1.7	0.1	-0.2	0.6	20.9
C	1.9	-4.0	4.8	-5.2	2.0	2.3	0.6	0.0	-0.4	0.0	0.4	0.0	2.3
All Year Types	0.1	-0.4	3.2	2.8	8.1	6.6	5.2	0.3	2.7	-1.7	0.5	0.2	27.7

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-1.0%	0.6%	-0.9%	0.4%	0.4%	0.1%	0.4%	0.2%	0.7%	-0.1%	0.3%	0.1%	0.2%
AN	-1.0%	0.3%	3.0%	-0.7%	0.3%	-0.3%	1.2%	0.1%	0.0%	-0.4%	-0.1%	0.0%	0.2%
BN	1.6%	-0.1%	-0.3%	0.9%	0.3%	1.1%	-1.1%	-1.4%	1.6%	-1.5%	0.6%	0.1%	0.2%
D	0.2%	0.1%	0.8%	-0.6%	0.1%	0.8%	0.2%	0.9%	-0.4%	0.0%	-0.1%	0.4%	0.3%
C	0.9%	-1.2%	2.2%	-0.7%	0.2%	0.6%	0.1%	0.0%	-0.1%	0.0%	0.1%	0.0%	0.1%
All Year Types	0.0%	0.0%	0.9%	-0.1%	0.3%	0.4%	0.2%	0.0%	0.4%	-0.3%	0.2%	0.1%	0.2%

Table 4-28. Average Changes in San Joaquin River Flow at Vernalis from Base Condition by Year Type (Alternative 1)

(a) In CFS

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	63.7	22.5	138.2	192.2	394.7	166.3	41.7	44.6	64.7	97.3	146.6	4.3	2.7	1.8
AN	88.4	11.8	52.6	117.7	301.3	14.9	106.0	24.2	-8.3	33.3	8.6	-0.5	-0.3	1.6
BN	215.6	12.5	2.4	4.2	30.9	47.5	38.3	-5.5	31.5	71.3	10.6	1.8	1.5	2.8
D	98.0	17.1	53.3	52.3	18.3	37.3	13.6	-4.9	-9.5	47.9	-2.9	-3.5	21.8	3.2
C	51.0	1.7	0.7	0.8	0.5	0.2	-0.1	23.1	20.0	-0.5	-0.8	5.5	13.4	7.5
All Year Types	95.8	13.5	56.5	84.0	173.9	61.9	40.1	20.3	24.3	51.9	42.9	2.1	7.1	3.4

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	3.0%	1.1%	4.7%	2.6%	3.5%	1.5%	0.3%	0.3%	0.5%	1.2%	3.0%	0.2%	0.1%	0.1%
AN	5.2%	0.8%	0.7%	1.3%	3.9%	0.3%	2.0%	0.3%	-0.1%	1.1%	0.3%	0.0%	0.0%	0.1%
BN	10.0%	0.7%	0.1%	0.3%	1.2%	0.9%	1.1%	-0.1%	0.6%	3.3%	0.5%	0.1%	0.1%	0.2%
D	1.7%	1.1%	2.5%	2.6%	1.0%	2.2%	0.7%	-0.1%	-0.2%	2.6%	-0.2%	-0.2%	2.2%	0.3%
C	3.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.8%	0.7%	0.0%	-0.1%	0.6%	2.1%	0.8%
All Year Types	4.4%	0.8%	1.8%	1.4%	2.1%	0.9%	0.8%	0.3%	0.3%	1.5%	0.9%	0.2%	0.8%	0.3%

Table 4-29. Average Flow of Newman Wasteway by Year Type in CFS (Alternative 1)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0	0	0	0	0	0	0	88	236	0	0	0	0	0
AN	0	0	0	0	0	0	0	569	1,418	0	0	0	0	0
BN	0	0	0	0	0	0	0	1,170	1,453	0	0	0	0	0
D	0	0	0	0	0	0	0	1,094	1,145	0	0	0	0	0
C	0	0	0	0	0	0	0	370	527	0	0	0	0	0
All Year Types	0	0	0	0	0	0	0	572	864	0	0	0	0	0

Table 4-30. Average Changes in Stanislaus River Flow below Goodwin Dam from Base Condition by Year Type (Alternative 1)

(a) In CFS

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	7.2	22.3	3.7	2.7	36.4	102.0	7.0	10.4	20.9	40.0	17.3	4.1	2.7	1.7
AN	14.2	2.0	1.4	51.1	-0.5	2.3	16.4	19.8	-86.0	33.1	8.7	-0.5	-0.5	0.7
BN	5.7	2.6	2.6	4.6	4.7	4.7	16.6	-49.2	-158.3	70.5	9.8	1.1	0.9	1.2
D	98.5	13.3	16.3	23.7	2.2	5.1	5.7	8.2	-110.4	48.4	-2.1	-2.5	22.2	-0.9
C	0.7	0.9	0.9	1.0	1.0	0.3	0.0	-30.9	-119.7	-0.3	-0.3	0.9	5.9	-0.2
All Year Types	20.6	9.2	4.4	15.1	11.2	30.0	8.6	-7.0	-79.7	36.1	7.6	1.0	5.4	0.6

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	1.0%	6.0%	1.1%	1.1%	3.6%	10.2%	0.6%	0.9%	1.4%	4.6%	1.5%	0.9%	0.7%	0.5%
AN	4.7%	0.8%	0.6%	9.9%	-0.2%	1.1%	2.2%	2.4%	-8.9%	8.4%	2.0%	-0.1%	-0.1%	0.3%
BN	1.2%	1.0%	1.0%	2.5%	2.5%	2.3%	2.0%	-3.7%	-14.6%	19.0%	2.0%	0.3%	0.2%	0.5%
D	6.0%	3.5%	4.2%	5.4%	1.1%	3.1%	2.0%	0.8%	-12.1%	5.9%	-0.2%	-0.3%	6.3%	-0.2%
C	0.2%	0.4%	0.4%	0.5%	0.5%	0.2%	0.0%	-4.1%	-12.5%	-0.1%	0.0%	0.2%	2.1%	-0.1%
All Year Types	2.3%	2.6%	1.3%	3.5%	1.6%	3.9%	1.2%	-0.7%	-8.3%	6.9%	1.1%	0.3%	1.6%	0.2%

Table 4-31. Average Changes in Tuolumne River Flow below New Don Pedro Reservoir from Base Condition by Year Type (Alternative 1)

(a) In CFS

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.0	0.0	50.5	48.3	56.5	29.2	0.0	-8.8	-16.3	4.5	10.4	0.0	0.0	0.0
AN	0.0	0.0	41.3	1.1	54.5	14.4	89.7	-34.7	-249.7	0.0	0.0	0.0	0.0	0.0
BN	0.0	0.0	0.0	0.0	26.5	42.8	21.6	-111.5	-376.7	0.0	0.0	0.0	0.0	0.0
D	0.0	0.0	0.0	0.0	12.7	32.1	7.9	-122.5	-274.5	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-88.1	0.0	0.0	0.0	0.0	0.0
All Year Types	0.0	0.0	21.7	13.5	32.2	22.6	21.9	-45.9	-174.9	1.2	2.8	0.0	0.0	0.0

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.0%	0.0%	4.4%	1.7%	1.8%	0.6%	0.0%	-0.2%	-0.4%	0.2%	0.2%	0.0%	0.0%	0.0%
AN	0.0%	0.0%	1.8%	0.1%	5.7%	1.2%	3.0%	-0.8%	-5.7%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.0%	0.0%	0.0%	0.0%	3.0%	1.1%	0.7%	-3.1%	-10.7%	0.0%	0.0%	0.0%	0.0%	0.0%
D	0.0%	0.0%	0.0%	0.0%	2.8%	3.4%	0.4%	-4.3%	-9.3%	0.0%	0.0%	0.0%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-3.5%	0.0%	0.0%	0.0%	0.0%	0.0%
All Year Types	0.0%	0.0%	1.6%	0.5%	2.5%	1.1%	0.7%	-1.4%	-5.1%	0.0%	0.1%	0.0%	0.0%	0.0%

Table 4-32. Average Changes in Merced River Flow below New Exchequer Dam (Lake McClure) from Base Condition by Year Type (Alternative 1)

(a) In CFS

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	65.1	2.2	79.3	128.1	264.7	32.9	34.7	-20.5	-136.7	57.5	118.8	0.0	0.0	0.0
AN	86.5	0.0	9.3	61.5	223.8	0.0	0.0	-394.4	-767.4	0.4	0.0	0.0	0.0	0.0
BN	211.2	2.4	0.0	0.0	0.0	0.0	0.0	-806.3	-579.5	0.0	0.0	0.0	0.0	12.7
D	0.0	0.0	37.6	29.3	4.8	0.0	0.0	-767.9	-477.7	0.0	0.0	0.0	0.0	51.8
C	50.5	0.0	0.0	0.0	0.0	0.0	0.0	-316.2	-226.9	0.0	0.0	42.3	51.1	71.2
All Year Types	80.2	1.0	29.2	51.3	116.2	9.0	9.5	-398.8	-401.6	15.8	32.5	9.3	11.2	25.5

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	58.5%	4.5%	56.4%	61.0%	70.2%	5.2%	2.1%	-0.7%	-4.6%	2.7%	4.0%	0.0%	0.0%	0.0%
AN	290.9%	0.0%	5.2%	10.5%	13.3%	0.0%	0.0%	-18.4%	-26.7%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	281.2%	4.8%	0.0%	0.0%	0.0%	0.0%	0.0%	-34.5%	-21.9%	0.0%	0.0%	0.0%	0.0%	1.4%
D	0.0%	0.0%	16.5%	22.6%	0.8%	0.0%	0.0%	-32.9%	-18.2%	0.0%	0.0%	0.0%	0.0%	15.8%
C	39.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-20.4%	-13.4%	0.0%	0.0%	9.4%	472.3%	2073.6%
All Year Types	126.7%	2.0%	18.9%	22.1%	21.9%	1.4%	0.6%	-18.8%	-15.6%	0.7%	1.1%	2.1%	103.5%	457.1%

CHAPTER 5. ALTERNATIVE 2 (FEB – JUN VERNALIS MINIMUM FLOW RECIRCULATION)

ALTERNATIVE DESCRIPTION

For Alternative 2, DMC recirculation would be used to supplement the San Joaquin River flow at Vernalis during February through June, with the exclusion of the 31-day pulse flow period (April 15 through May 15), to meet minimum flow objectives set forth in the 1995 WQCP. However, recirculation is only intended to supplement the Vernalis flow deficiency after releases from New Melones Reservoir per the 1996 Interim Operations Agreement. In addition, the necessity of supplementing San Joaquin River flows during October pulse/attraction flows was also investigated.

Alternative 2 includes the same assumptions as the Base condition, except:

1. Recirculation will provide flows to supplement releases from New Melones Reservoir to meet Vernalis minimum target flows (based on X2 position) during February through June excluding the VAMP period. New Melones Reservoir will release for X2 minimum target flows of up to 75 TAF when storage and inflow conditions permit. The recirculation flow will be Delta export water from the Tracy Pumping Plant. In some years, Tracy export restrictions may prevent the pumping of the full X2 augmentation flow. Diversions will then be made from the DMC to fulfill the full augmentation flow, and CVP San Luis will release for downstream water customers when permissible.

2. A storage release from San Luis is required to initiate, or “prime”, the recirculation process.

SAN JOAQUIN RIVER FLOW OBJECTIVES AT VERNALIS PER SWRCB D-1641

X2 is the location of the 2 parts per thousand isohaline one-meter off the bottom of the estuary as measured in kilometers from the Golden Gate Bridge. It is used to represent the approximate location of the estuarine entrapment zone. The 1995 WQCP minimum monthly average flow objectives at Vernalis, or X2 target flows (Table 5-1), are X2 protection measures used to provide attraction and transport flows, as well as suitable habitat for various life stages of aquatic organisms, including Delta smelt and chinook salmon. Water quality objectives at Vernalis (Table 5-2) are met first, then additional flows required to meet X2 target flows (known as X2 flows). Per D-1641, Reclamation is responsible for meeting 1995 WQCP Vernalis flow objectives; this is currently accomplished through releases from New Melones Reservoir.

During the period from February through June, excluding the pulse flow period, the combined exports of CVP and SWP are subject to export limitations of the 1995 WQCP (Table 5-3). These limitations are applicable to Alternative 2.

Recirculation for this alternative will provide additional flow from the CVP portion of the San Luis Reservoir and/or Delta to meet Vernalis flow objectives that cannot be met by New Melones Reservoir releases alone.

Note that the potential of recirculation for supplementing October pulse/attraction flows, which are a minimum of 1,000 CFS at Vernalis for all year types per 1995 WQCP, was also investigated. By the direction of SWRCB (Nick Wilcox), October pulse/attraction flows will continue to be provided primarily by eastside tributaries. Recirculation would be implemented if Vernalis minimum flows of 1,000 CFS could not be met; however, it was found that recirculation was not necessary for any month of October in the 73-year simulation.

Table 5-1. Minimum Monthly Average Flow Rates in CFS of San Joaquin River at Airport Way Bridge, Vernalis, for February to April 14 and May 16 to June per 1995 WQCP

San Joaquin Valley Water Year Type	X2 is East of Chipps Island	X2 is West of Chipps Island
Wet, Above Normal	2,130	3,420
Below Normal, Dry	1,420	2,280
Critical	710	1,140

Source: Table 3 of 1995 WQCP

Table 5-2. Water Quality Objectives at Vernalis Per 1995 WQCP

Months	Maximum 30-Day Running Average of Mean Daily Electrical Conductivity (μS/cm)
April to August	0.7
September to March	1.0

Source: Table 2 of 1995 WQCP

Table 5-3. Maximum Percentage of Delta 3-Day Running Average Inflow for Export per 1995 WQCP (for All San Joaquin Valley Water Year Types)

Time Period	Estimate of Eight River Index for January	Maximum Percentage of Delta Inflow Diverted
October to January	Not Applicable	65 percent
February	<= 1,000 TAF	35 percent
	> 1,500 TAF	45 percent
	>1,000 and <= 1,500 TAF	35 percent to 45 percent
March to April 14	Not Applicable	35 percent
May 16 to June	Not Applicable	35 percent
July to September	Not Applicable	65 percent

Note: The Eight River Index refers to the sum of the unimpaired runoff as published in DWR Bulletin 120 for the following locations:

1. Sacramento River flow at Bend Bridge, near Red Bluff
2. Feather River, total inflow to Oroville Reservoir
3. Yuba River at Smartville
4. American River, total inflow to Folsom Reservoir
5. Stanislaus River, total inflow to New Melones Reservoir
6. Tuolumne River, total inflow to Don Pedro Reservoir
7. Merced River, total inflow to Exchequer Reservoir
8. San Joaquin River, total inflow to Millerton Lake

SUMMARY OF ALTERNATIVE 2 RESULTS

The impacts on various components of each San Joaquin Valley water year type are presented similarly to Alternative 1 as presented in Chapter 4, with average changes and the average percentage change from the Base condition.

It is important to distinguish the actual impacts to the system caused by an alternative from changes beyond the resolution of the model to calculate. Therefore, a 1-percent or 5.0 TAF threshold has been designated for this study. Changes between an alternative and the base condition that are less than 1-percent or 5.0 TAF are **not** considered impacts due to Recirculation.

X2 Flow

X2 flow is provided by DMC recirculation and/or releases from New Melones Reservoir. Annual X2 flow from recirculation varies from zero to 77 TAF; it is required only 22 out of 73 years. The CALSIM2 result of X2 flow is presented in five periods: February, March, April 1 to 14, May 16 to 31, and June (Figure 5-1). In February, only 3 of 73 hydrologic years (one wet, one below normal, and one dry year) required X2 flows from DMC; recirculation flows are 3, 14, and 18 TAF for (Tables 5-4, and 5-5). In March, only 4 years – 1 above normal and 3 dry years – need recirculation flows, which are between 22 to 40 TAF (Tables 5-6 and 5-7). For the April 1 to 14 period, only 1 dry year needs 20 TAF of X2 flow from the DMC (Table 5-8 and 5-9). Between May 16 and 31, eight non-wet years have X2 flows from DMC, ranging from 1 to 17 TAF (Tables 5-10 and 5-11). In June, 6 out of 73 hydrologic years (1 wet, 3 above normal, and 2 dry years) need recirculation flows of 2 to 27 TAF (Tables 5-12 and 5-13) to meet the water quality objectives.

Impacts on Storage

For this alternative, there is no significant impact to the average CVP end-of-September total storage (-4 TAF) and no change to average SWP end-of-September total storage (Figure 5-2) due to recirculation.

Changes in the long-term average of CVP San Luis end-of-month storage (Table 5-14) are between –3.0 to 0.5 TAF (-1.3 percent to zero percent). The long-term average of SWP San Luis end-of-month storage (Table 5-15) also changed between –3.4 to 2.8 TAF (–0.8 percent to 0.6 percent).

New Melones Reservoir average end-of-month storage (Table 5-16) is only affected by recirculation during wet and above normal years; reductions are from 0.1 to 0.8 TAF. In some of these years, New Melones Reservoir released water for X2 flows.

Average changes in NOD CVP reservoirs end-of-month storage are between –0.7 and –3.3 TAF (Table 5-17). Average changes in NOD SWP reservoir end-of-month storage (Table 5-18) vary between –0.5 and 1.7 TAF. These changes generally follow those of CVP and SWP San Luis, but to a relatively smaller degree.

Impacts on Deliveries and Exports

Since the occurrence of X2 flows from the DMC is infrequent, the impacts on SOD CVP total deliveries (Table 5-19) are insignificant; changes are between –0.4 to 0.3 TAF. The long-term average of SOD SWP total annual deliveries (Table 5-20) have been increased by 2.7 TAF. The percent increase is 0.1%. SWP interruptible deliveries (Table 5-21) are not subject to significant impact; average annual deliveries increased by 0.3 TAF.

Long-term annual average exports at the Tracy and Banks Pumping Plants (Table 5-22 and 5-23) increased by 4.1 TAF (0.2 percent) and 5.6 TAF (0.1 percent), respectively. SWP exports at Banks Pumping increased by 5.7 TAF for a 0.1 percent change (Table 5-24). There is no significant change (0.1 TAF increase) in annual average CVP wheeling (Table 5-25). The Delta export/inflow ratio (Table 5-26) is not affected.

Impacts on Delta Inflow and Outflow

Long-term average of annual Delta inflow (Table 5-27) increased by 4.5 TAF while the Delta outflow decreased by 5.3 TAF (Table 5-28). Nevertheless, the percentage changes are close to zero.

Impacts on Flows at Recirculation Control Points

During the time period of recirculation, the long-term average river flow of the San Joaquin River at Vernalis (Table 5-29) increased between 8.6 and 29.0 CFS. Such an impact is more obvious during dry years; for example, the increase in Vernalis river flow for March in an average dry year is 133 CFS, which is 7.5 percent of the Base Condition.

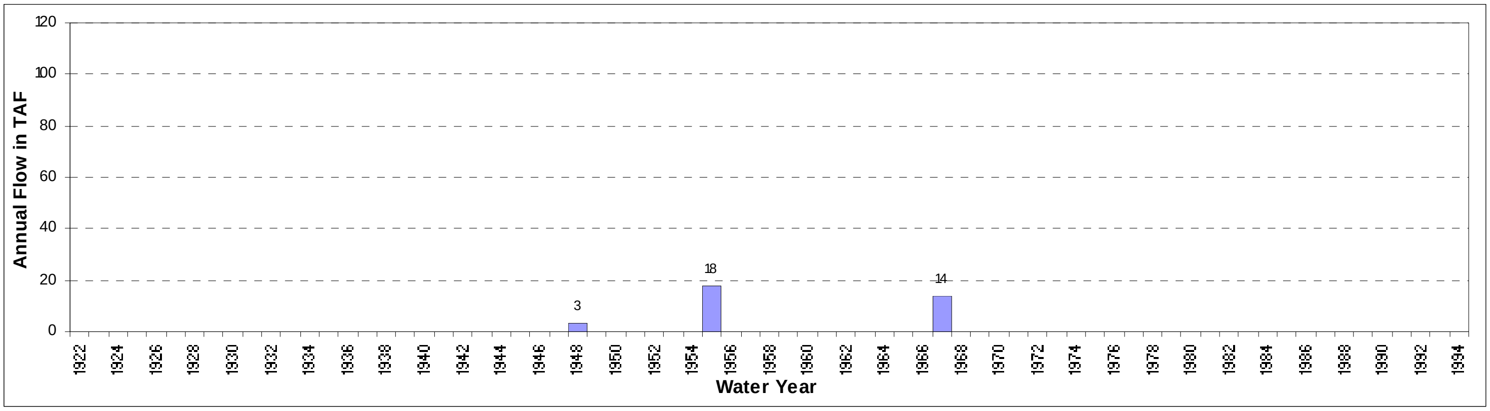
Flows only exist in the Newman Wasteway (Table 5-30) when recirculation is required to supplement the X2 flow. The flow rate in Newman Wasteway is same as the DMC recirculation amount (between 17 and 709 CFS).

Impacts on Eastside Tributary Reservoir Releases

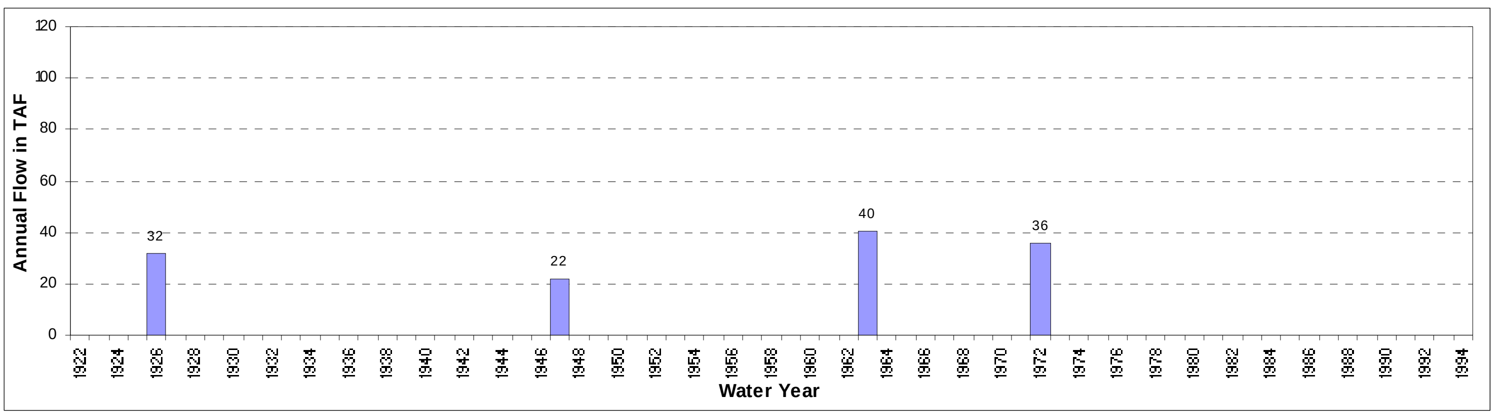
Recirculation has no obvious impacts on river flows below Goodwin Dam, New Don Pedro Reservoir, and Lake McClure (Table 5-31, 5-32, and 5-33) because recirculation is not intended to relieve any the responsibilities of these reservoirs for meeting flow requirements.

Figure 5-1. Recirculation Flow of Alternative 2 in TAF

(a) February



(b) March



(c) April 1-14

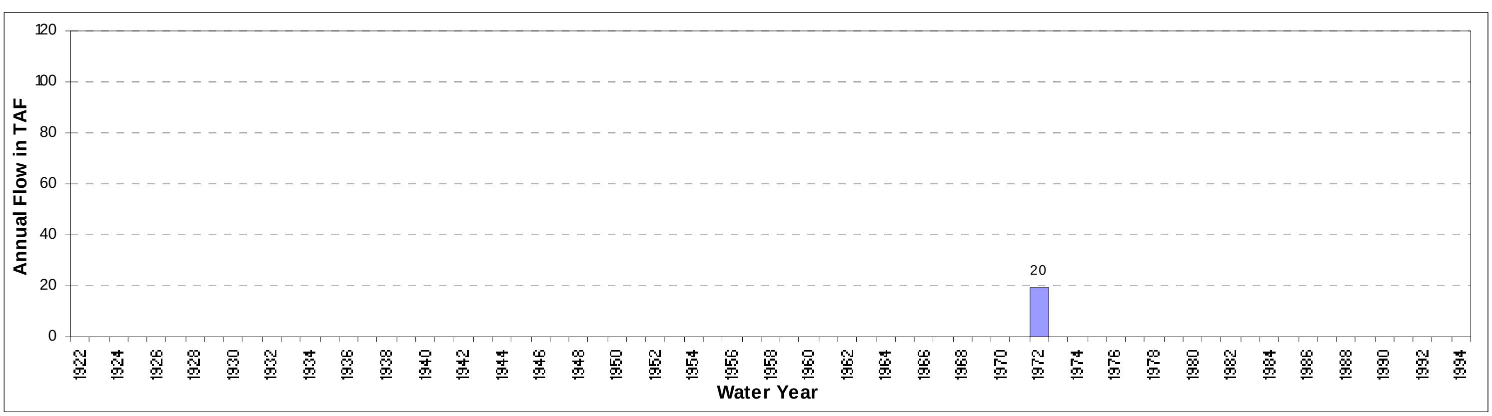
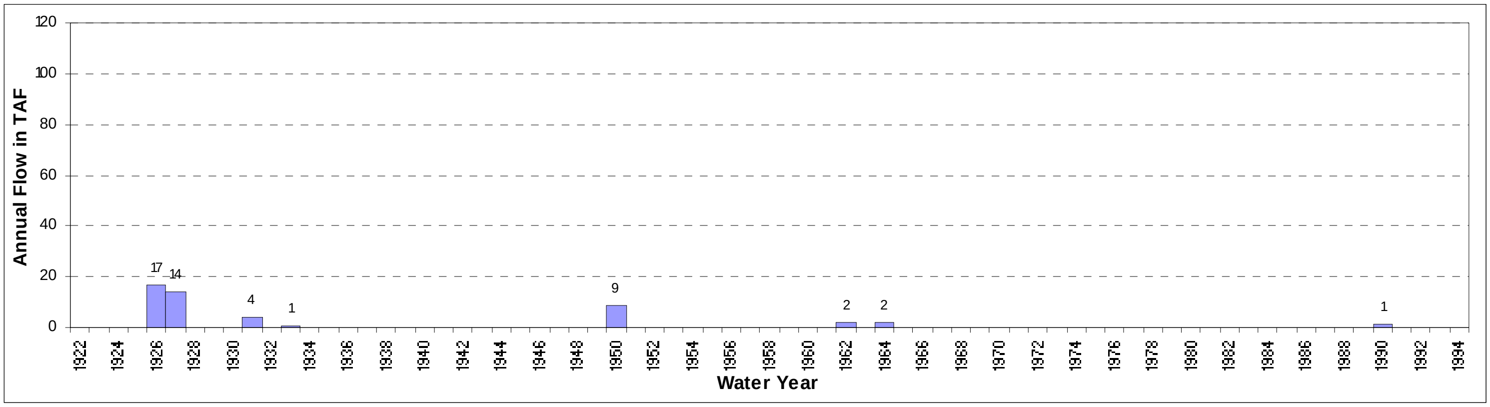
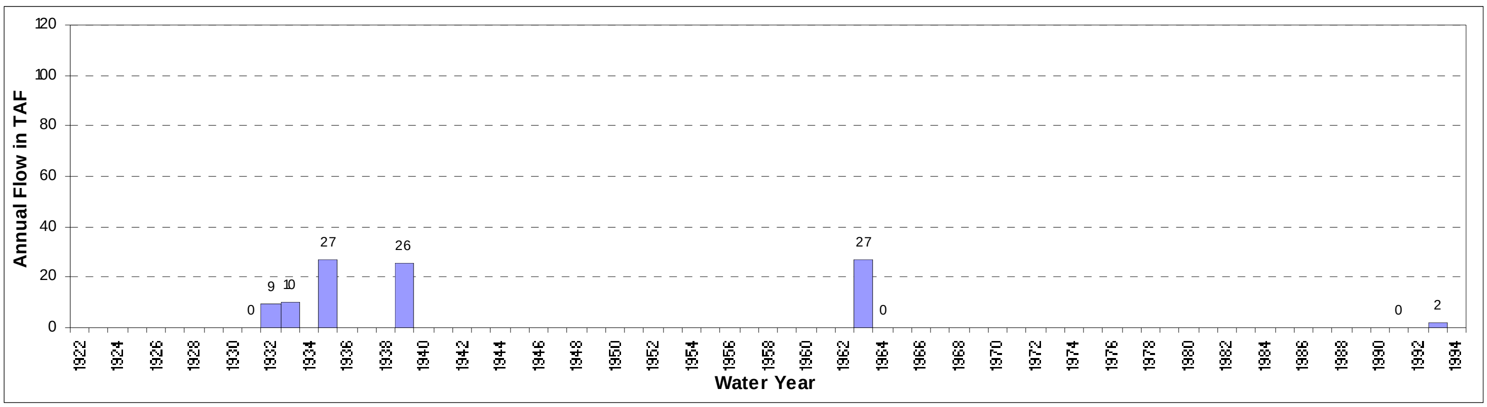


Figure 5-1. (Continued)

(d) May 16-31



(e) June



(f) Annual Total

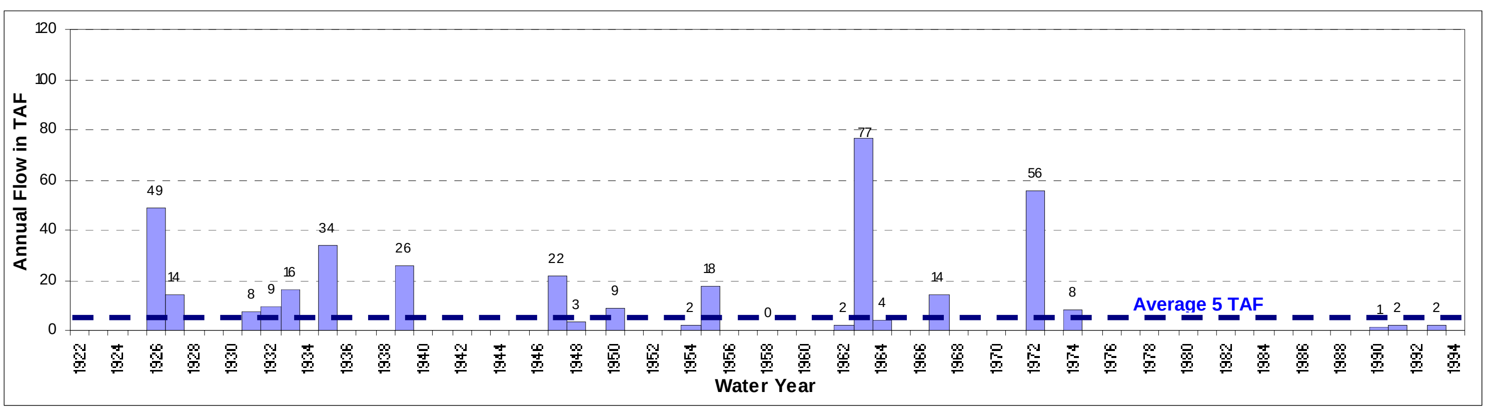


Figure 5-2. Comparison of Selective Water Supply Components between Base Condition and Alternative 2

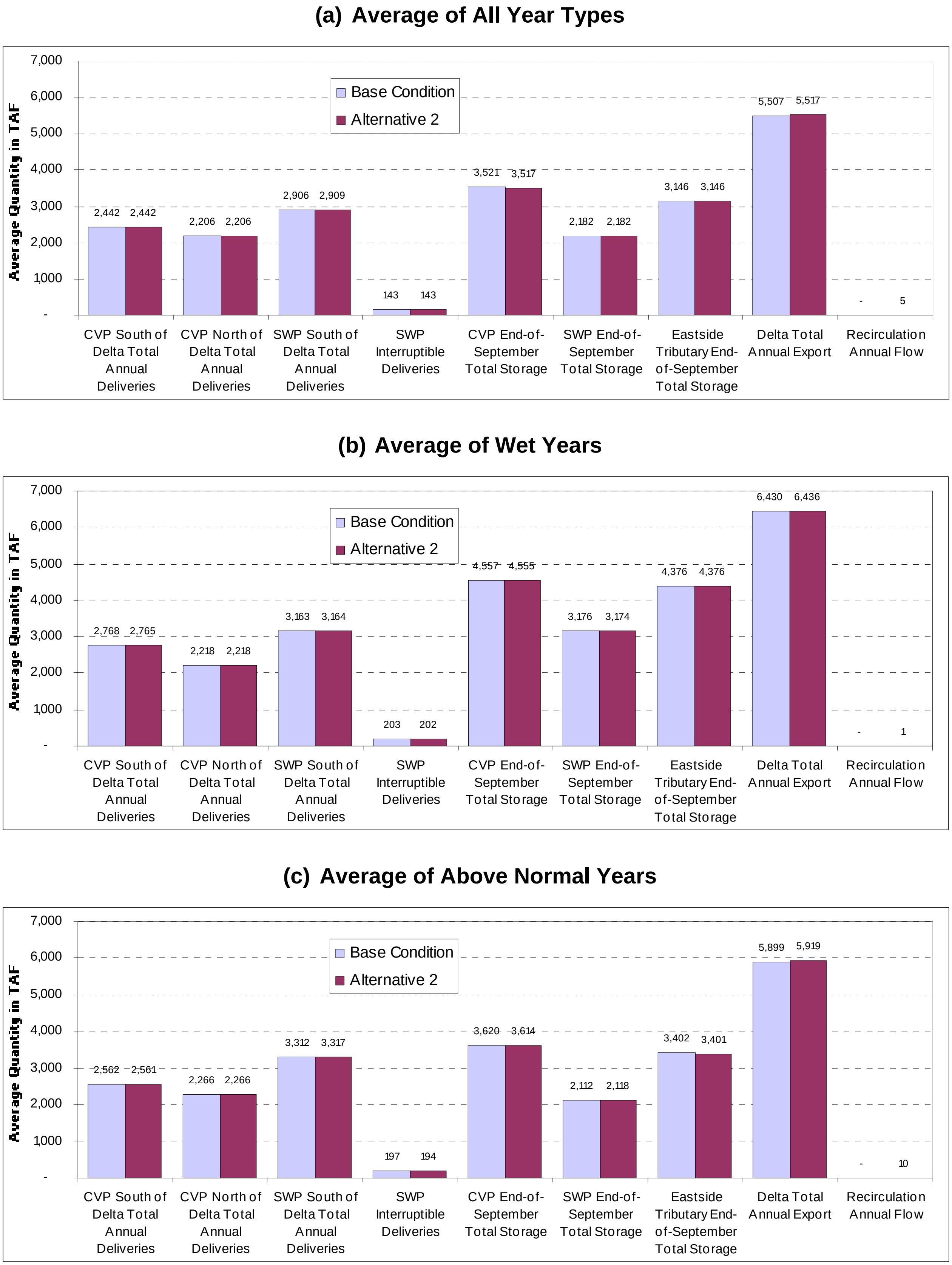
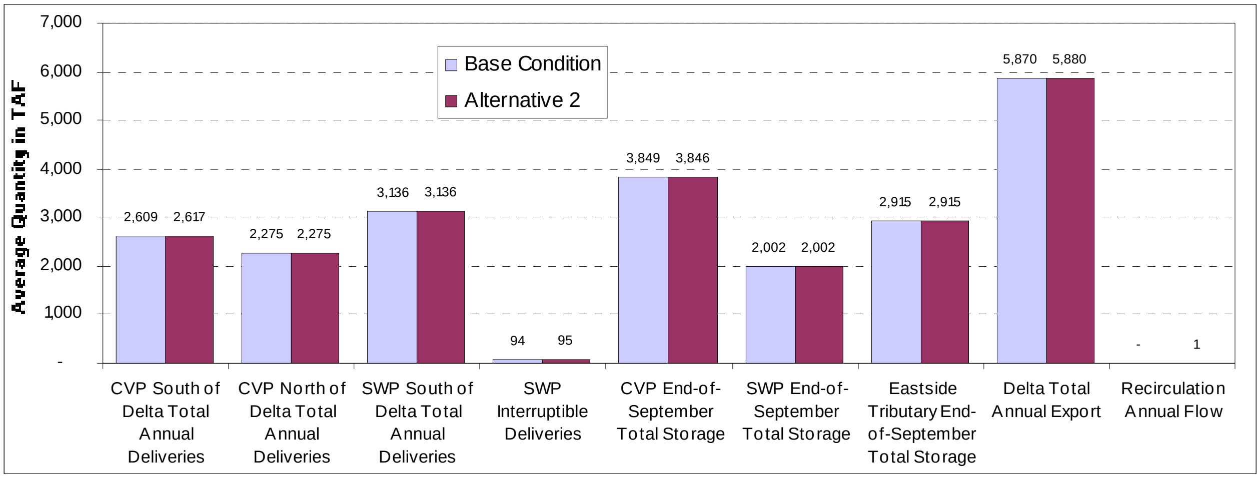
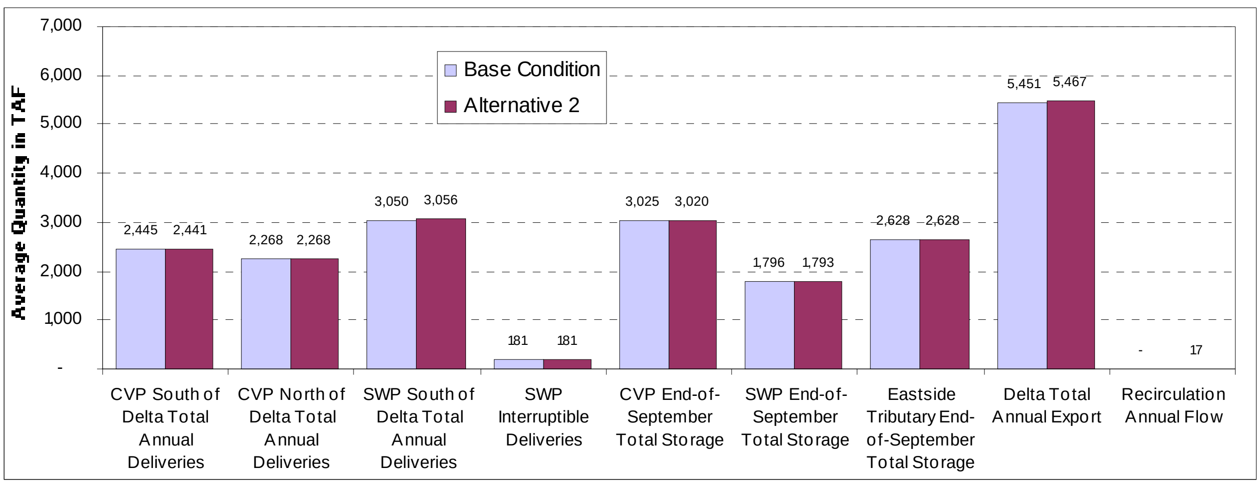


Figure 5-2. (Continued)

(d) Average of Below Normal Years



(e) Average of Dry Years



(f) Average of Critical Years

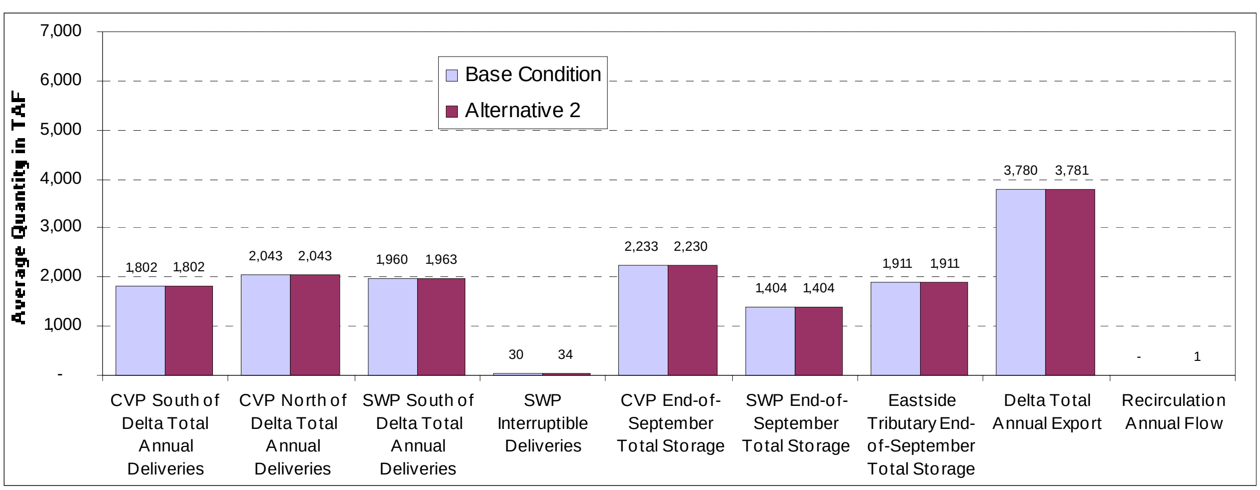


Table 5-4. Average of San Joaquin River Flow at Vernalis in February (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation	X2 Flow Deficiency	X2 Flow Augmentation	After X2 Flow Augmentation	X2 Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	11,722	-13	13	11,734	0
AN	6,961	-21	21	6,981	0
BN	3,082	-8	8	3,090	0
D	2,624	-29	29	2,653	0
C	1,652	0	0	1,652	0
All Year Types	5,810	-13	13	5,824	0

(b) In TAF

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation	X2 Flow Deficiency	X2 Flow Augmentation	After X2 Flow Augmentation	X2 Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	655	-1	1	655	0
AN	391	-1	1	392	0
BN	172	0	0	173	0
D	147	-2	2	149	0
C	93	0	0	93	0
All Year Types	325	-1	1	326	0

Table 5-5. Summary of Components Used in X2 Flow Augmentation in February (Alternative 2)

	Average Flow (TAF)				Total Number of Years				
San Joaquin Valley Water Year Type	Diversion from DMC	Total Releases from New Melones Reservoir*	Total X2 Flow Augmentation	X2 Flow Shortage	San Joaquin Valley Water Year Type	With Diversion from DMC	With Release from New Melones Reservoir *	Total X2 Flow Augmentation	With X2 Flow Shortage
W	1	0	1	0	20	1	1	2	0
AN	0	1	1	0	14	0	2	2	0
BN	0	0	0	0	12	1	1	2	0
D	2	0	2	0	11	1	0	1	0
C	0	0	0	0	16	0	0	0	0

* Releases from New Melones Reservoir are for instream and minimum flow requirements of Stanislaus River.

Table 5-6. Average of San Joaquin River Flow at Vernalis in March (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation	X2 Flow Deficiency	X2 Flow Augmentation	After X2 Flow Augmentation	X2 Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	12,659	0	0	12,659	0
AN	5,806	-47	47	5,853	0
BN	3,341	0	0	3,341	0
D	2,463	-133	133	2,596	0
C	1,638	0	0	1,638	0
All Year Types	5,861	-29	29	5,890	0

(b) In TAF

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation	X2 Flow Deficiency	X2 Flow Augmentation	After X2 Flow Augmentation	X2 Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	778	0	0	778	0
AN	357	-3	3	360	0
BN	205	0	0	205	0
D	151	-8	8	160	0
C	101	0	0	101	0
All Year Types	360	-2	2	362	0

Table 5-7. Summary of Components Used in X2 Flow Augmentation in March (Alternative 2)

	Average Flow (TAF)				Total Number of Years				
San Joaquin Valley Water Year Type	Diversion from DMC	Total Releases from New Melones Reservoir*	Total X2 Flow Augmentation	X2 Flow Shortage	San Joaquin Valley Water Year Type	With Diversion from DMC	With Release from New Melones Reservoir *	Total X2 Flow Augmentation	With X2 Flow Shortage
W	0	0	0	0	20	0	0	0	0
AN	3	0	3	0	14	1	0	1	0
BN	0	0	0	0	12	0	0	0	0
D	8	0	8	0	11	3	0	3	0
C	0	0	0	0	16	0	0	0	0

* Releases from New Melones Reservoir are for instream and minimum flow requirements of Stanislaus River.

Table 5-8. Average of San Joaquin River Flow at Vernalis from April 1 - 14 (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation <1>	X2 Flow Deficiency <2>	X2 Flow Augmentation <3>	After X2 Flow Augmentation <4> =<1>+<3>	X2 Flow Shortage <5> =<2>+<3>
W	10,878	0	0	10,878	0
AN	4,995	0	0	4,995	0
BN	3,205	0	0	3,205	0
D	2,196	-64	64	2,260	0
C	1,479	0	0	1,479	0
All Year Types	5,120	-10	10	5,130	0

(b) In TAF

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation <1>	X2 Flow Deficiency <2>	X2 Flow Augmentation <3>	After X2 Flow Augmentation <4> =<1>+<3>	X2 Flow Shortage <5> =<2>+<3>
W	302	0	0	302	0
AN	139	0	0	139	0
BN	89	0	0	89	0
D	61	-2	2	63	0
C	41	0	0	41	0
All Year Types	142	0	0	142	0

Table 5-9. Summary of Components Used in X2 Flow Augmentation from April 1 - 14 (Alternative 2)

	Average Flow (TAF)				Total Number of Years				
San Joaquin Valley Water Year Type	Diversion from DMC	Total Releases from New Melones Reservoir*	Total X2 Flow Augmentation	X2 Flow Shortage	San Joaquin Valley Water Year Type	With Diversion from DMC	With Release from New Melones Reservoir *	Total X2 Flow Augmentation	With X2 Flow Shortage
W	0	0	0	0	20	0	0	0	0
AN	0	0	0	0	14	0	0	0	0
BN	0	0	0	0	12	0	0	0	0
D	2	0	2	0	11	1	0	1	0
C	0	0	0	0	16	0	0	0	0

*Releases from New Melones Reservoir are for instream and minimum flow requirements of Stanislaus River.

Table 5-10. Average of San Joaquin River Flow at Vernalis from May 16 - 31 (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation <1>	X2 Flow Deficiency <2>	X2 Flow Augmentation <3>	After X2 Flow Augmentation <4> =<1>+<3>	X2 Flow Shortage <5> =<2>+<3>
W	9,782	0	0	9,782	0
AN	3,655	-32	32	3,687	0
BN	2,644	-28	28	2,672	0
D	1,910	-55	55	1,965	0
C	1,231	-10	10	1,242	0
All Year Types	4,373	-21	21	4,395	0

(b) In TAF

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation <1>	X2 Flow Deficiency <2>	X2 Flow Augmentation <3>	After X2 Flow Augmentation <4> =<1>+<3>	X2 Flow Shortage <5> =<2>+<3>
W	310	0	0	310	0
AN	116	-1	1	117	0
BN	84	-1	1	85	0
D	61	-2	2	62	0
C	39	0	0	39	0
All Year Types	139	-1	1	139	0

Table 5-11. Summary of Components Used in X2 Flow Augmentation from May 16 - 31 (Alternative 2)

	Average Flow (TAF)				Total Number of Years				
San Joaquin Valley Water Year Type	Diversion from DMC	Total Releases from New Melones Reservoir*	Total X2 Flow Augmentation	X2 Flow Shortage	San Joaquin Valley Water Year Type	With Diversion from DMC	With Release from New Melones Reservoir *	Total X2 Flow Augmentation	With X2 Flow Shortage
W	0	0	0	0	20	0	0	0	0
AN	1	0	1	0	14	1	0	1	0
BN	1	0	1	0	12	2	0	2	0
D	2	0	2	0	11	3	0	3	0
C	0	0	0	0	16	2	0	2	0

* Releases from New Melones Reservoir are for instream and minimum flow requirements of Stanislaus River.

Table 5-12. Average of San Joaquin River Flow at Vernalis in June (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation	X2 Flow Deficiency	X2 Flow Augmentation	After X2 Flow Augmentation	X2 Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	10,063	-8	8	10,071	0
AN	2,493	-77	77	2,569	0
BN	2,018	0	0	2,018	0
D	1,603	-67	67	1,670	0
C	1,271	-6	6	1,276	0
All Year Types	4,087	-28	28	4,115	0

(b) In TAF

San Joaquin Valley Water Year Type	Before X2 Flow Augmentation	X2 Flow Deficiency	X2 Flow Augmentation	After X2 Flow Augmentation	X2 Flow Shortage
	<1>	<2>	<3>	<4> =<1>+<3>	<5> =<2>+<3>
W	599	0	0	599	0
AN	148	-5	5	153	0
BN	120	0	0	120	0
D	95	-4	4	99	0
C	1,271	-6	6	1,276	0
All Year Types	243	-2	2	245	0

Table 5-13. Summary of Components Used in X2 Flow Augmentation in June (Alternative 2)

	Average Flow (TAF)				Total Number of Years				
San Joaquin Valley Water Year Type	Diversion from DMC	Total Releases from New Melones Reservoir*	Total X2 Flow Augmentation	X2 Flow Shortage	San Joaquin Valley Water Year Type	With Diversion from DMC	With Release from New Melones Reservoir *	Total X2 Flow Augmentation	With X2 Flow Shortage
W	0	0	0	0	20	1	1	2	0
AN	5	0	5	0	14	3	0	3	0
BN	0	0	0	0	12	0	0	0	0
D	3	1	4	0	11	2	2	3	0
C	0	0	0	0	16	0	2	2	0

* Releases from New Melones Reservoir are for instream and minimum flow requirements of Stanislaus River.

Table 5-14. Average Changes in End-of-Month Storage for San Luis Reservoir (CVP Portion) from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-0.5	-0.4	-0.5	-0.7	-1.6	0.4	-5.2	-5.0	-4.0	-8.4	-6.0	-0.9
AN	-5.5	-5.6	-2.4	3.4	5.3	5.7	12.9	7.7	-1.4	-2.1	-3.6	-4.9
BN	-0.8	-0.6	-0.7	-0.6	-0.6	-0.5	-0.5	2.8	5.3	3.8	-0.2	-0.7
D	-4.9	-0.8	-0.9	-1.1	-0.6	-1.1	-2.3	-3.9	-2.1	0.2	-3.6	-3.6
C	-1.5	-1.6	-1.8	-1.1	-0.7	-2.1	-2.1	-2.4	-1.9	-1.2	-0.7	-0.6
All Year Types	-2.4	-1.8	-1.3	-0.1	0.2	0.5	0.1	-0.6	-1.2	-2.3	-3.0	-2.0

(b) In Percentage Change

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-0.7%	-0.6%	-0.2%	-0.2%	-0.2%	0.0%	-0.6%	-0.8%	-0.9%	-2.8%	-3.8%	-0.8%
AN	-2.1%	-1.3%	-0.4%	0.5%	0.7%	0.7%	1.5%	1.2%	0.2%	0.4%	0.2%	-0.7%
BN	-0.3%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.7%	2.6%	9.7%	0.1%	-0.3%
D	-0.9%	-0.3%	-0.2%	-0.2%	-0.1%	0.0%	-0.3%	-0.5%	-0.4%	1.4%	-1.5%	-1.2%
C	-0.4%	-0.5%	-0.4%	-0.3%	-0.3%	-0.6%	-0.7%	-1.2%	-0.9%	-0.7%	-0.5%	-0.4%
All Year Types	-0.9%	-0.6%	-0.3%	-0.1%	0.0%	0.0%	-0.1%	-0.2%	-0.1%	1.0%	-1.3%	-0.7%

Table 5-15. Average Changes in End-of-Month Storage for San Luis Reservoir (SWP Portion) from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-1.6	-2.6	-3.1	-1.7	-0.9	8.2	2.0	2.0	-5.0	8.8	8.1	6.6
AN	-2.6	-2.9	-13.1	0.2	2.0	3.6	11.8	11.2	-6.9	2.9	0.9	-2.0
BN	1.8	1.7	1.7	0.7	0.5	0.6	0.5	0.6	0.5	2.0	1.3	0.7
D	-1.4	-5.4	-5.7	-4.6	-5.1	-3.5	-4.0	-4.7	-4.9	-3.1	-2.4	-3.9
C	6.8	5.6	4.3	-1.0	1.4	1.3	1.2	0.8	-0.2	-0.9	-0.9	-1.1
All Year Types	0.6	-0.6	-3.0	-1.2	-0.2	2.8	2.6	2.3	-3.4	2.6	2.0	0.7

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-1.0%	-1.3%	-0.6%	-0.2%	-0.1%	0.9%	0.4%	0.6%	-0.7%	1.9%	1.9%	1.3%
AN	-0.8%	-0.6%	-2.1%	0.0%	0.2%	0.4%	1.4%	2.1%	-2.3%	0.3%	0.9%	-0.7%
BN	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.1%	0.2%	0.4%	0.9%	0.7%	0.3%
D	-0.2%	-0.7%	-0.7%	-0.4%	-0.5%	-0.3%	-0.4%	-0.4%	-1.8%	-1.1%	-1.4%	-1.2%
C	1.0%	0.5%	0.8%	-0.1%	0.2%	0.2%	0.5%	0.4%	0.4%	0.0%	-0.2%	-0.2%
All Year Types	-0.1%	-0.4%	-0.4%	-0.1%	0.0%	0.3%	0.4%	0.6%	-0.8%	0.6%	0.6%	0.0%

Table 5-16. Average Changes in End-of-Month Storage for New Melones Reservoir from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-0.8	-0.8	-0.7	-0.7	-0.7	-0.7	-0.7	-0.5	-0.3	-0.3	-0.3	-0.3
AN	-0.8	-0.8	0.0	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.7	-0.7	-0.7
BN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Year Types	-0.4	-0.4	-0.2	-0.4	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	-0.1%	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All Year Types	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 5-17. Average Changes in End-of-Month Storage of North-for-Delta CVP Reservoirs from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.4	-4.3	-1.7	-1.9	-0.4	0.2	-0.4	-0.3	-0.3	3.0	-1.1	-1.1
AN	-1.9	-1.9	-0.4	-1.3	-1.0	-1.6	-0.6	-1.8	-3.5	-2.1	-2.1	-1.1
BN	0.4	0.5	0.9	0.9	1.0	0.5	0.5	0.5	-4.7	-4.8	-2.1	-2.0
D	-0.4	-0.5	-0.3	-0.3	-0.3	-5.3	-7.8	-7.2	-7.4	-5.2	0.6	-1.4
C	-2.2	-3.7	-3.7	-3.4	-3.5	-3.1	-3.3	-3.4	-2.9	-3.9	-2.9	-2.4
All Year Types	-0.7	-2.3	-1.3	-1.4	-0.9	-1.7	-2.0	-2.2	-3.3	-2.0	-1.6	-1.6

Note: North of Delta CVP Reservoirs are: Whiskeytown Lake, Shasta Lake, Keswick Reservoir, Folsom Lake, and Lake Natoma.

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.0%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	0.0%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%
D	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.2%	-0.2%	-0.1%	0.0%	0.0%
C	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.1%
All Year Types	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%

Table 5-18. Average Changes in End-of-Month Storage for North-of-Delta SWP Reservoirs from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.2	1.7	0.4	0.1	0.2	0.2	0.1	0.2	0.5	-14.5	-10.3	-8.7
AN	3.4	3.5	2.7	3.0	3.4	4.7	4.7	3.8	22.5	16.9	13.7	7.8
BN	-0.3	-0.4	-0.5	-0.4	-0.3	-0.7	-0.7	-0.5	-0.2	-2.0	-1.7	-1.0
D	4.2	4.2	4.2	4.2	4.2	3.3	2.8	4.1	4.5	2.1	3.2	0.7
C	-1.6	-0.1	0.6	0.6	0.6	0.6	0.6	1.0	1.0	1.0	2.3	1.5
All Year Types	0.9	1.7	1.3	1.3	1.4	1.5	1.4	1.5	5.3	-0.5	0.5	-0.6

Note: North of Delta SWP Reservoirs are: Lake Oroville, Thermalito Forebay, Thermalito Afterbay, and Thermalito Diversion Dam Reservoir.

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.4%	-0.3%	-0.3%
AN	0.7%	0.7%	0.6%	0.4%	0.3%	0.3%	0.2%	0.1%	1.0%	0.9%	0.9%	0.5%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%
D	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.2%	0.3%	0.1%
C	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.4%	0.4%
All Year Types	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.3%	0.1%	0.2%	0.1%

Table 5-19. Average Changes in South-of-Delta CVP Total Deliveries from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.1	0.1	0.1	0.2	-0.1	0.0	-0.1	-0.2	-0.3	-0.4	-1.6	-0.7	-2.9
AN	-0.1	0.0	-0.1	-0.1	-0.1	0.1	-0.1	-0.1	-0.1	-0.2	-0.1	0.0	-0.9
BN	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	0.7	1.1	1.8	4.6	0.4	8.2
D	-0.1	-0.1	-0.1	-0.1	-1.7	0.0	-0.4	-0.2	-0.3	-0.3	-0.3	-0.1	-3.6
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2
All Year Types	0.0	0.0	0.0	0.0	-0.4	0.0	-0.1	0.0	0.0	0.1	0.3	-0.2	-0.1

Note: South of Delta CVP Total Deliveries excludes the Cross Valley Canal deliveries.

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.1%	0.1%	0.1%	0.2%	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.4%	-0.3%	-0.1%
AN	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.1%
BN	0.0%	0.0%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.3%	0.3%	0.4%	1.5%	0.2%	0.3%
D	-0.1%	-0.1%	-0.2%	-0.2%	-1.2%	0.0%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.2%
C	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All Year Types	0.0%	0.0%	0.0%	0.0%	-0.3%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.1%	-0.1%	0.0%

Table 5-20. Average Changes in South-of-Delta SWP Total Deliveries from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.2	0.2	0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.7
AN	0.4	0.4	0.4	-0.1	0.0	0.3	0.5	0.6	0.7	0.7	0.7	0.5	5.1
BN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
D	0.1	0.1	0.1	-0.1	0.2	0.4	0.7	0.8	1.0	1.0	0.9	0.7	5.7
C	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.4	0.4	0.3	3.3
All Year Types	0.2	0.2	0.2	0.0	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.3	2.7

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.1%	0.1%	0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.3%	0.3%	0.3%	-0.1%	0.0%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
D	0.1%	0.1%	0.1%	-0.2%	0.2%	0.3%	0.5%	0.4%	0.4%	0.3%	0.4%	0.4%	0.3%
C	0.2%	0.2%	0.2%	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
All Year Types	0.1%	0.1%	0.1%	-0.1%	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%

Table 5-21. Average Changes in SWP Interruptible Deliveries from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0	0.0	0.0	-0.6	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.8
AN	0.0	0.0	0.0	0.0	-2.4	-0.5	-0.2	0.0	0.0	0.0	0.0	0.0	-3.1
BN	0.0	0.0	0.0	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
D	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
C	0.0	0.0	0.0	6.2	-2.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	4.0
All Year Types	0.0	0.0	0.0	1.3	-0.9	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	0.0%	0.0%	0.0%	-1.7%	2.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.3%
AN	0.0%	0.0%	0.0%	0%	-4.3%	-0.2%	-2%	0%	0.0%	0.0%	0.0%	0.0%	-1.9%
BN	0.0%	0.0%	0.0%	1.2%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
D	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
C	0.0%	0.0%	0.0%	63.8%	-3.4%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.9%	0.2%
All Year Types	0.0%	0.0%	0.1%	14%	-0.8%	-0.1%	0%	0%	0.0%	0.0%	0.0%	-0.4%	-0.3%

N/A: Divided by zero.

Table 5-22. Average Changes in CVP Tracy Pumping Plant Export from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-0.7	0.1	0.1	0.0	0.4	2.0	-5.7	0.0	0.0	0.5	0.0	0.0	-3.5
AN	-1.8	-0.1	1.1	5.8	1.5	1.4	7.1	-4.3	-0.1	-0.6	0.2	0.0	10.0
BN	-0.1	0.2	-0.1	0.0	0.3	0.3	0.0	5.0	2.8	0.1	0.0	0.0	8.6
D	0.5	4.1	-0.2	-0.3	0.7	7.7	0.1	0.0	3.7	-0.2	-4.8	-1.0	10.3
C	-0.1	-0.1	-0.2	0.7	0.4	-1.5	0.0	0.0	0.0	0.6	1.0	0.1	0.9
All Year Types	-0.5	0.6	0.1	1.2	0.6	1.7	-0.2	0.0	1.0	0.1	-0.5	-0.1	4.1

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-0.5%	0.1%	0.0%	0.0%	0.2%	1.0%	-3.8%	0.0%	0.0%	0.2%	0.0%	0.0%	-0.1%
AN	-0.7%	-0.1%	1.3%	3.0%	0.8%	0.6%	9.1%	-3.3%	-0.1%	-0.2%	0.1%	0.0%	0.4%
BN	0.0%	0.1%	-0.1%	0.0%	0.1%	0.2%	0.0%	7.2%	2.2%	0.0%	0.0%	0.0%	0.3%
D	0.2%	5.7%	-0.2%	-0.3%	0.3%	5.1%	0.1%	0.0%	3.0%	0.2%	-2.0%	-0.4%	0.7%
C	-0.1%	-0.1%	-0.1%	0.4%	0.3%	-2.1%	0.0%	0.0%	-0.1%	0.6%	1.5%	0.0%	0.1%
All Year Types	-0.2%	0.9%	0.2%	0.6%	0.3%	0.7%	0.7%	0.5%	0.8%	0.2%	0.0%	-0.1%	0.2%

Table 5-23. Average Changes in SWP Banks Pumping Plant Export from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-3.2	0.3	-0.1	0.3	0.8	9.3	-6.8	0.0	-0.3	8.9	0.0	0.0	9.3
AN	1.7	-0.7	-7.1	13.4	-0.6	2.6	8.3	0.0	-16.3	5.9	3.2	-0.5	9.7
BN	1.2	-0.1	-0.1	-0.1	-0.3	0.0	0.0	0.1	-1.0	1.8	-0.1	0.2	1.7
D	-0.5	-4.0	-0.1	0.0	0.8	2.0	0.2	0.0	-1.7	3.5	1.2	4.6	5.8
C	0.1	0.1	0.2	-0.5	0.3	0.1	0.0	0.0	0.0	0.4	-0.6	0.1	0.2
All Year Types	-0.4	-0.7	-1.4	2.5	0.2	3.4	-0.3	0.0	-3.6	4.5	0.7	0.6	5.6

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-1.1%	0.8%	0.0%	0.1%	0.2%	4.7%	-3.8%	0.0%	-0.3%	3.9%	0.0%	0.0%	0.2%
AN	0.7%	-0.4%	-1.5%	4.9%	-0.2%	0.7%	9.3%	0.0%	-4.3%	1.8%	1.0%	-0.2%	0.2%
BN	0.5%	-0.1%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.1%	-0.4%	0.6%	0.0%	0.1%	0.0%
D	-0.3%	-2.2%	0.0%	0.0%	0.8%	2.3%	0.1%	0.0%	-0.6%	1.0%	0.5%	1.7%	0.1%
C	0.0%	0.1%	0.2%	-0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.2%	1.2%	0.0%	0.0%
All Year Types	-0.1%	-0.2%	-0.3%	0.9%	0.1%	1.8%	0.8%	0.0%	-1.1%	1.7%	0.5%	0.2%	0.1%

Table 5-24. Average Changes in SWP Banks Pumping Plant Export for SWP from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-0.4	-0.8	-0.1	0.3	1.5	9.7	-6.8	0.0	-0.3	14.1	-0.1	0.5	17.7
AN	1.6	-0.7	-9.2	13.4	-0.6	1.6	8.3	0.0	-19.6	6.2	2.0	-0.5	2.6
BN	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	-0.9	1.7	-0.3	0.1	0.5
D	-0.5	-3.9	0.0	0.0	0.8	2.0	0.2	0.0	-2.2	2.5	0.1	4.1	3.0
C	0.1	-1.0	0.2	-0.5	0.2	0.1	0.0	0.0	0.3	-0.1	0.0	0.1	-0.6
All Year Types	0.1	-1.2	-1.7	2.5	0.4	3.3	-0.3	0.0	-4.2	5.7	0.3	0.7	5.7

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-0.1%	0.4%	0.0%	0.1%	0.4%	4.7%	-3.8%	0.0%	-0.3%	12.4%	0.0%	0.1%	0.5%
AN	0.8%	-0.4%	-1.9%	4.9%	-0.2%	0.4%	9.3%	0.0%	-5.7%	2.5%	0.6%	-0.2%	0.0%
BN	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	-0.4%	0.6%	-0.1%	0.0%	0.0%
D	-0.3%	-2.1%	0.0%	0.0%	0.8%	2.3%	0.1%	0.0%	-0.7%	0.9%	0.0%	1.6%	0.0%
C	0.0%	-0.2%	0.2%	-0.2%	0.2%	0.2%	0.0%	0.0%	0.4%	-0.2%	0.0%	0.0%	0.0%
All Year Types	0.1%	-0.3%	-0.3%	0.9%	0.2%	1.8%	0.8%	0.0%	-1.3%	4.1%	0.1%	0.3%	0.1%

Table 5-25. Average Changes in SWP Banks Pumping Plant Export for CVP Wheeling from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-0.2	1.4	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	-5.8	0.0	-0.5	-5.4
AN	0.1	0.0	2.1	0.0	0.0	1.0	0.0	0.0	0.0	0.5	0.0	0.0	3.6
BN	1.2	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.1	1.1
D	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.7	-0.1	2.6
C	0.0	1.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
All Year Types	0.2	0.6	0.4	0.0	-0.1	0.2	0.0	0.0	0.0	-1.2	0.1	-0.1	0.1

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-4%	2.2%	0.0%	-0.1%	-0.4%	0.0%	0.0%	0.0%	0.0%	-8.8%	0.1%	-0.6%	-1.9%
AN	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	-3.0%	-1.6%	-0.3%
BN	6.7%	0.0%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	-0.2%	0.4%
D	-1.3%	-0.1%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	1.3%	-0.1%	0.7%
C	0%	54.8%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	5.2%
All Year Types	-0.2%	12.6%	0.2%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-1.8%	-0.3%	-0.5%	0.8%

Table 5-26. Average Changes in Delta Export/Inflow Ratio from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AN	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.00	0.00	0.00
BN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All Year Types	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Delta Export is the total exports at SWP Banks Pumping Plant and CVP Tracy Pumping Plant.

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-3.0%	0.0%	0.0%	0.0%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All Year Types	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.6%	0.0%	0.0%	0.0%

Table 5-27. Average Changes in Delta Inflow from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-8.9	-0.7	-1.2	1.0	-1.1	-0.6	0.6	-0.3	-0.5	10.1	0.0	1.3	-0.5
AN	-1.9	-0.1	-1.1	0.9	-0.7	2.1	-0.9	3.1	-12.6	4.2	3.2	-0.9	-4.6
BN	1.4	-0.1	-0.3	-0.1	0.0	1.0	0.0	0.7	5.0	1.8	-0.1	0.4	9.6
D	-0.3	0.1	-0.2	0.0	1.6	13.5	4.4	0.0	3.2	3.4	-5.9	5.5	25.4
C	0.0	-0.1	-0.8	-0.1	0.2	-0.2	-0.1	0.0	0.1	1.0	0.1	0.2	0.3
All Year Types	-2.6	-0.2	-0.8	0.4	-0.2	2.4	0.6	0.6	-1.2	4.6	-0.3	1.1	4.5

Note: Delta Inflow is the total of inflows from Sacramento River, Mokelumne River, Yolo Bypass, San Joaquin River, and Marsh Creek.

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-1.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	0.1%	0.0%
AN	-0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.2%	-0.8%	0.4%	0.3%	-0.1%	0.0%
BN	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%	0.1%	0.0%	0.0%	0.1%
D	0.0%	0.0%	0.0%	0.0%	0.2%	1.3%	0.5%	0.0%	0.4%	0.3%	-0.5%	0.7%	0.2%
C	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
All Year Types	-0.3%	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%	0.0%	0.0%	0.4%	0.0%	0.1%	0.0%

Table 5-28. Average Changes in Delta Outflow from Base Condition by Year Type (Alternative 2)

(a) In TAF

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-5.0	-1.1	-1.1	0.7	-2.4	-11.9	13.1	-0.3	-0.2	0.7	0.0	1.3	-6.3
AN	-1.8	0.7	5.0	-18.2	-1.5	-1.9	-16.3	7.3	3.8	-1.0	-0.2	-0.3	-24.3
BN	0.2	-0.2	-0.1	-0.1	0.0	0.7	0.0	-4.4	3.1	-0.1	0.0	0.1	-0.7
D	-0.3	0.0	0.2	0.4	0.1	3.8	4.2	0.0	1.2	0.0	-2.2	1.9	9.3
C	0.0	0.0	-0.9	-0.3	-0.5	1.2	-0.1	0.0	0.0	0.0	-0.4	0.0	-0.9
All Year Types	-1.7	-0.2	0.5	-3.3	-1.0	-2.7	1.1	0.6	1.4	0.0	-0.4	0.6	-5.3

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	-1.0%	-0.3%	-0.1%	0.0%	-0.1%	-0.2%	0.3%	0.0%	0.0%	0.1%	0.0%	0.3%	-0.1%
AN	-0.6%	0.2%	0.5%	-0.3%	0.0%	-0.1%	-0.8%	0.8%	0.7%	-0.2%	-0.1%	-0.2%	-0.2%
BN	0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.6%	0.7%	0.0%	0.0%	0.1%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.6%	0.0%	0.7%	0.0%	-0.8%	1.0%	0.1%
C	0.0%	0.0%	-0.2%	0.1%	-0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%
All Year Types	-0.4%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.3%	0.0%	-0.2%	0.2%	0.0%

Table 5-29. Average Changes in San Joaquin River Flow at Vernalis from Base Condition by Year Type (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.6	-0.1	-0.1	-0.1	12.8	-0.1	0.1	-1.4	-1.4	-4.6	-2.4	0.1	-0.1	-0.1
AN	13.4	0.0	0.0	0.0	0.0	46.9	-0.1	-0.3	0.0	32.2	76.6	0.0	0.0	0.0
BN	0.7	0.0	0.0	0.0	4.9	0.0	0.0	0.0	0.2	28.4	0.9	1.1	0.8	0.3
D	-2.2	0.0	0.0	-0.1	28.9	133.1	63.8	0.0	0.0	55.3	54.2	-0.3	-0.2	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.2	-0.2
All Year Types	2.5	0.0	0.0	0.0	8.6	29.0	9.6	-0.4	-0.3	20.2	22.3	0.2	0.1	0.0

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
AN	0.8%	0.0%	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%	1.1%	2.8%	0.0%	0.0%	0.0%
BN	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	1.4%	0.1%	0.1%	0.0%	0.0%
D	0.0%	0.0%	0.0%	0.0%	1.5%	7.5%	4.0%	0.0%	0.0%	3.3%	3.3%	0.0%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%
All Year Types	0.2%	0.0%	0.0%	0.0%	0.4%	1.5%	0.6%	0.0%	0.0%	1.1%	1.0%	0.0%	0.0%	0.0%

Table 5-30. Average Flow of Newman Wasteway by Year Type in CFS (Alternative 2)

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.0	0.0	0.0	0.0	12.7	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	46.8	0.0	0.0	0.0	32.2	76.6	0.0	0.0	0.0
BN	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0	0.0	28.2	0.0	0.0	0.0	0.0
D	0.0	0.0	0.0	0.0	29.0	133.1	64.0	0.0	0.0	55.4	54.3	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0
All Year Types	0.0	0.0	0.0	0.0	8.6	29.0	9.6	0.0	0.0	21.5	23.3	0.0	0.0	0.0

Table 5-31. Average Changes in Stanislaus River Flow below Goodwin Dam from Base Condition by Year Type (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	-0.2	-0.1	-0.1	-0.1	0.0	-0.1	0.0	-1.5	-1.5	-4.7	-2.9	0.0	0.0	0.0
AN	13.4	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-0.3	0.0	0.0	0.0	0.0	0.0
BN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.6	0.0
D	-2.1	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	-0.2	-0.2	0.1
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	-0.2
All Year Types	2.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	-0.5	-1.3	-0.7	0.1	0.1	0.0

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.6%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.1%	0.0%
D	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	-0.3%	-0.2%	-0.1%
All Year Types	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 5-32. Average Changes in Tuolumne River Flow below New Don Pedro Reservoir from Base Condition by Year Type (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
BN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Year Types	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All Year Types	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 5-33. Average Changes in Merced River Flow below New Exchequer Dam (Lake McClure) from Base Condition by Year Type (Alternative 2)

(a) In CFS

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.3	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BN	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Year Types	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	0.0

(b) In Percentage

San Joaquin Valley Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr 1-14	Apr 15-30	May 1-15	May 16-31	Jun	Jul	Aug	Sep
W	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BN	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All Year Types	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

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CHAPTER 6. FINDINGS

SUMMARY

To satisfy requirements set forth in SWRCB D-1641, Reclamation began this Study to assess potential impacts of recirculating water from the Delta through Newman Wasteway as a mean to supplement San Joaquin River flow at Vernalis. This Study requires analyses in various disciplinary areas, and the study approach was detailed in the POA prepared by Reclamation in 2001.

The first phase of the Study focuses on hydrologic analysis and the water quality analyses. CALSIM2 was used to perform hydrologic analysis. The procedure of hydrologic modeling procedure and findings regarding potential water supply impacts from recirculation are summarized in this Report. Results of hydrologic analysis were used in water quality analysis, the results of which are summarized in a separate report.

Through continued consultation with SWRCB, the Base Condition and two recirculation alternatives that satisfy SWRCB's requirements were defined. In addition, fundamental guidelines for the Study are to observe current applicable water rights, laws, regulations, contracts, and other operation principles and guidelines.

- **Base Condition** —Base Condition is based on the CALSIM Benchmark Study for 2001 LOD dated September 2002. Per SWRCB's request, a different time series for Yuba River flow that conforms to D-1644 was used as modeling input. Note that this change in modeling input for Yuba River flow does not have much effect on Study findings because the same modeling input was consistently used in simulations for Base Condition and both alternatives. Impact assessments are based on the differences between the alternatives and the Base Condition.

- **Alternative 1** — For this alternative, DMC recirculation would be used to supplement the San Joaquin River flow at Vernalis during the 31-day pulse flow period (April 15 through May 15), completely relieving Exchange Contractors and tributary reservoirs (New Melones, New Don Pedro, and Lake McClure) of the responsibility for meeting VAMP flow requirements.

- **Alternative 2** — For this alternative, DMC recirculation would be used to supplement the San Joaquin River flow at Vernalis during February through June, with the exclusion of the 31-day pulse flow period (April 15 through May 15), to meet flow objectives set forth in the 1995 WQCP. However, recirculation is only used to supplement the deficiency after releases are made from the New Melones Reservoir, per the 1997 Interim Operations Agreement.

FINDINGS

Alternative 1 (VAMP Recirculation)

DMC recirculation could be used to supplement San Joaquin River flow during the 31-day pulse flow period (April 15 through May 15), in lieu of the releases from tributary reservoirs (New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure). The major impact would be to SOD CVP delivery, which would be reduced to facilitate recirculation flow. Recirculation would have limited impacts on reservoir operation, CVP/SWP deliveries north of Delta, and reservoir storage in San Luis Reservoir. The following are key findings regarding Alternative 1 hydrologic and water supply impacts:

- Annual average recirculation flows are about 44 TAF, ranging from zero to 110 TAF. For the 73 years used in the simulation, recirculation flow would have been required in 54 years (Figure 5-1).

- Average required flow for recirculation purposes is 10, 60, 80, 69, and 27 TAF for wet, above normal, below normal, dry, and critical years, respectively. This flow directly reduces south of delta CVP deliveries.

- Annual average SOD CVP deliveries were reduced by 43.5 TAF, which is equivalent to the average annual volume required for DMC recirculation. The majority of the reductions occur during April and May (VAMP period) with a decrease in deliveries of 13.6 TAF (-8.4%) and 19.6 TAF (-8.0%) respectively.

- Average end-of-August (San Luis low-point) storage for CVP San Luis would decrease by 6.8 TAF (-3.5 %).

- Changes to NOD CVP deliveries and SOD SWP deliveries were both below the 1% threshold and were not considered significantly impacted.

- Impacts to NOD CVP and NOD SWP reservoir storage, and SWP San Luis Reservoir all fell within the 1% or 5.0 TAF threshold and were not considered significant.

- Changes to CVP and SWP exports, including CVP wheeling, all fell within the 1% or 5.0 TAF threshold and were not considered significant.

- Average end-of-September storage in New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure would increase by 27.6 TAF, 15.5 TAF, and 57.2 TAF, respectively.

- Releases from eastside tributary reservoirs during the VAMP pulse flow period were reduced. Note that in this Study, no alternative uses of this saved water were identified. As a result, these unused flows could be released outside of the VAMP pulse flow period; for example, pre-releases prior to the flood control season or to meet instream flows.

Alternative 2 (Feb –June Vernalis Minimum Flow Recirculation)

DMC recirculation could be used to supplement San Joaquin River flow in addition to the releases from New Melones Reservoir during February through June, excluding the 31-day pulse flow period (April 15 through May 15). Also, application of recirculation for October pulse/attraction flows was also investigated. The overall water supply impact from recirculation is minimal because required recirculation flow is small. The following are key findings regarding Alternative 2 hydrologic and water supply impacts:

- The annual average recirculation flow was about 5.1 TAF, ranging from zero to 76.6 TAF. For the 73 years of simulation used in the model, recirculation flow would have been required in 22 years (Figure 5-2).
- Average required flow for recirculation purposes was 1, 10, 1, 17, and 1 TAF for wet, above normal, below normal, dry, and critical years, respectively. However, recirculation flow is consistently provided by withdrawals from San Luis Reservoir and increases in Delta pumping.
- The average end-of-August storage (San Luis Low Point) for CVP San Luis would decrease by 3.0 TAF (-1.3%).
- Impacts to SWP deliveries and SWP San Luis were both below the 1% threshold and were not considered significant.
- On an annual average basis, there would be insignificant impacts to CVP delivery and storage (both NOD and SOD), Delta pump operation, and releases from the tributary reservoirs (New Melones, New Don Pedro, and Lake McClure).
- The October minimum flow of 1,000 cfs was always achieved through pulse/attraction flows; thus recirculation was never required for this month.

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