RECLAMATION

Managing Water in the West

Upper San Joaquin River Basin Storage Investigation

Plan Formulation Report




October 2008

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

State of California
Department of Water Resources

Summary

This Plan Formulation Report (PFR) is an interim product of the Upper San Joaquin River Basin Storage Investigation (Investigation), a feasibility study by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), and the California Department of Water Resources (DWR). The purpose of the Investigation is to determine the type and extent of Federal, State, and regional interests in a potential project(s) in the upper San Joaquin River watershed to expand water storage capacity; improve water supply reliability and flexibility of the water management system for agricultural, urban, and environmental uses; and enhance San Joaquin River water temperature and flow conditions to support anadromous fish restoration efforts. The primary purposes of this PFR are to describe the formulation, evaluation, and comparison of alternative plans that address Investigation planning objectives, and to define a set of alternative plans to be considered in detail in the Feasibility Report and Environmental Impact Statement/Environmental Impact Report (EIS/EIR). This PFR is not a decision document; it is a report based on available information at this stage of the feasibility study process. Additional studies and documentation will follow this PFR during the Investigation, with continued opportunities for public review and participation.

Background

The Investigation is one of five surface water storage studies recommended in the CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Report (PEIS/EIR) Record of Decision (ROD) of August 2000. Reclamation and DWR are coordinating the Investigation with the California Bay-Delta Public Advisory Committee, which provides advice to the Secretary of the Interior regarding implementation of CALFED, and the California Bay-Delta Authority, which provides general oversight and coordination of all CALFED activities.

Federal authorization for the Investigation was initially provided in Public Law 108-7, Division D, Title II, Section 215, the omnibus appropriations legislation for fiscal year 2003. Subsequent authorization was provided in Public Law 108-361, Title I, Section 103, Subsection (d)(1)(A)(ii), the Water Supply, Reliability, and Environmental Improvement Act of 2004, which authorized feasibility studies of new water storage for three potential projects identified in the CALFED ROD. Reclamation is the responsible Federal agency for preparing the Feasibility Report and EIS. Section 227 of California Water Code authorizes DWR to participate in water resources investigations. DWR is the State lead agency for the Investigation and preparation of the EIR.

Existing and Future Conditions

The primary study area, shown in Figure S-1, encompasses the San Joaquin River watershed upstream from Friant Dam to Kerckhoff Dam, including Millerton Lake, and areas that would be directly affected by construction-related activities. The extended study area, shown in Figure S-2, encompasses locations of potential project features and areas potentially affected by alternatives implementation and/or operations. These include the upper San Joaquin River watershed, the San Joaquin River downstream from Friant Dam, the Sacramento-San Joaquin Delta (Delta), lands with San Joaquin River water rights, and water service areas in the Friant Division, south-of-Delta (SOD) Central Valley Project (CVP), and State Water Project (SWP).

This PFR describes existing and likely future without-project conditions in the primary and extended study areas. The description of these conditions includes information available at this stage of the planning process on physical, biological, cultural, and socioeconomic resources. Additional information will be documented in the pending Feasibility Report and EIS/EIR.

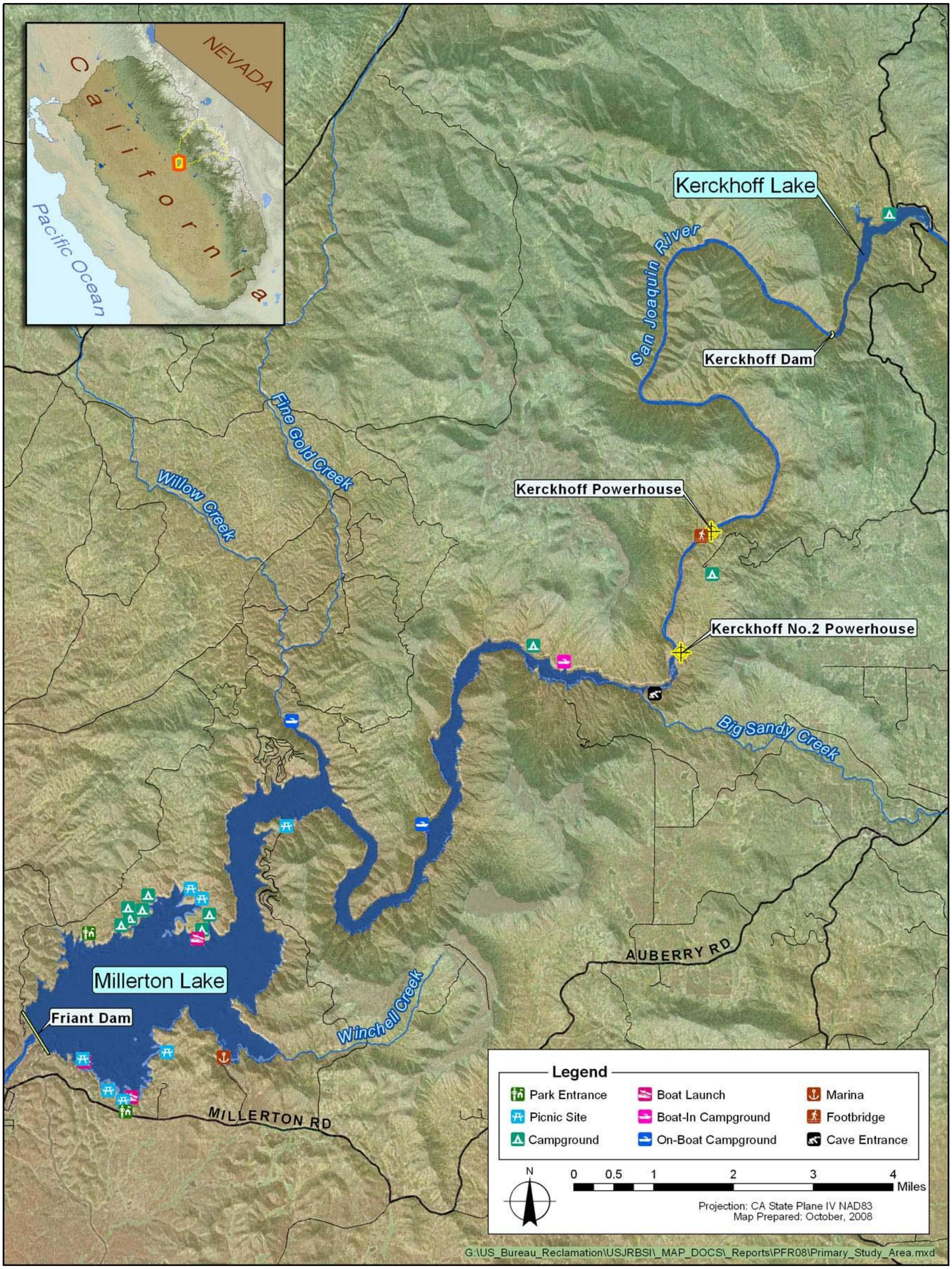


Figure S-1. Primary Study Area

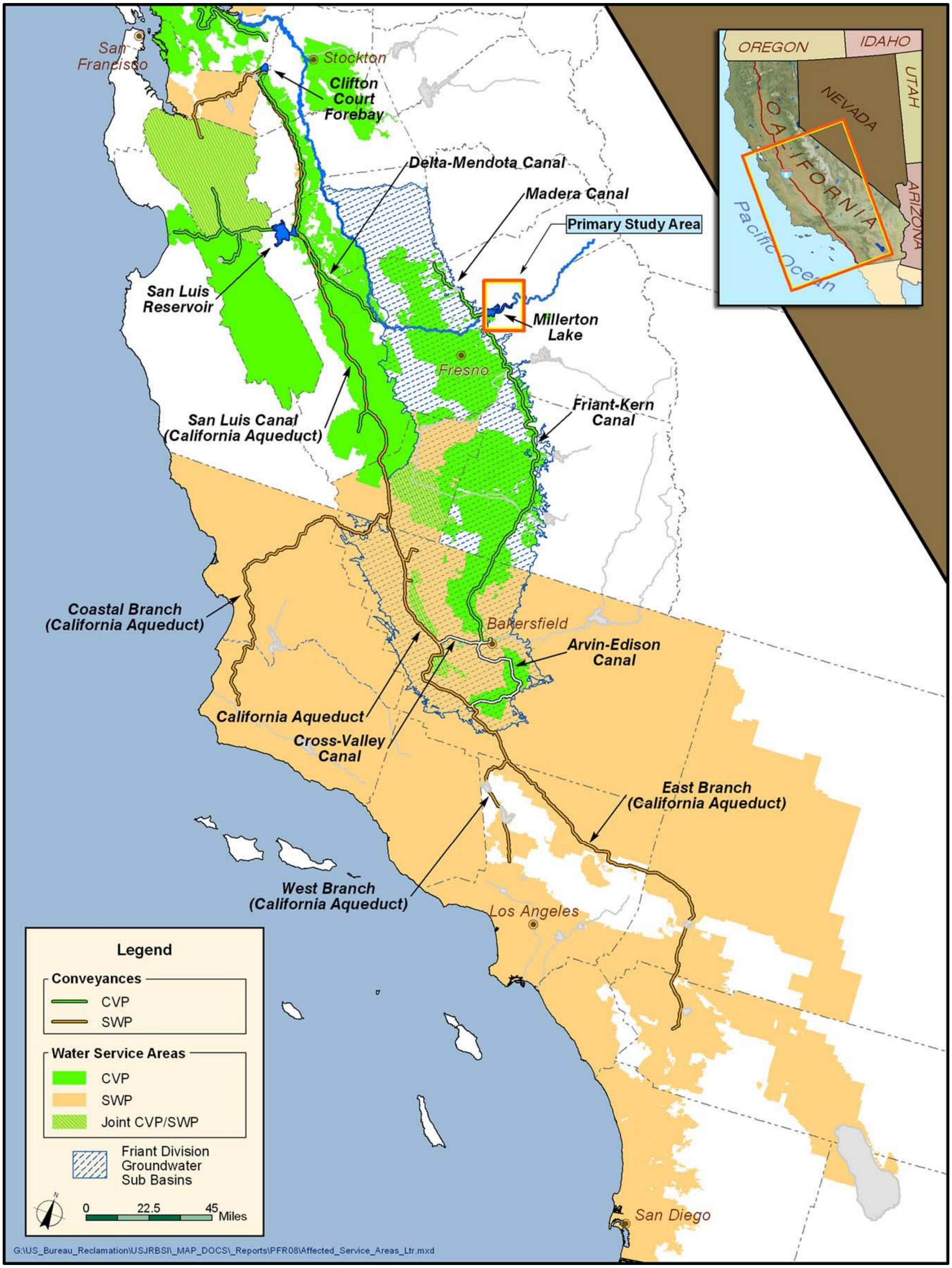


Figure S-2. Extended Study Area

Problems, Needs, and Opportunities

Major water and related resources problems and needs for the Investigation pertain to the San Joaquin River ecosystem and water supply reliability. Opportunities have been identified during the Investigation relative to flood damage reduction, hydropower, recreation, and water quality.

Water Supply Reliability Problems and Needs

Major factors affecting California's future water supplies include rapid population growth; agricultural-to-urban land use conversion; and climate change and related uncertainties, including Delta infrastructure, operations criteria, and ecosystem conditions. The California Water Plan Update 2005 states that California must invest in reliable, high-quality, sustainable and affordable water conservation; efficient water management; and development of water supplies.

The Friant Division of the CVP provides surface water supplies to many areas that also rely on groundwater, and was designed and is operated to support conjunctive water management to reduce groundwater overdraft in the eastern San Joaquin Valley. Although surface water deliveries from Friant Dam help reduce groundwater pumping and contribute to groundwater recharge, the groundwater basins in the eastern San Joaquin Valley remain in a state of overdraft in most years, which may ultimately reduce water use and irrigated acreage in the San Joaquin Valley.

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and CVP Friant Division contractors. After more than 18 years of litigation of this lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, a Stipulation of Settlement (Settlement) was reached. Through implementation of the Settlement, average total system water deliveries from Friant Dam are expected to be reduced by about 208 thousand acre-feet (TAF) per year, or approximately 15 to 19 percent of deliveries under existing conditions.

San Joaquin River Ecosystem Problems and Needs

Generally unhealthy ecosystem conditions in the San Joaquin River from Friant Dam to the Merced River have resulted from lack of reliable flows and poor water quality. The Settlement led to the inclusion of Settlement-stipulated releases from Friant Dam for river restoration as a without-project condition for the Investigation. The Restoration Goal of the Settlement is to provide continuous flows in the San Joaquin River at Friant Dam to sustain naturally reproducing Chinook salmon and other fish populations in the river. The ability to manage volumes of cold water and to release water from Friant Dam at suitable temperatures, and provide for Settlement flows during critical-low years, may be challenges to fully meeting the Restoration Goal of the Settlement.

Opportunities

Identified opportunities include potential improvement in the reduction of flood damages; additional hydropower generation capacity; recreation site development and water level management; and water quality improvements in the San Joaquin River and in water supplies delivered to urban areas.

Planning Objectives

On the basis of the identified water and related resources problems, needs, and opportunities, study authorizations, and other pertinent direction, including information contained in the August 2000 CALFED ROD, the following planning objectives were developed:

- Increase water supply reliability and system operational flexibility for agricultural, municipal and industrial (M&I), and environmental purposes in the Friant Division, other San Joaquin Valley areas, and other regions.

- Enhance water temperature and flow conditions in the San Joaquin River from Friant Dam to the Merced River in support of restoring and maintaining naturally reproducing and self-sustaining anadromous fish (i.e., Settlement reintroduced fall- and/or spring-run Chinook salmon).

Alternatives were formulated specifically to accomplish the planning objectives. To the extent possible, through pursuit of the planning objectives, alternatives also include features to help address the following opportunities:

- Improve management of flood flows at Friant Dam.
- Preserve and increase energy generation, and improve energy management in the study area.
- Preserve and increase recreation opportunities in the study area.
- Improve San Joaquin River water quality.
- Improve the quality of water supplies delivered to urban areas.

Specific planning constraints, considerations, and criteria were also established to help guide the Investigation planning process.

Formulation and Evaluation of Alternative Plans

Once water resources problems, needs, and opportunities have been identified, and planning objectives, constraints, considerations, and criteria have been developed, the next major elements of the plan formulation process are identifying management measures, and formulating alternative plans to meet the planning objectives.

Management Measures

A management measure is any structural or nonstructural action or feature that could address the planning objectives and satisfy the other planning constraints, considerations, and criteria. Alternative plans are formulated by combining the most applicable measures that address the planning objectives, and adding measures that address opportunities. Numerous management measures were identified to address the Investigation planning objectives and opportunities. Of the management measures identified, nine measures were retained specifically to address the planning objective of enhancing water temperature and flow conditions in the San Joaquin River, seven measures were retained specifically to address improving water supply reliability, and six measures were retained specifically to address the identified opportunities. Tables S-1 and S-2 summarize the management measures carried forward to address the planning objectives and opportunities, respectively.

Additionally, measures to increase groundwater storage that were retained in concept only are listed in Table S-1. Other measures retained in concept only are not discussed because they are either under evaluation in another study or have unspecified operations.

Table S-1. Management Measures Addressing Planning Objectives

MANAGEMENT MEASURES
Planning Objective: ***Enhance water temperature and flow conditions in the San Joaquin River***
Perform Reservoir Operations and Water Management
Balance water storage in Millerton Lake and new upstream reservoirs
Modify storage and release operations at Friant Dam
Increase Surface Water Storage in the Upper San Joaquin River Basin
Enlarge Millerton Lake by raising Friant Dam
Construct Temperance Flat RM 274 Reservoir
Construct Temperance Flat RM 279 Reservoir
Construct Fine Gold Reservoir
Construct Water Temperature Management Devices
Construct temperature control devices on Friant Dam canal outlets
Construct temperature control device on Friant Dam river outlet
Construct selective level intake structures on new upstream dams
Increase Groundwater Storage
Increase conjunctive management of water in the Friant Division *(retained in concept only)*
Construct and operate groundwater banks in the Friant Division *(retained in concept only)*
Planning Objective: ***Increase water supply reliability and system operational flexibility***
Perform Reservoir Operations and Water Management
Modify storage and release operations at Friant Dam
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division
Increase Surface Water Storage in the Upper San Joaquin River Basin
Enlarge Millerton Lake by raising Friant Dam
Construct Temperance Flat RM 274 Reservoir
Construct Temperance Flat RM 279 Reservoir
Construct Fine Gold Reservoir
Increase Groundwater Storage
Increase conjunctive management of water in the Friant Division *(retained in concept only)*
Construct and operate groundwater banks in the Friant Division *(retained in concept only)*
Increase Transvalley Conveyance Capacity
Construct Trans Valley Canal

Key:
CVP = Central Valley Project RM = river mile SWP = State Water Project

Table S-2. Management Measures Addressing Opportunities

MANAGEMENT MEASURES
Opportunity: Improve management of flood flows at Friant Dam
Increase flood storage space in or upstream from Millerton Lake
Opportunity: Preserve and increase energy generation and improve energy generation management
Modify existing or construct new generation facilities at Friant Dam canal outlets
Construct new hydropower generation facilities on retained new surface water storage measures
Extend Kerckhoff No. 2 tunnel around new surface water storage measures
Opportunity: Preserve and increase recreation opportunities in the study area
Replace or upgrade recreation facilities
Opportunity: Improve quality of water supplies delivered to urban areas
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division

Key:
CVP = Central Valley Project No. = number SWP = State Water Project

Refinement of Initial Alternatives

Combinations of retained measures formed various initial alternatives that were developed to address the planning objectives. Many measures that either were not well defined or were under study by others were retained in concept only and, therefore, were not explicitly defined for inclusion in alternative plans.

Further evaluation and comparison of initial alternatives was performed early during the plan formulation phase. Initial plan formulation efforts concluded that combining an enlargement of Millerton Lake with one of the other storage sites (Temperance Flat River Mile (RM) 274, Temperance Flat RM 279, or Fine Gold reservoirs) would not be effective because very limited additional water supply would be provided, and because of the effects to private property and recreation facilities. Thus, the Enlarge Millerton Lake management measure was not considered further in this PFR or the Investigation. On the basis of these evaluations, the following five refined initial alternatives were retained for further evaluation during plan formulation:

- Fine Gold Reservoir up to 380 TAF of new storage capacity (380 TAF) with pump-generating facility
- Fine Gold Reservoir up to 780 TAF of new storage capacity (780 TAF) with pump-generating facility
- Temperance Flat RM 279 Reservoir up to 430 TAF of new storage capacity (430 TAF) with extended Kerckhoff No. 2 tunnel
- Temperance Flat RM 279 Reservoir up to 690 TAF of new storage capacity (690 TAF) with extended Kerckhoff No. 2 tunnel
- Temperance Flat RM 274 Reservoir up to 1,260 TAF of new storage capacity (1,260 TAF) with extended Kerckhoff No. 2 tunnel

For each initial alternative, several configurations were formulated to assess the incremental costs and benefits that would result from additional storage, reservoir operations, multiple reservoir elevations, and water temperature management, where relevant.

The five surface water storage measures in the refined initial alternatives were evaluated in a two-step process and two were retained for development into alternative plans (when combined with other retained measures) to be further evaluated in the PFR. In the first step, three of the five measures, Temperance Flat RM 274 Reservoir (1,260 TAF), Temperance Flat RM 279 Reservoir (690 TAF), and Fine Gold Reservoir (780 TAF) were retained for further evaluation in the Investigation. The first step evaluation was based on technical evaluations performed during initial plan formulation for incremental cost effectiveness at a range of potential sizes. At a lesser incremental cost, the larger size storage measures provide more operational flexibility, greater increases in water supply reliability, and greater ability to manage cold water supplies for release to the San Joaquin River.

The three remaining surface water storage measures retained through the first step were comparatively evaluated across sites in the second step. The second step evaluations were based on the relative ability of the three remaining surface water storage measures to meet each of the four criteria from the 1983 U.S Water Resources Council *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), including (1) effectiveness, (2) efficiency, (3) acceptability, and (4) completeness.

Based on this second step evaluation, as seen in Table S-3, the Fine Gold Reservoir (780 TAF) surface water storage measure was considered inferior to the Temperance Flat RM 274 and RM 279 surface water storage measures. This surface water storage measure provides fewer water supply and cold water management benefits (the primary purposes), and results in more reservoir area environmental consequences. Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF) rank consistently higher than Fine Gold Reservoir (780 TAF), as shown in Table S-3.

The Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF) surface water storage measures were retained for alternative plans. Further evaluations of Temperance Flat RM 279 Reservoir (690 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) were performed and are described in this PFR.

Table S-3. Surface Water Storage Measures Comparison and Selection Summary

Criteria	Temperance Flat RM 279 Reservoir (690 TAF)	Fine Gold Reservoir (780 TAF)	Temperance Flat RM 274 Reservoir (1,260 TAF)
Effectiveness	Medium to High	Low to Medium	High
Efficiency	Medium	Low to Medium	Medium
Acceptability	Medium	Low to Medium	Low to Medium
Completeness	Medium to High	Medium	Medium to High
COMBINED RANKING[1]	Medium	Low to Medium (LOWEST)	Medium to High (HIGHEST)
STATUS	RETAINED FOR FURTHER CONSIDERATION	NOT RETAINED FOR FURTHER CONSIDERATION[2]	RETAINED FOR FURTHER CONSIDERATION

Notes:
[1] In developing a combined ranking, the effectiveness criterion was given twice the weight compared to each of the efficiency, acceptability, and completeness criteria.
[2] The Fine Gold Reservoir (780 TAF) surface water storage measure was not retained for further consideration because it is considered inferior to the Temperance Flat RM 279 and RM 274 surface water storage measures. This surface water storage measure would provide less water supply and cold water management benefits, and result in more reservoir area environmental consequences.

Key:
RM = river mile
TAF = thousand acre-feet

Scale
Less Desirable — More Desirable

Features and Potential Effects of Alternative Plans

In addition to surface water storage measures, the alternative plans consist of other retained management measures discussed previously, such as operations, conveyance features, temperature management features, energy features, etc. Many of these measures are included in all action alternative plans described in this PFR. Measures to increase transvalley conveyance capacity are included in some alternative plans. In addition to the No-Action/No-Project Alternative, four groupings of alternative plans are addressed in this PFR:

- Temperance Flat RM 274 Reservoir
- Temperance Flat RM 274 Reservoir and Trans Valley Canal
- Temperance Flat RM 279 Reservoir
- Temperance Flat RM 279 Reservoir and Trans Valley Canal

The effects of the four groupings of alternative plans are determined in comparison to the No-Action/No-Project Alternative. For each alternative plan grouping, several operational scenarios were formulated and evaluated to assess the sensitivity of accomplishments for the alternatives to varying operational strategies and assumptions reflecting various management measures.

For all operations scenarios, the primary focus is increasing water supply reliability and enhancing water temperature conditions in the San Joaquin River. To the extent possible, without impacting the ability to meet the planning objectives, the alternative plans also would be managed to improve opportunities for hydropower generation and recreation. Potential flood damage reduction benefits would be achieved through the incidental effect of additional available storage space. Major components, accomplishments, potential benefits, and estimated costs of the four groupings of alternative plans and the No-Action/No-Project Alternative are summarized in Table S-4.

Operations scenarios vary, in part, on the degree to which Friant Dam would be operated in a coordinated manner with SWP facilities and other CVP facilities (operations integration). The level of integration, in combination with additional storage, has the potential to affect the geographic extent, type, and magnitude of potential water supply benefits that could be achieved with alternative plans for each reservoir site. Operations integration with the SWP and/or CVP would include coordinated management of water supplies in Millerton Lake and new storage with project operations of SOD facilities. This would involve delivery of water supplies to the Friant Division in combination with water exchanges between the Friant Division and SWP and/or other CVP service areas. Some Delta water supplies diverted to San Luis Reservoir would be delivered to water users in the Friant Division, while San Joaquin water would be stored in the new reservoir. Additional available storage space would accrue in San Luis Reservoir during wet periods, allowing export of additional Delta supplies. Accumulated San Joaquin supplies would be provided to SWP and/or CVP SOD water users through exchange at a later time.

Table S-4. Summary of Potential Alternative Plan Accomplishments, Potential Benefits, and Estimated Costs

Item	No-Action/ No-Project Alternative	Temperance Flat RM 274 Reservoir		Temperance Flat RM 274 Reservoir with Trans Valley Canal		Temperance Flat RM 279 Reservoir		Temperance Flat RM 279 Reservoir with Trans Valley Canal	
		Operations Integration							
		SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant
Physical Characteristics									
Additional Storage Capacity (TAF)	0	1,260				690			
Additional Conveyance Capacity (cfs)	0	N/A		1,000		N/A		1,000	
Accomplishments									
Dry and Critical Year Increase in Delivery (TAF)[1]	0	168	171	254	230	120	103	137	126
Long-Term Avg. Increase in Delivery (TAF)[1]	0	180	158	240	177	132	107	158	120
Increase in Cold-Water Volume in All Year-Types	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Replacement of Impacted Hydropower Generation (%)	N/A	97%	98%	94%	NE	100%	100%	NE	NE
Available Flood Space at 90% Exceedence (TAF)	170	301	285	210	257	191	191	172	180
Potential Annual Benefits and Estimated Costs ($ million)[2]									
Agricultural Water Supply Reliability	$0	$55.2	$50.4	$59.1	$50.4	$44.4	$40.0	$45.0	$40.0
M&I Water Supply Reliability	$0	$57.3	$74.2	$81.9	$93.2	$36.5	$46.3	$41.2	$57.1
M&I Water Quality	$0	$8.2	$7.4	$16.4	$15.2	$7.5	$7.4	$15.7	$13.0
Flood Damage Reduction	$0	$2.3	$2.1	$1.4	$1.9	$0.7	$0.7	$0.1	$0.3
Net Hydropower Generation[3]	$0	-$0.4	-$0.3	-$1.2	-$0.3	$0.3	$0.3	$0.3	$0.3
Recreation	$0	$7.3	$7.3	$7.3	$7.3	$4.0	$4.0	$4.0	$4.0
Emergency Water Supply	$0	$14.6	$14.5	$23.8	$22.0	$11.5	$11.1	$15.8	$15.0
Ecosystem	$0	$24.5	$24.5	$24.5	$24.5	$24.5	$24.5	$24.5	$24.5
Total Potential Monetary Benefits ($million)	**$0**	**$169.0**	**$180.1**	**$213.2**	**$214.2**	**$129.5**	**$134.4**	**$146.6**	**$154.2**
Total Estimated Capital Cost ($million)	**$0**	**$3,358**		**$4,045**		**$2,962**		**$3,662**	
Total Estimated Annual Cost ($million)[4]	**$0**	**$169.1**		**$204.1**		**$149.7**		**$185.2**	
Potential Net Benefits ($million)	**N/A**	**-$0.2**	**$11.0**	**$9.1**	**$10.2**	**-$20.2**	**-$15.3**	**-$38.6**	**-$31.0**
Preliminary Benefit-Cost Ratio	**N/A**	**1.00**	**1.06**	**1.04**	**1.05**	**0.87**	**0.90**	**0.79**	**0.83**

Notes:
General: All alternative plans listed in this table assume available transvalley conveyance capacity in Shafter-Wasco Pipeline, Cross Valley Canal, and Arvin-Edison Canal.
General: Potential benefits for alternative plans listed in this table are based on the Millerton Baseline reservoir balancing option.
General: All costs and benefits are preliminary and subject to revision in the Feasibility Report.
[1] Increase) in water supply deliveries compared to the No-Action/No-Project Alternative. Dry and critical years as defined by the Sacramento River hydrologic index.
[2] Based on October 2006 price levels.
[3] Net hydropower generation benefits include hydropower generation in the primary study area and minor effects to hydropower generation in the CVP/SWP system.
[4] Based on 4-7/8 discount rate and 100-year period of analysis.

Key:

Avg. = average
cfs = cubic feet per second
CVP = Central Valley Project
M&I = municipal and industrial
N/A = not applicable
NE = not estimated
RM = river mile
SWP = State Water Project
TAF = thousand acre-feet

No-Action/No-Project

Under the No-Action/No-Project Alternative, the Federal Government and the State would take no additional action toward implementing a specific plan to enhance water temperature and flow conditions in the San Joaquin River; address growing water supply reliability issues in California; or address threats of flooding along the San Joaquin River, California's demand for electricity, growing demands for water-oriented recreation, or improving water quality.

Temperance Flat RM 274 Reservoir

Temperance Flat RM 274 Reservoir would be formed by a dam in the upstream portion of Millerton Lake at RM 274. At the top of active storage elevation of 985 feet above mean sea level (elevation 985), the reservoir would provide about 1,260 TAF of additional storage. Water temperature management measures include a selective level intake structure on the main dam and temperature control devices on Friant Dam. The alternative plans also include features to mitigate the loss of generation from the Kerckhoff Project powerhouses. Temperance Flat RM 274 Reservoir alternative plans were evaluated under several distinct operations scenarios, which vary according to the extent of operations integration, available transvalley conveyance, and reservoir balancing. The primary operational focus is increasing water supply reliability and enhancing water temperature conditions in the San Joaquin River. Figure S-3 shows the extent of Temperance Flat RM 274 Reservoir and power features, and affected features in the reservoir area.

Temperance Flat RM 274 Reservoir with Trans Valley Canal

This grouping of alternative plans is the same as described for the Temperance Flat RM 274 Reservoir alternative plans, with an increased transvalley conveyance capacity through construction of a Trans Valley Canal. The Trans Valley Canal would have a conveyance capacity of 1,000 cubic feet per second (cfs), and could have several potential alternative configurations.

Temperance Flat RM 279 Reservoir Alternative Plans

Temperance Flat RM 279 Reservoir would be formed by a dam in the upstream portion of Millerton Lake at RM 279. At the top of active storage elevation of 985, the reservoir would provide about 690 TAF of additional storage. Potential water temperature management measures and features to mitigate the loss of generation from the Kerckhoff Project powerhouses are also included, and a variety of operations scenarios were considered (similar to the Temperance Flat RM 274 Reservoir alternative plans). Figure S-4 shows the extent of Temperance Flat RM 279 Reservoir and power features, and affected features in the reservoir area.

Temperance Flat RM 279 Reservoir with Trans Valley Canal

This grouping of alternative plans is the same as described for the Temperance Flat RM 279 Reservoir alternative plans, with an increased transvalley conveyance capacity via a Trans Valley Canal, with the same capacity and alignment assumptions as described previously.

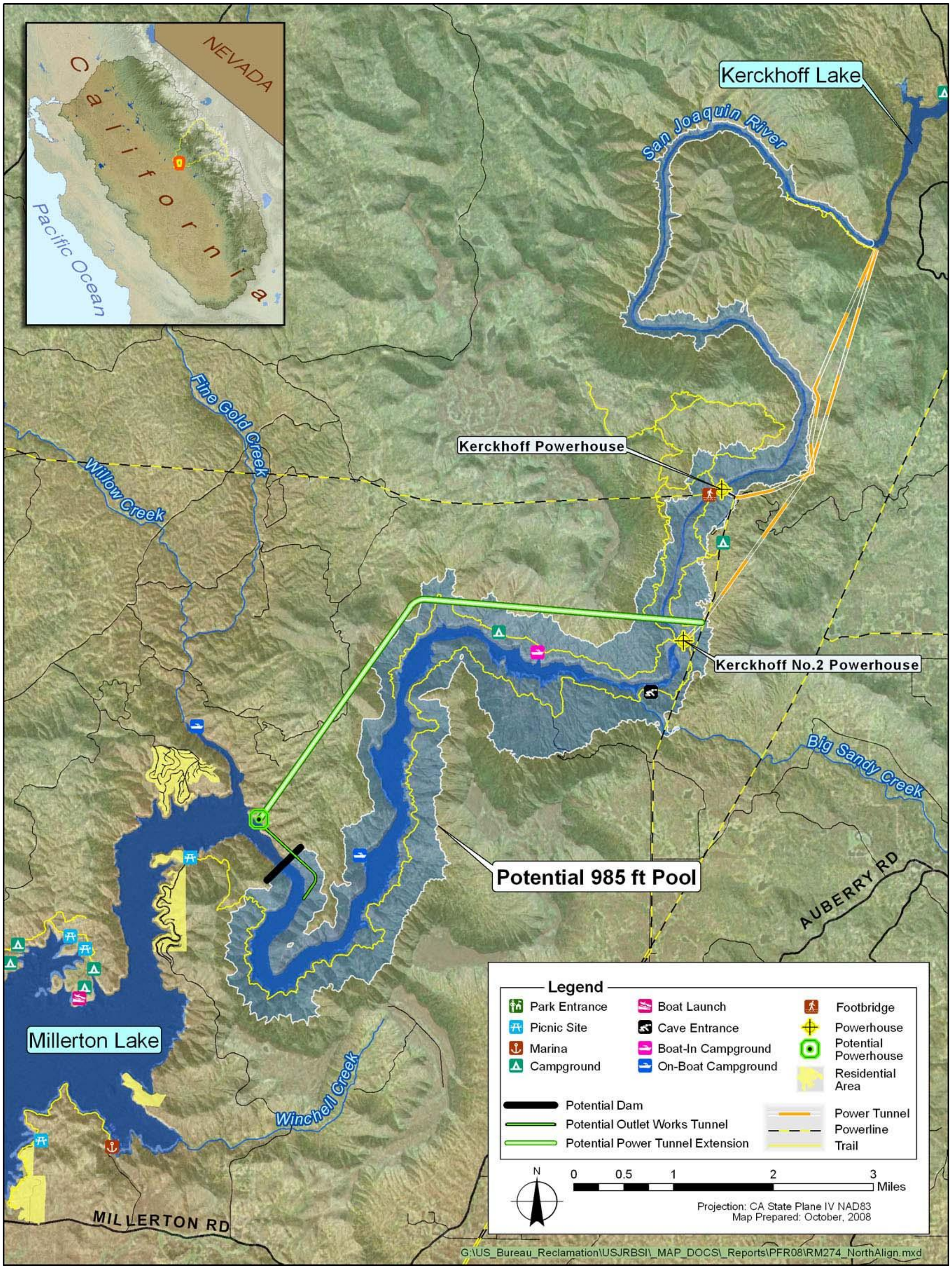


Figure S-3. Potential Temperance Flat RM 274 Reservoir

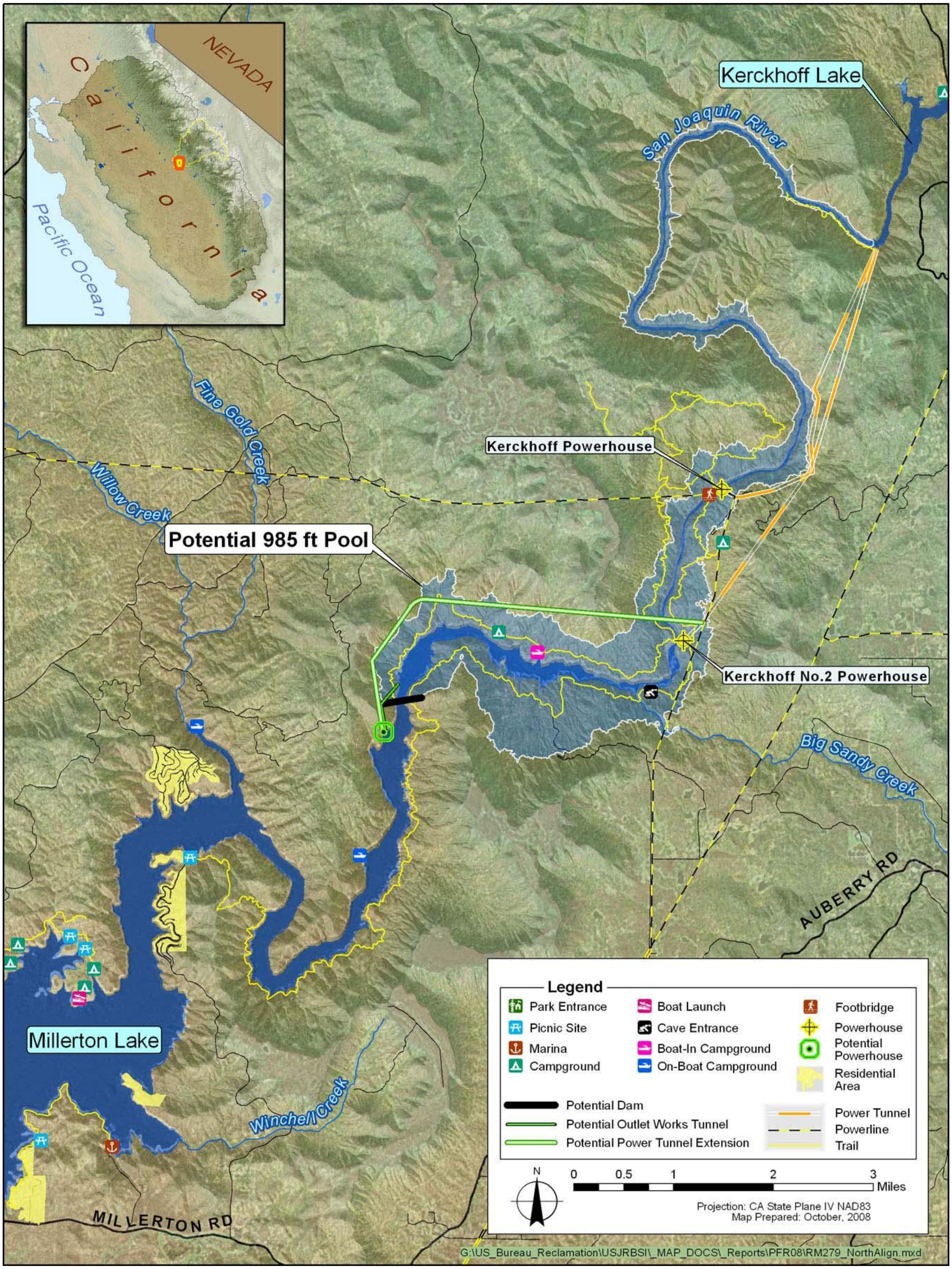


Figure S-4. Potential Temperance Flat RM 279 Reservoir

Comparison of Alternative Plans

Table S-4, shown previously, summarizes accomplishments, potential benefits, and estimated costs for the alternative plans that had the highest potential monetary benefits within each grouping. Estimates of potential net benefits and benefit-cost ratios are preliminary and subject to further refinement, but are useful for comparison purposes. Temperance Flat RM 274 Reservoir operated for SWP and Friant integration has the greatest preliminary potential net benefits and highest preliminary benefit cost-ratio.

Table S-5 compares the groupings of alternative plans for the four P&G planning criteria. Alternatives that include Temperance Flat RM 274 Reservoir rank highest in meeting the planning criteria.

Table S-5. Summary of Alternative Plan Comparison Related to Planning Criteria

CRITERION	No-Action/ No-Project Alternative	Temperance Flat RM 274 Reservoir	Temperance Flat RM 274 Reservoir with Trans Valley Canal	Temperance Flat RM 279 Reservoir	Temperance Flat RM 279 Reservoir with Trans Valley Canal
Effectiveness	N/A	High	High	Medium	Medium
Enhance water temperature and flow conditions in the San Joaquin River	N/A	High	High	Medium	Medium
Increase water supply reliability and system operational flexibility	N/A	High	High	Medium	Medium
Efficiency	N/A	High	High	Medium	Medium
Acceptability	N/A	Medium	Medium	High	High
Completeness	N/A	High	Medium	High	Medium
COMBINED RANKING[1]	**N/A**	**HIGH**	**HIGH**	**MEDIUM**	**MEDIUM**

Note:
[1] In developing a combined ranking, the effectiveness criterion was given twice the weight compared to each of the efficiency, acceptability, and completeness criteria.
Key:
N/A = not applicable
RM = river mile

Table S-6 summarizes how well alternative plans address planning objectives and opportunities, and meet planning constraints and considerations. All alternative plans (except the No-Action/No-Project Alternative) are formulated to address the planning objectives for the Investigation, and provide benefits associated with the opportunities to varying degrees (see Table S-4). At this stage in the planning process, all alternative plans meet planning constraints and considerations identified for the Investigation. Alternatives that include Temperance Flat RM 274 Reservoir rank highest in addressing the planning objectives and meeting planning constraints and criteria.

Table S-6. Summary Comparison of Alternative Plans Related to Planning Objectives, Opportunities, Constraints, and Considerations

Planning Objectives, Constraints, and Considerations	No-Action/ No-Project Alternative	Temperance Flat RM 274 Reservoir		Temperance Flat RM 274 Reservoir with Trans Valley Canal		Temperance Flat RM 279 Reservoir		Temperance Flat RM 279 Reservoir with Trans Valley Canal	
		Operations Integration Option							
		SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant
OBJECTIVES									
Enhance water temperature and flow conditions in the San Joaquin River									
Dry Year Increase in Cold-Water Volume Below 52°F (September to December) (TAF)	0	119	119	134	NE	61	63	NE	NE
Dry Year Increase in Cold-Water Volume Below 60°F (September to December) (TAF)	0	184	184	205	NE	123	116	NE	NE
Long-Term Avg. Increase in Cold-Water Volume Below 52°F (September to December) (TAF)	0	365	359	396	NE	183	178	NE	NE
Long-Term Avg. Increase in Cold-Water Volume Below 60°F (September to December) (TAF)	0	553	543	596	NE	313	305	NE	NE
Ability to Provide Restoration Flows to the San Joaquin River Below Friant Dam During Critical Years	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Increase Water Supply Reliability and System Operational Flexibility									
Dry and Critical Year Change in Delivery (TAF)	0	168	171	254	230	120	103	137	126
Long-Term Avg. Change in Delivery (TAF)	0	180	158	240	177	132	107	158	120
Operational Flexibility	Very Low	High	High	High	High	Medium	Medium	Medium	Medium
ADDRESSES PLANNING OPPORTUNITIES	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MEETS PLANNING CONSTRAINTS	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MEETS PLANNING CONSIDERATIONS	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
COMBINED RANKING FOR ADDRESSING OBJECTIVES, AND MEETING PLANNING CONSTRAINTS AND CRITERIA	**VERY LOW**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**MEDIUM**	**MEDIUM**	**MEDIUM**	**MEDIUM**

Key:
ºF = degrees Fahrenheit
Avg. = average
cfs = cubic feet per second
CVP = Central Valley Project
M&I = municipal and industrial
N/A = not applicable
NE = not estimated
RM = river mile
SWP = State Water Project
TAF = thousand acre-feet

Storage Site Selection

The Temperance Flat RM 274 Reservoir grouping of alternative plans is retained for further evaluation in the feasibility phase of the Investigation, and the Temperance Flat RM 279 Reservoir grouping of alternative plans will not be retained for further evaluation for the following major reasons:

- Temperance Flat RM 274 Reservoir alternative plans have greater benefits, greater net benefits, and a higher benefit-cost ratio compared to the Temperance Flat RM 279 Reservoir alternative plans.
- Most of the Temperance Flat RM 274 Reservoir alternative plans provide positive net benefits, but Temperance Flat RM 279 Reservoir alternative plans do not provide positive net benefits.
- Temperance Flat RM 274 Reservoir alternative plans address the planning objectives of enhancing water temperature and flow conditions in the San Joaquin River, and increasing water supply reliability and operational flexibility to a greater degree than Temperance Flat RM 279 Reservoir alternative plans.
- Based on comparing the alternative plans according to the four P&G criteria, Temperance Flat RM 274 Reservoir alternative plans ranked higher than Temperance Flat RM 279 Reservoir alternative plans.

The Trans Valley Canal will also not be retained for further evaluation in the feasibility phase of the Investigation. The ranking of alternative plans and benefit-cost ratios are not substantially affected by including the Trans Valley Canal with the Temperance Flat reservoirs, and the canal is not needed to achieve a positive benefit-cost ratio. The Trans Valley Canal is a potentially beneficial increment that could be added to an alternative at a later time.

Implementation Considerations

Potential project purposes include agricultural water supply, M&I water supply and water quality, ecosystem enhancement, hydropower, recreation, and flood damage reduction. A non-Federal sponsor has not been officially identified at this stage of the Investigation, but potential non-Federal sponsors include DWR and/or the Friant Water Users Authority. Through operations integration, benefits could also accrue to a larger geographic region, including the CVP and SWP SOD service areas. Construction of a new reservoir in the upper San Joaquin River basin would be subject to the requirements of numerous Federal, State, and local laws, policies, and regulations. Reclamation would need to obtain various permits and meet regulatory requirements before beginning any project construction, and comply with a number of environmental regulatory requirements as part of the NEPA and CEQA compliance process.

Preliminary Cost Allocation

A preliminary cost allocation was developed for Temperance Flat RM 274 Reservoir. A cost allocation for the recommended plan will be included in the Feasibility Report. Cost allocations are made for Federal water resources projects to derive an equitable distribution of project costs among authorized project purposes, or those purposes proposed for authorization, in accordance with existing law. The three basic steps associated with cost allocation are (1) identifying costs to be allocated, (2) allocating costs to project purposes; and (3) determining reimbursability.

At this stage of the Investigation, single-purpose alternative projects have not been developed and alternative costs have not been determined. As such, a full Separable Cost - Remaining Benefits (SCRB) analysis cannot be presented and the Alternative Justifiable Expenditure (AJE) approach is used for this preliminary cost allocation. The AJE method is a modified SCRB method used in situations when derivation of the separable costs is not feasible.

For the preliminary cost allocation, the benefit categories are grouped into five purposes supported by existing legislation. The two primary project purposes for cost allocation are water supply and fish and wildlife enhancement. Flood damage reduction, recreation, and hydropower generation are considered secondary purposes. Once costs are allocated to appropriate purposes, they can be apportioned to the Federal government and non-Federal sponsor(s) based on specific project authorization and/or established Federal cost-sharing laws and regulations. Federal costs are designated as either reimbursable or non-reimbursable. Non-reimbursable costs are those that can be borne by the Federal government. Costs allocated to agricultural and M&I water supply and hydropower purposes are fully reimbursable based on existing legislation.

Specific costs have been identified only for the fish and wildlife enhancement purpose associated with temperature management features on Friant Dam and Temperance Flat RM 274 Dam. All other costs are considered joint costs. The hydropower feature costs are not considered specific costs because the features are necessary for replacement of affected generation due to inundation of the Kerckhoff Project powerhouses within the alternative footprint. The recreation feature costs are not considered specific costs because the features are associated with replacement of the existing recreation facilities that would be inundated by the alternative.

Table S-7 provides the results of the cost allocation procedure based on the AJE approach. The annualized capital costs, annual O&M, and annual net decrease in hydropower generation value total $169.4 million. Based upon this procedure, the largest share of total annual costs of $169.4 million is allocated to M&I water supply reliability, followed by agricultural water supply reliability. A large portion of annual project costs is anticipated to be Federal reimbursable.

Table S-7. Preliminary Cost Allocation for Temperance Flat RM 274 Reservoir Alternative Based on an Alternative Justifiable Expenditure Approach

Purpose	Annual Benefits	Specific Costs	Remaining Benefits[1]	% Distribution of Remaining Benefits	Allocated Joint Costs[2]	Total Allocated Costs[3]	Overall % Cost Allocation
Water Supply	$146.5	$0	$146.5	88.0%	$136.8	$136.8	80.8%
Agricultural Water Supply Reliability	$50.4	$0	$50.4	30.3%	$47.1	$47.1	27.8%
M&I Water Supply Reliability	$74.2	$0	$74.2	44.6%	$69.3	$69.3	40.9%
Emergency Water Supply	$14.5	$0	$14.5	8.7%	$13.5	$13.5	8.0%
M&I Water Quality	$7.4	$0	$7.4	4.4%	$6.9	$6.9	4.1%
Fish and Wildlife Enhancement	$24.5	$13.9	$10.6	6.4%	$9.9	$23.8	14.0%
Ecosystem (Water Temperature)	$24.5	$13.9	$10.6	6.4%	$9.9	$23.8	14.0%
Flood Damage Reduction	$2.1	$0	$2.1	1.3%	$2.0	$2.0	1.2%
Recreation	$7.3	$0	$7.3	4.4%	$6.8	$6.8	4.0%
Hydropower Generation	$0	$0	$0	0.0%	$0	$0	0.0%
Total	$180.4	$13.9	$166.5	100.0%	$155.5	$169.4	100.0%

Notes:
General. Cost and benefit information presented is based on annual values.
General. Values may not sum to total due to rounding.
1 Remaining benefits = Benefits less specific costs, but must be greater than $0.
2 Total project costs less sum of specific costs, times share of remaining benefits.
3 Sum of specific costs and allocated joint costs.

Key:
% = percent
M&I = municipal and industrial

Study Management, Public Involvement, and Outreach

The Study Management Team (SMT) consists of Project Managers from Reclamation, DWR, the consultant team, and members of technical teams, including water operations, environmental resources, economics, engineering, hydropower, and temperature. The SMT directs work performed by the technical teams, coordinates results into the overall study, and directs public involvement activities.

A public involvement plan was initiated at the beginning of the Investigation that is designed to provide meaningful opportunities for stakeholder participation and to inform the public. Information dissemination methods include Investigation newsletters, Websites, and media relations. Since the beginning of the study, Investigation team members have provided periodic updates through the following outreach activities:

- Structured series of interactive public meetings and workshops
- Briefings for governmental and nongovernmental agencies and coalitions, and briefings for tribal representatives
- Coordination with local water resources management groups
- Coordination with agencies
- Tours of Millerton Lake and portions of the upper San Joaquin River
- Distribution of informative brochures, fact sheets, and documents that provided background and updates on the Investigation's progress and distribution of Investigation documents via a Website

Continued public and stakeholder involvement will be a critical component during the final phase of the Investigation, which will culminate with release of the Final Feasibility Report and its accompanying EIS/EIR.

Findings and Future Actions

Findings regarding storage site selection, Federal and State interest, and uncertainties and refinements, and future actions are summarized below.

Storage Site Selection

The Temperance Flat RM 274 Reservoir grouping of alternative plans is retained for further evaluation in the feasibility phase of the Investigation, and the Temperance Flat RM 279 Reservoir grouping of alternative plans will not be retained for further evaluation. The Trans Valley Canal will also not be retained for further evaluation in the feasibility phase of the Investigation.

Federal and State Interest

This PFR concludes there is a Federal and State interest in continuing the Investigation to determine the feasibility of a project in the Upper San Joaquin River Basin to meet the objectives associated with M&I, agricultural, and environmental water supply reliability; anadromous fish survival; power; incremental flood damage reduction; and recreation. The degree and magnitude of the Federal and State interest in a potential project will be refined and quantified in the Feasibility Report, EIS/EIR, and supporting documentation. Alternative plans have been identified that result in positive net National Economic Development (NED) benefits and significant positive regional economic effects. To date, there has been strong local, regional, State, and Federal interest in a potential project to address the identified planning objectives and opportunities.

Uncertainties and Refinements

Various uncertainties associated with the Investigation include hydrology and climate change, system operations facilities and constraints, cost estimates, and alternative refinements. Some key areas of uncertainty potentially affecting operational analyses for the Investigation include implementation of the San Joaquin River Restoration Program (SJRRP) on the operations of Friant Dam and the San Joaquin River, and changes in Delta export regulations or policies resulting from the pending Operations Criteria and Plan (OCAP) biological opinions, new Endangered Species Act (ESA) listings, or recommendations from various planning processes for the Delta. As uncertainties regarding some of these plans and policies are resolved during the next phase of study, assumptions will be refined, which may change the basis of comparison for or magnitude of the accomplishments of the alternative plans.

As the Investigation progresses, Temperance Flat RM 274 Reservoir alternative plans will likely evolve as technical studies are refined and additional information related to potential benefits, effects, and estimated costs is obtained, developed, and evaluated. Further, additional environmental analyses will be completed, which will inform the nature of potential mitigation and/or enhancement measures. Additional comparisons will be conducted for the alternative plans during the feasibility study and included in the Final Feasibility Report and accompanying EIS/EIR. The comparisons in the next phase of the Investigation will provide the basis for selection of a Recommended Plan. At that time, implementation responsibilities and an updated cost allocation will be developed and identified for that plan.

Future Actions

The Draft Feasibility Report and EIS/EIR are scheduled for 2009. It is estimated that the Final Feasibility Report and EIS/EIR would be completed in 2010. Major future actions required to complete the Investigation include:

- Completing environmental studies, including a detailed comparison of the environmental impacts of the alternative plans with the No-Action/No-Project Alternative for National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA), process documentation, agency coordination, and consultation.
- Completing identification of potential effects (adverse and beneficial) and mitigation features of the alternative plans.
- Developing detailed designs, cost estimates, potential benefits, and cost allocation, and defining the rationale for, and selection of, a Recommended Plan.
- Identifying a non-Federal cost share partner.
- Determining financial feasibility through ability-to-pay analyses of Federal and non-Federal project partners.
- Preparing a Federal decision document that will incorporate the NEPA and CEQA compliance documentation by reference.

Plan Formulation Report

Upper San Joaquin River Basin Storage Investigation

Prepared by

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

U.S. Department of the Interior
Bureau of Reclamation

October 2008

Contents

Tables

Figures

Abbreviations and Acronyms

ºC	degrees Celsius
ºF	degrees Fahrenheit
AB	Assembly Bill
ADA	Americans with Disabilities Act
AE	Arvin-Edison
AJE	Alternative Justifiable Expenditure
ALP	Alternative Licensing Process
Bay Area	San Francisco Bay Area
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BDCP	Bay Delta Conservation Plan
BDPAC	California Bay-Delta Public Advisory Committee
BLM	U.S. Department of the Interior, Bureau of Land Management
CAA	Federal Clean Air Act
CAAA	Federal Clean Air Act Amendments of 1990
CalEPA	California Environmental Protection Agency
CALFED	CALFED Bay-Delta Program
CALSIM	CALSIM II
CBDA	California Bay-Delta Authority
CDEC	California Data Exchange Center
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHABA	Committee of Hearing, Bio Acoustics, and Bio Mechanics
CMP	Common Model Package
CNDDB	California Natural Diversity Database
CNEL	community noise equivalent level
CNPS	California Native Plant Society
CO	carbon monoxide
Comprehensive Study	Sacramento and San Joaquin River Basins Comprehensive Study
CVC	Cross Valley Canal
CVP	Central Valley Project

CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
CWA	Clean Water Act
Delta	Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DHAC	Division of Hydropower Administration and Compliance
DO	dissolved oxygen
DPR	California Department of Parks and Recreation
DRMS	Delta Risk Management Strategy
DSM2	Delta Simulation Model
DWR	California Department of Water Resources
EFH	essential fish habitat
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
elevation xxx	elevation in feet above mean sea level
EPA	U.S. Environmental Protection Agency
EQ	Environmental Quality
ESA	Endangered Species Act
FCRPA	Federal Cave Resources Protection Act
FERC	Federal Energy Regulatory Commission
FIP	Federal Implementation Plan
FPA	Friant Power Authority
FTA	Federal Transit Administration
FWCA	Fish and Wildlife Coordination Act
FWUA	Friant Water Users Authority
GAMA	Groundwater Ambient Monitoring and Assessment
GIS	geographic information system
HEC-FDA	Hydrologic Engineering Center – Flood Damage Analysis
hp	horsepower
IAIR	Initial Alternatives Information Report
IDC	interest during construction
Investigation	Upper San Joaquin River Basin Storage Investigation
IRWMP	Integrated Regional Water Management Plan
ITA	Indian Trust Assets
I-O	input-output
kW	kilowatt

LCPSIM	Least Cost Planning Simulation Model
LEDPA	least environmentally damaging practicable alternative
LTGen	LongTermGen
M&I	municipal and industrial
MAF	million acre-feet
MBTA	Migratory Bird Treaty Act
mg/L	milligrams per liter
msl	mean sea level
MW	megawatt
MWDSC	Metropolitan Water District of Southern California
NAAQS	national ambient air quality standard
NAHC	Native American Heritage Commission
NAWQA	National Water Quality Assessment
NED	National Economic Development
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOD	north-of-Delta
NOI	Notice of Intent
NOP	Notice of Preparation
NPPA	Native Plant Protection Act
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRDC	Natural Resources Defense Council
NRHP	National Register of Historic Places
O&M	operations and maintenance
O_3	ozone
OCAP	Operations Criteria and Plan
OSE	Other Social Effects
P&G	Federal Principles and Guidelines for Water and Related Land Resources Implementation Studies
PEIS/EIR	Programmatic Environmental Impact Statement/Environmental Impact Report
PFR	Plan Formulation Report
PG&E	Pacific Gas and Electric Company
PM^{10}	particulate matter
$PM^{2.5}$	fine particulate matter
PMT	Program Management Team

PPV	peak particle velocity
RCC	roller-compacted concrete
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
The Reclamation Board	The Reclamation Board of the State of California
RED	Regional Economic Development
RHA	Rivers and Harbors Act
RM	river mile
RMP	Resource Management Plan
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SCRB	Separable Cost - Remaining Benefits
SCE	Southern California Edison Company
Secretary	Secretary of the Interior
Settlement	Stipulation of Settlement
SIP	State Implementation Plan
SJRA	San Joaquin River Agreement
SJRGA	San Joaquin River Group Authority
SJRGMA	San Joaquin River Gorge Management Area
SJRRP	San Joaquin River Restoration Program
SJVAB	San Joaquin Valley Air Basin
SJVAPCD	San Joaquin Valley Air Pollution Control District
SLIS	selective level intake structure
SMT	Study Management Team
SO_2	sulfur dioxide
SOD	south-of-Delta
SP15	South of Path 15
SRA	State Recreation Area
SRWQM	Sacramento River Water Quality Model
State	State of California
SW	Shafter-Wasco
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TCD	temperature control device
TDS	total dissolved solids
TMDL	total maximum daily load
UFAS	Uniform Federal Accessibility Standards

USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAMP	Vernalis Adaptive Management Program
VdB	vibration decibel
W2	CE-QUAL-W2
WAM	Water Analysis Module
Williamson Act	California Land Conservation Act of 1965
WQCP	Water Quality Control Plan
WRC	U.S. Water Resources Council
WUE	water use efficiency

Chapter 1
Introduction

The Upper San Joaquin River Basin Storage Investigation (Investigation) is a feasibility study by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), and the California Department of Water Resources (DWR). The purpose of the Investigation is to determine the type and extent of Federal, State, and regional interests in a potential project(s) in the upper San Joaquin River watershed to expand water storage capacity; improve water supply reliability and flexibility of the water management system for agricultural, urban, and environmental uses; and enhance San Joaquin River water temperature and flow conditions to support anadromous fish restoration efforts.

The Investigation is one of five surface water storage studies recommended in the CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/EIR) Record of Decision (ROD) of August 2000. Previous studies in support of the CALFED PEIS/EIR considered more than 50 surface water storage sites throughout California and recommended more detailed study of the five identified in the ROD (CALFED, 2000a). Reclamation and DWR are coordinating the Investigation with the California Bay-Delta Public Advisory Committee (BDPAC), which provides advice to the Secretary of the Interior (Secretary) regarding implementation of CALFED, and the California Bay-Delta Authority (CBDA), which provides general oversight and coordination of all CALFED activities.

Progress and results of the Investigation are being documented in a series of interim reports that will culminate in a Feasibility Report and an Environmental Impact Statement/Environmental Impact Report (EIS/EIR), consistent with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (WRC, 1983), Reclamation directives and standards, DWR guidance, and applicable environmental laws. This Plan Formulation Report (PFR) is the third interim planning report in the Investigation feasibility study process and builds on the results and findings of the previous two interim planning documents.

The first interim planning document, the Phase 1 Investigation Report, completed in October 2003 (Reclamation), identified and addressed 17 possible reservoir sites in the eastern San Joaquin Valley and selected 6 for continued study. Nearly all retained sites are located in the upper San Joaquin River basin. In February 2004, formal initiation of environmental compliance processes began, consistent with Federal and State of California (State) regulations, and will continue through completion of all study requirements.

The second interim planning document, the Initial Alternatives Information Report (IAIR), was completed in June 2005 (Reclamation). It evaluated the six reservoir sites retained from Phase 1, and other reservoir storage sites added in response to comments received during public scoping, and identified potential groundwater storage measures. Twenty-four reservoir measures (based on location and size), many with multiple alternative hydropower generation options, were evaluated in the IAIR. The evaluations considered construction cost, potential new water supply that could be developed, hydropower impacts, potential replacement power generation, and preliminary environmental impacts. In addition, several initial water operations scenarios that could address various planning objectives were identified and evaluated at a preliminary level of detail. The IAIR recommended continued study of four reservoir sites that, when combined with a set of operating rules, constitute initial alternatives.

Purpose, Scope, and Organization of this Plan Formulation Report

The primary purposes of this PFR are as follows:

- Describe the planning objectives for the Investigation
- Describe the formulation and refinement of alternative plans to address the planning objectives
- Present the results of initial alternative plan evaluations
- Compare accomplishments and potential effects of the alternative plans
- Define a set of alternative plans to be considered in detail in the Feasibility Report and EIS/EIR

This PFR is not a decision document; it is a report based on available information at this stage of the feasibility study process. Additional studies and documentation (e.g., Feasibility Report, EIS/EIR) will follow this PFR during the Investigation, with continued opportunities for public review and participation in compliance with National Environmental Policy Act (NEPA), California Environmental Quality Act (CEQA), and other pertinent laws and regulations.

The scope of the report includes the following topics:

- Description of the plan formulation process, including water resources problems and needs in the study area warranting Federal consideration; planning objectives and opportunities; and planning constraints, principles, and criteria used to help guide the feasibility study (Chapter 2).
- Description of existing and likely future water resources and related conditions in the study area (Chapter 3).

- Description of management measures, and from these measures, the formulation and evaluation of a set of initial alternatives to address the planning objectives and opportunities, and screening of initial alternatives and subsequent alternative plans for continued study. (Chapter 4).
- Description of features and evaluation of accomplishments, effects, costs, and benefits of alternative plans (Chapter 5).
- Comparison of alternative plans and conclusions regarding which alternatives merit further study (Chapter 6).
- Implementation considerations; compliance with applicable laws, policies, and plans; and identification of stakeholder and public involvement considerations (Chapter 7).
- Summary of findings for this PFR and future actions and schedule for the feasibility study (Chapter 8).
- Sources used to prepare this PFR (Chapter 9).

Study Authorization and Guidance

Federal and State authorizations for the feasibility study/Investigation and related guidance are described below.

Federal Authorization

Federal authorization for the Investigation was initially provided in Public Law 108-7, Division D, Title II, Section 215, the omnibus appropriations legislation for fiscal year 2003, enacted in February 2003. This act authorized the Secretary to conduct feasibility studies for several storage projects identified in the CALFED ROD (2000a), including the Investigation:

> The Secretary of the Interior, in carrying out CALFED-related activities, may undertake feasibility studies for Sites Reservoir, Los Vaqueros Reservoir Enlargement, and Upper San Joaquin Storage projects. These storage studies should be pursued along with ongoing environmental and other projects in a balanced manner.

Subsequent authorization for the Investigation was provided in Public Law 108-361, Title I, Section 103, Subsection (d)(1)(A)(ii), the Water Supply, Reliability, and Environmental Improvement Act, signed October 25, 2004:

> Planning and feasibility studies for the following projects requiring further consideration –…(II) the Upper San Joaquin River storage in Fresno and Madera Counties.

Other provisions in the same act authorize Federal participation in groundwater management and storage projects and actions to improve water quality in the lower San Joaquin River at or near Vernalis. Reclamation is the Federal lead agency for the Investigation.

State of California Authorization

DWR is the State lead agency for the Investigation. Section 227 of the California Water Code authorizes DWR to participate in water resources investigations:

> The department may investigate any natural situation available for reservoirs or reservoir systems for gathering and distributing flood or other water not under beneficial use in any stream, stream system, lake, or other body of water. The department may ascertain the feasibility of projects for such reservoirs or reservoir systems, the supply of water that may thereby be made available, and the extent and character of the areas that may be thereby irrigated. The department may estimate the cost of such projects.

Guidance in the CALFED Record of Decision

The principal objective of CALFED is to develop a comprehensive, long-term strategy to provide reliable water supplies to cities, agriculture, and the environment while restoring the overall health of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta). The CALFED ROD recommended numerous projects and actions to increase water supply reliability, improve ecosystem health, increase water quality, and improve Sacramento-San Joaquin Delta (Delta) levee stability (CALFED, 2000a).

Several program elements were defined that, in combination, would help attain the overall goals of CALFED. The Storage Program element includes five investigations of potential increased surface storage capabilities at various locations in the Central Valley, including the upper San Joaquin River basin, as well as efforts to increase groundwater storage through conjunctive management. For the upper San Joaquin River basin, the CALFED ROD states the following:

> … 250-700 [thousand acre-feet (TAF)] of additional storage in the upper San Joaquin watershed… would be designed to contribute to restoration of and improve water quality for the San Joaquin River and facilitate conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities. Additional storage could come from enlargement of Millerton Lake at Friant Dam or a functionally equivalent storage program in the region.

Study Area

The upper San Joaquin River basin comprises the San Joaquin River and tributary lands upstream from its confluence with the Merced River to its source high in the Sierra Nevada Mountains. The characteristics of the San Joaquin River vary greatly throughout this range. Friant Dam, located on the San Joaquin River about 20 miles northeast of Fresno, diverts much of the water from the San Joaquin River to the eastern portions of the San Joaquin and Tulare Lake hydrologic regions (Figure 1-1), from Chowchilla in the north to Bakersfield in the south.

The study area comprises features and areas that would be affected by changes in water management to support Investigation objectives and opportunities. The study area has been refined as the Investigation has progressed. Through previous phases, and this plan formulation phase, geographic areas were added and deleted from consideration as the potential effects of alternatives were better understood, and management measures were added and deleted.

The primary study area, shown in Figure 1-2, encompasses the San Joaquin River watershed upstream from Friant Dam to Kerckhoff Dam, including Millerton Lake, and the areas that would be directly affected by construction-related activities, including the footprint of reservoir alternatives and related facilities upstream from Friant Dam.

The extended study area presented in this document encompasses locations of potential project features and areas potentially affected by alternative implementation and/or operation (Figure 1-3). These locations and areas include the following:

- San Joaquin River watershed upstream from Friant Dam
- San Joaquin River downstream from Friant Dam, including the Delta
- Lands with San Joaquin River water rights
- Friant Division of the Central Valley Project (CVP), including underlying groundwater basins in the eastern San Joaquin Valley
- South-of-Delta (SOD) water service areas of the CVP and State Water Project (SWP)

Figure 1-1. San Joaquin and Tulare Lake Hydrologic Regions

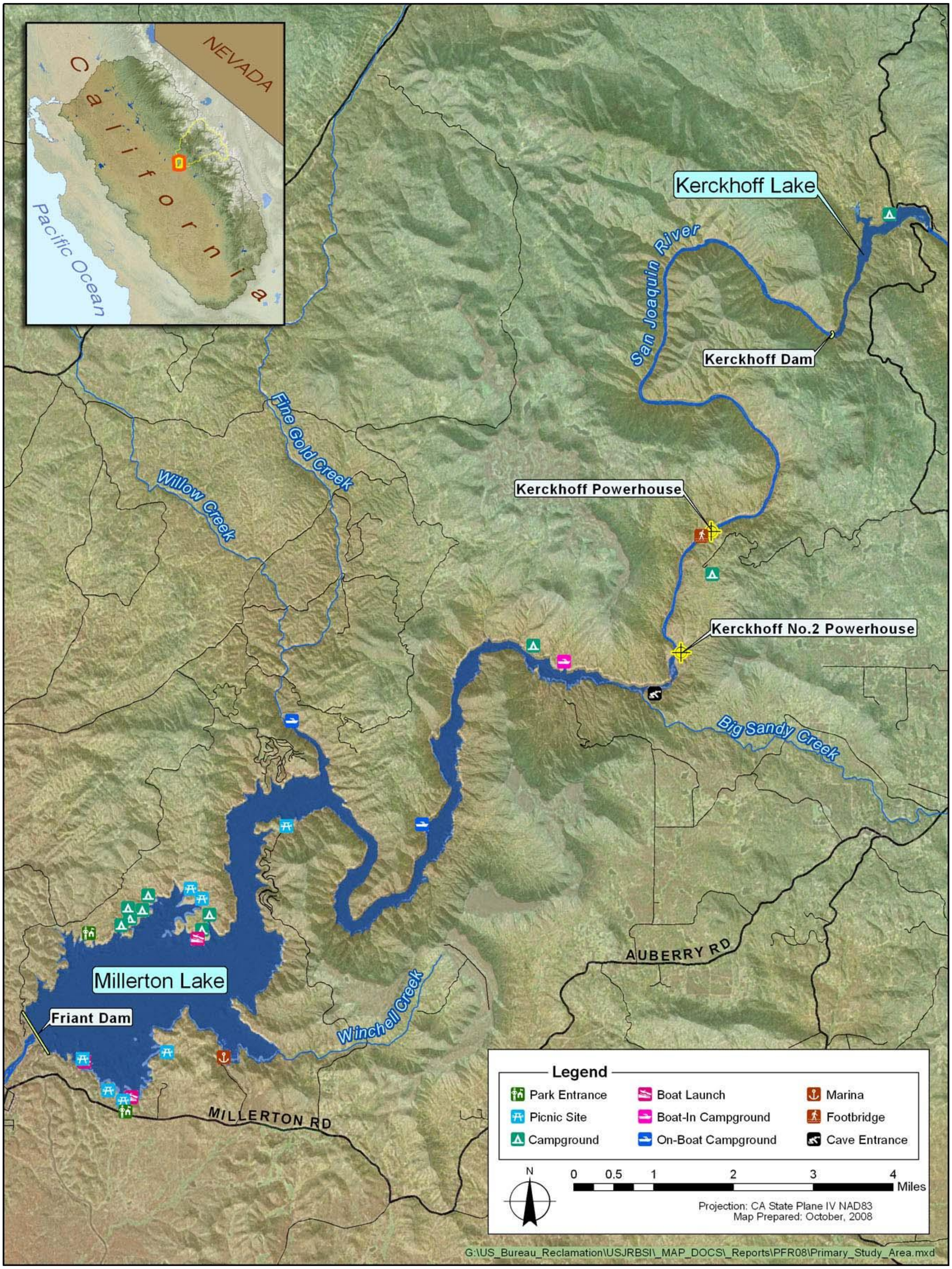


Figure 1-2. Primary Study Area

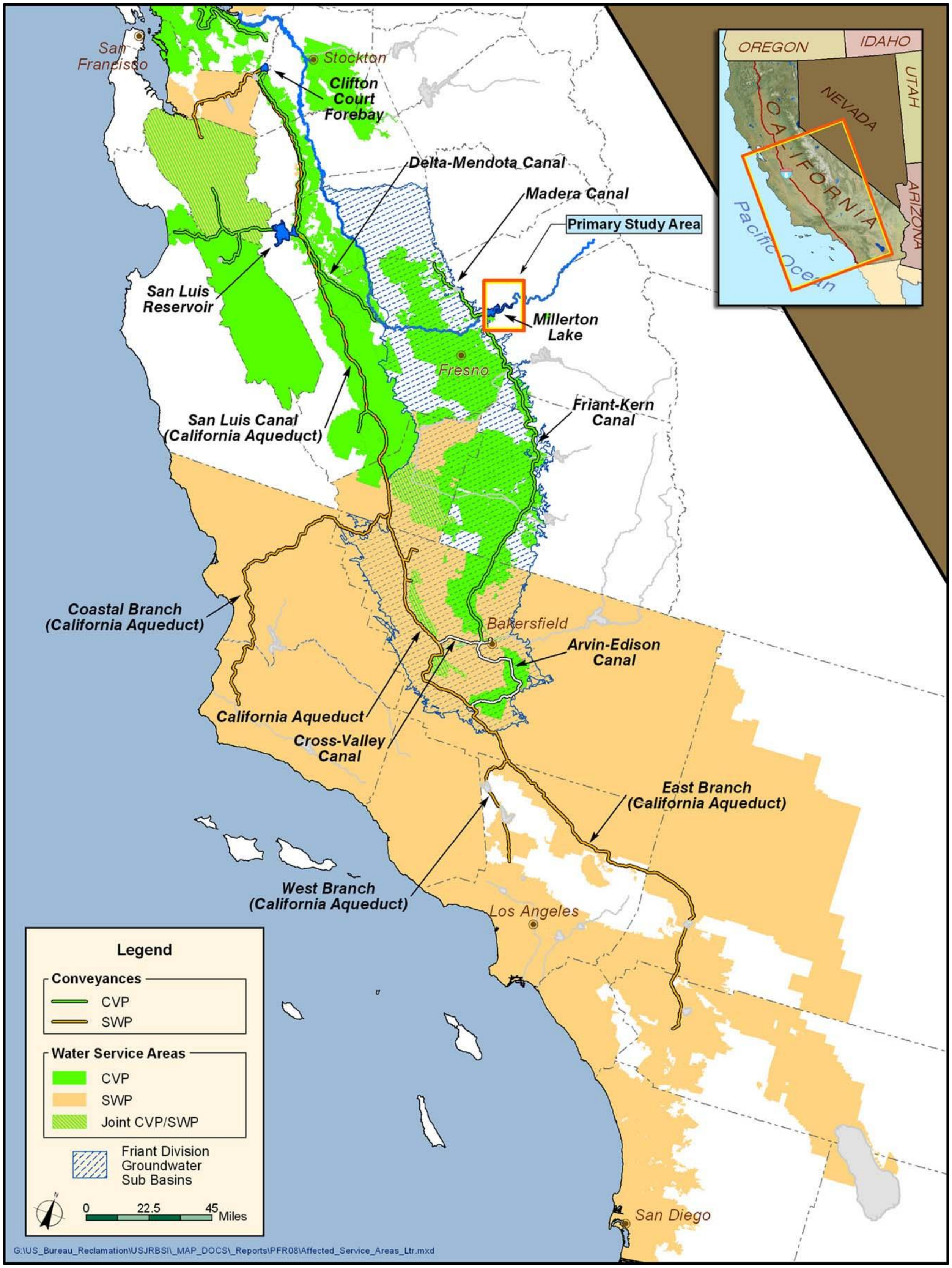


Figure 1-3. Extended Study Area

Related Studies, Projects, Programs, and Plans

Following is a summary of studies, projects, programs, and plans conducted by various Federal and State agencies and numerous local working groups and private organizations in the study area that are directly or indirectly relevant to the Investigation.

Federal

Following are Federal studies, projects, programs, and plans relevant to the Investigation.

U.S. Department of the Interior – Bureau of Reclamation

As the owner and operator of various components of the CVP in the study area, including Friant Dam and Millerton Lake, Reclamation has many ongoing projects or continuing programs relevant to the Investigation.

Central Valley Project The CVP, the largest surface water storage and delivery system in California, supplies water to more than 250 long-term water contractors in the Central Valley, Santa Clara Valley, and San Francisco Bay Area (Bay Area). Annually, the CVP has the potential to supply about 6.2 million acre-feet (MAF) for agricultural uses, 0.5 MAF for urban uses, and 0.3 MAF for wildlife refuges. The CVP also provides flood damage reduction, navigation, power, recreation, and water quality benefits. As part of the Friant Division of the CVP, Friant Dam regulates an average annual inflow of about 1.8 MAF and delivers about 1.4 MAF of water annually on average to water users in the eastern San Joaquin Valley, approximately 20 percent of the potential annual CVP supply.

Prior Studies of Enlarging Friant Dam Several previous studies examined the potential to provide new water storage at Millerton Lake. In 1952, 10 years after completion of Friant Dam, Reclamation conducted a study to determine the feasibility of raising Friant Dam (Reclamation, 1952). The study included designs and costs for raising Friant Dam by 60 feet and constructing four earth saddle dams. Based on a comparison of costs to potential revenue from the sale of increased yield, the study concluded that the raise would be infeasible.

Reclamation revisited the potential cost for a 60-foot raise at a reconnaissance level in 1975, and developed a cost estimate for an approximate 140-foot raise in 1982 (Reclamation, 1982). In 1997, Reclamation again reconsidered the feasibility of raising Friant Dam to provide additional storage capacity in Millerton Lake. Raises of 60 feet and 140 feet were considered (Reclamation, 1997). Also, in 2000, a study conducted for the Friant Water Users Authority (FWUA) and Natural Resources Defense Council (NRDC) coalition considered a 20-foot raise of Friant Dam as one of many alternatives for increasing potential water supply to the San Joaquin River (FWUA and NRDC, 2002).

Central Valley Project Improvement Act The Central Valley Project Improvement Act (CVPIA) was signed into law in October 1992 as Title 34 of Public Law 102-575. The CVPIA addresses conflicts over water rates, irrigation land limitations, and environmental impacts of the CVP. One of the purposes of the CVPIA is to ensure equal priority and consideration for protection, restoration, and enhancement of fish, wildlife, and associated habitats of the Bay-Delta estuary and tributaries when evaluating the purpose of the CVP. The CVPIA also addresses the operational flexibility of the CVP and methods to expand the use of voluntary water transfers and improved water conservation. The CVPIA dedicates 1.2 MAF of water annually to the environment which, through operations flexibility, results in a reduction of 585 TAF previously available to CVP contractors.

Operations Criteria and Plan Biological Assessment In March 2004, Reclamation prepared a Long-Term Operations Criteria and Plan (OCAP) to address how the CVP would be operated in the future, as several proposed projects come online and as water demands increase. The 2004 document is a revision of the previous 1992 OCAP release, incorporating numerous new considerations and criteria that address conditions that have arisen since 1992 (Reclamation, 2004a). Given the numerous changed circumstances since the 2004/2005 OCAP consultations (e.g., delta smelt population decline, newly designated critical habitat for steelhead, spring-run Chinook salmon, and new listing of the Southern distinct population segment of North American green sturgeon), in 2006 Reclamation requested initiation of Section 7 Endangered Species Act (ESA) consultation with both the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). It is expected that consultations will be complete by spring 2009.

San Luis Drainage Feature Reevaluation During June 2006, Reclamation filed the Final EIS for the San Luis Drainage Feature Reevaluation with the U.S. Environmental Protection Agency (EPA) and made the document available to the public. Reclamation prepared the environmental document, pursuant to NEPA, to evaluate options for providing drainage service to the San Luis Unit of the CVP. The proposed Federal action is to plan and construct a drainage system for the San Luis Unit and the general area (of which lands served by the San Luis Unit are a part) that achieves long-term, sustainable salt and water balance in the root zone of irrigated lands. Drainage service is defined as managing the regional shallow groundwater table by collecting and disposing of shallow groundwater from the root zone and/or reducing contributions of water to the shallow groundwater table through land retirement. This proposed action would meet the needs of the San Luis Unit for drainage service, fulfill the requirements of a February 2000 Court Order issued in litigation concerning drainage in the San Luis Unit, and be completed under the authority of Public Law 86-488. A ROD was issued in March 2007 (Reclamation, 2007a), identifying Reclamation’s decision to select the In-Valley/Water Needs Land Retirement Alternative for implementation. The Feasibility Report was transmitted to Congress on July 8, 2008.

Millerton Lake Resource Management Plan and General Plan In June 2008, Reclamation, in cooperation with the California Department of Parks and Recreation (DPR), completed a Millerton Lake Draft Resource Management Plan (RMP)/General Plan and associated Draft EIS/EIR. The RMP/General Plan is a long-term plan that will guide future actions in the Millerton Lake State Recreation Area and is based on a comprehensive inventory of environmental resources and facilities. The RMP establishes management objectives, guidelines, and actions to protect water quality and natural and cultural resources, while enhancing recreational uses in the Millerton Lake State Recreation Area (Reclamation, 2008a). Alternatives currently under consideration emphasize more passive recreation opportunities upstream from Fine Gold Creek, while emphasizing more intensive recreation activities downstream from Fine Gold Creek. The alternative selected in the Final EIS will serve as the framework for negotiating a management agreement with the managing partner, and will provide guidance for resource management and recreation on lands managed by the U.S. Department of the Interior, Bureau of Land Management (BLM), in the San Joaquin River Gorge Management Area (SJRGMA). Relevant information developed in this planning effort regarding resources and recreational opportunities and impacts in the areas around and upstream from Millerton Lake will be used in the Investigation.

U.S. Department of the Interior – U.S. Geological Survey National Water Quality Assessment Program

As part of the National Water Quality Assessment (NAWQA) program initiated by the U.S. Geological Survey (USGS) in 1991, the San Joaquin-Tulare basins study unit was a part of the first decadal cycle of investigations into the quality of water resources conducted to establish existing water quality conditions of streams and aquifers across the Nation. Long-term goals of the NAWQA program are to assess the status of, and trends in, the quality of freshwater streams and aquifers, and to provide a sound understanding of the natural and human factors that affect the quality of these resources. NAWQA again will intensively investigate the quality of water resources in the San Joaquin-Tulare basins, as part of the second 10-year cycle of the program. While long-term goals remain the same, the emphasis of these renewed investigations will shift from status of water quality to trends in water quality and understanding of natural and anthropogenic factors affecting water quality.

U.S. Department of Defense – U.S. Army Corps of Engineers Reservoir Regulation, Post-Flood Assessment, and Comprehensive Study

The U.S. Army Corps of Engineers (USACE) prescribed the operating space and developed the operating rules at Friant Dam and Millerton Lake for flood damage reduction. In addition to reservoir regulation rules, USACE has conducted various studies and implemented many projects and programs that affect the upper San Joaquin River and its tributaries. Several of the most recent efforts have included the March 1999 Post-Flood Assessment (USACE, 1999) and the Sacramento and San Joaquin River Basins Comprehensive Study (Comprehensive Study) (USACE and The Reclamation Board, 2002).

State

Following are DWR, DPR, State Water Resources Control Board (SWRCB), and Central Valley Regional Water Quality Control Board (RWQCB) studies, projects, programs, and plans relevant to the Investigation.

State of California Department of Water Resources

DWR projects, programs, and plans described below include the SWP, California Water Plan, and Conjunctive Water Management Program.

State Water Project The SWP delivers water to the Feather River Settlement Contractors and SWP Contract Entitlements in the Feather River basin, Bay Area, San Joaquin Valley, Tulare basin, and Southern California service areas. The SWP has contracted a total of 4.23 MAF for average annual delivery: about 2.5 MAF for the Southern California Transfer Area; nearly 1.36 MAF for the San Joaquin Valley; and the remaining 370,000 acre-feet for San Francisco Bay, the central coast, and Feather River areas.

California Water Plan The California Water Plan, through the DWR Bulletin 160 series, helps define California's agricultural, environmental, and urban water needs and identifies potential solutions to these needs. The 1998 Update used and expanded the analytical methods developed in previous versions and contains extensive quantitative information. The most recent plan, distributed in December 2005, identifies water resource issues and includes a strategic plan, goals, policy recommendations, and recommended actions to ensure sustainable water uses and reliable water supply. Bulletin 160-05 lacks substantial quantitative information, but rather "provides qualitative discussions and presents the analytical approach for use in future California Water Plan updates" (DWR, 2005). As a result, Bulletin 160-98 was used to provide the majority of quantitative California Water Plan data for this report.

The plan, which is updated every 5 years, identifies and evaluates existing and proposed statewide demand management and water supply augmentation programs and projects for meeting the challenges of sustainable water use in California through 2030. The next plan update is scheduled for late 2009.

Two key initiatives outline the ways the foundational actions will be achieved. The first is to implement integrated regional water management, which is a comprehensive systems approach for determining the appropriate mix of demand and supply management options that provide long-term, reliable water supply at the lowest reasonable cost and with highest possible benefits to customers, economic development, environmental quality, and other social objectives. The second initiative is to improve statewide water management systems. California depends on vast statewide water management systems to provide clean and reliable water supplies, protect lives and property from flood, withstand drought, and sustain environmental values. To improve the efficiency and flexibility of California water systems, water facilities must be maintained and improved.

The Investigation will contribute to both initiatives by evaluating opportunities that can enhance regional objectives and contribute to statewide system flexibility. Consistent with the Water Plan Update, DWR will consider how Investigation alternatives can contribute to broad regional water management issues and an Integrated Regional Water Management Plan.

Conjunctive Water Management Program DWR's Conjunctive Water Management Program is working with local water agencies and stakeholders throughout the State, including the San Joaquin Valley, to develop partnerships and provide assistance for planning and developing locally controlled and managed conjunctive use programs and projects. Project proposals to be pursued by these local agencies may be considered in the Investigation or in the future without-project conditions.

California Department of Parks and Recreation

DPR manages the Millerton Lake State Recreation Area (SRA), which includes Millerton Lake and adjacent lands, under an operating agreement with Reclamation for recreation, preservation of biological diversity, and protection of natural and cultural resources. The Millerton Lake SRA offers interpretive programs for wildlife viewing, tours of the historic Millerton County Courthouse, tours of a fish hatchery downstream from Friant Dam, and various campfire programs in addition to high-quality recreational opportunities. The SRA is one of the most popular recreation areas in the San Joaquin Valley.

State Water Resources Control Board

SWRCB manages the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The primary objective of GAMA is to comprehensively assess statewide groundwater quality and gain an understanding about contamination risk to specific groundwater resources. The Groundwater Quality Monitoring Act of 2001 resulted in a publicly accepted plan to monitor and assess the quality of all priority groundwater basins, which account for over 90 percent of all groundwater used in the State. The plan builds on the existing GAMA Program and prioritizes groundwater basins for assessment based on groundwater use. Groundwater basin assessments are in progress or scheduled across the State and represent areas in all 10 hydrogeologic provinces. Uniform and consistent study-design and data-collection protocols are being applied to the entire State to facilitate efficient statewide, comprehensive groundwater quality monitoring and assessment. Monitoring and assessments for priority groundwater basins are to be completed every 10 years, with trend monitoring every 3 years. SWRCB is collaborating with USGS and Lawrence Livermore National Laboratory to implement the GAMA Program.

Central Valley Regional Water Quality Control Board

Central Valley RWQCB projects, programs, and plans described below include the Conditional Waiver of Waste Discharge Requirements for Irrigated Lands and Impaired Water Bodies 303(d) List and total maximum daily load (TMDL).

Conditional Waiver of Waste Discharge Requirements for Irrigated Lands Growers with irrigated lands who discharge waste that can degrade surface water quality must now select one of three options to obtain regulatory coverage under the Water Code: elect to join a Coalition Group approved by the Central Valley RWQCB, file for an Individual Discharger Conditional Waiver, or file a Report of Waste Discharge for the purpose of receiving Waste Discharge Requirements, if appropriate.

Impaired Water Bodies 303(d) List and Total Maximum Daily Loads In 2006, the Federal EPA approved the Central Valley RWQCB's 303(d) list for portions of the San Joaquin River downstream from Friant Dam that do not meet, or are not expected to meet, water quality standards, or are considered impaired. The Clean Water Act (CWA) further requires development of a TMDL for each listing.

Federal-State

Programs and studies conducted jointly by Federal and State agencies are described below.

CALFED Bay-Delta Program

CALFED is a collaboration of 25 Federal, State, and local agencies that established a program after the Bay-Delta Accord to address water quality, ecosystem quality, water supply reliability, and levee system integrity. Major CALFED programs include the Conveyance, Water Transfer, Environmental Water Account, Water Use Efficiency, Water Quality, Levee System Integrity, Ecosystem Restoration and Watershed Management, and Storage programs.

Following issuance of a CALFED Bay-Delta Final PEIS/EIR in July 2000, the CALFED agencies issued a programmatic ROD in August 2000 that identified 12 action plans, including plans for Governance, Ecosystem Restoration, Watersheds, Water Supply Reliability, Storage, Conveyance, Environmental Water Account, Water Use Efficiency, Water Quality, Water Transfer, Levees, and Science programs (CALFED, 2000b). The CALFED agencies then began implementing Stage 1 of the ROD, including the first 7 years of a 30-year program, to establish a foundation for long-term actions. CALFED Stage 1 ended on December 31, 2007, and Stage 1 actions are continuing to be implemented. CALFED Stage 2 actions will be defined through the Delta Vision process as well as the through development of a Bay Delta Conservation Plan. The Investigation is being developed with consistent guidance provided in the CALFED ROD and other supporting documents.

CALFED Surface Water Storage Program Results of initial evaluations to formulate this program were presented in the Integrated Storage Investigation Report - Initial Surface Water Storage Screening (CALFED, 2000c), which assessed and screened numerous potential reservoir sites. Of many potential surface water storage projects considered, 12 were retained for more detailed evaluation. From these 12 retained sites, five were included in the Preferred

Program Alternative for consideration during Phase 1 of CALFED implementation. Reclamation and DWR committed to assume lead agency roles for investigation of these sites and to work with other CALFED agencies in pursuing their implementation. The five surface water storage projects include Enlarge Shasta Lake, In-Delta Storage, Los Vaqueros Reservoir Enlargement, Sites Reservoir (also known as North-of-the-Delta Offstream Storage (NODOS)), and Upper San Joaquin River Basin Storage.

Common Assumptions for CALFED Water Storage Projects A CALFED Common Assumptions work group has been established for the primary purpose of developing common baseline conditions against which the various water storage investigations can assess the feasibility of their projects. A major task of the Common Assumptions effort is to develop common analytical tools. To date, the work group has assembled a number of modeling tools under one package, termed the Common Model Package (CMP). The CMP includes CALSIM-II, Least Cost Planning Simulation Model (LCPSIM), Central Valley Production Model (CVPM), Delta Simulation Model (DSM2), Sacramento River Water Quality Model (SRWQM), Salmod, Long Term Gen (LTGen), and SWP-Power. CALSIM-II is a statewide water resources planning model, primarily reflecting the Central Valley and Delta operations of the CVP and SWP. The model is used to evaluate water supply facilities and demands; regulatory standards, including minimum flow requirements, water rights, contracts, and water quality standards; system operations; and likely foreseeable actions.

San Joaquin River Restoration Program

In 1988, a coalition of environmental groups, led by NRDC, filed a lawsuit challenging the renewal of long-term water service contracts between the United States and CVP Friant Division contractors. After more than 18 years of litigation of this lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, a Stipulation of Settlement (Settlement) was reached. On September 13, 2006, the Settling Parties, including NRDC, FWUA, and the U.S. Departments of the Interior and Commerce, reached agreement on the terms and conditions of the Settlement, which was subsequently approved by the U.S. Eastern District Court of California on October 23, 2006.

Once authorized, The San Joaquin River Restoration Program (SJRRP) will implement the San Joaquin River litigation Settlement. The “Implementing Agencies” responsible for managing the SJRRP are the U.S Department of the Interior, through Reclamation and USFWS; U.S Department of Commerce through NMFS; and the State of California through DWR, the California Department of Fish and Game (DFG), and the California Environmental Protection Agency (CalEPA). Consistent with the Memorandum of Understanding between the Settling Parties and the State, which was signed at the same time as the Settlement, the State, through DFG, DWR, the Resources Agency, and CalEPA, will play a major, collaborative role in planning, designing, funding, and implementing the actions called for in the Settlement.

The SJRRP is a comprehensive long-term effort to restore flows in the San Joaquin River from Friant Dam to the confluence of the Merced River, ensure irrigation supplies to Friant water users, and restore a self-sustaining fishery in the river.

The Settlement has two primary goals:

- **Restoration Goal** – To restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.

- **Water Management Goal** – To reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

Reclamation and DWR have initiated environmental compliance documentation for the SJRRP. The Implementing Agencies have organized a Program Management Team (PMT) and several Technical Work Groups to develop a plan for implementing the Settlement through a joint NEPA and CEQA process, which includes preparation of a PEIS/EIR. Reclamation is the lead NEPA agency and DWR is the lead CEQA agency for the SJRRP.

The Settlement includes a schedule of implementing actions that support the Restoration Goal. These include channel modifications to provide sufficient flow capacity, gravel pit isolation, flow control structures, and fish passage facilities along the San Joaquin River and San Joaquin River Flood Control Project between Friant Dam and the confluence with the Merced River. According to the schedule provided in the Settlement, full Restoration Flows will begin by 2014, and all river facility construction required by the Settlement will be completed by 2016. A program of Interim Flows will commence no later than October 1, 2009, and continue until full Restoration Flows begin. At this time, Congressional action is pending to authorize Federal participation in the Settlement and to appropriate funds to support implementation goals.

Bay Delta Conservation Plan

The Bay Delta Conservation Plan (BDCP) is a Habitat Conservation Plan being prepared to help recover endangered and sensitive species and their habitats in the Delta in a way that also will provide for sufficient and reliable water supplies. The BDCP is intended to meet the requirements of Section 10 of the ESA; provide the basis for consultations between Reclamation, FWS and NMFS under Section 7 of the ESA; and meet the requirements of either Section 2835 or Section 2081 of the State Fish and Game Code.

An objective of the BDCP is to obtain long-term permits that will allow for the incidental take of threatened and endangered species resulting from covered activities and conservation measures associated with water operations of the SWP and CVP, including facility improvements and maintenance activities, operational activities related to water transfers, new Delta conveyance facilities, and habitat conservation measures included in the BDCP. Entities seeking incidental take coverage through the BDCP include Reclamation, DWR, Metropolitan Water District of Southern California, Kern County Water Agency, Santa Clara Valley Water District, Zone 7 Water Agency, San Luis Delta and Mendota Water Authority, Westlands Water District, and Mirant Delta.

The BDCP will likely include capital improvements for water supply conveyance, ecological restoration, monitoring, and adaptive management. The BDCP is in the early stages of planning. A Notice of Preparation (NOP) of a joint EIR/EIS was issued by DWR on March 17, 2008. A Notice of Intent (NOI) to prepare an EIR/EIS and conduct scoping meetings was issued by Reclamation, FWS, and NMFS on April 15, 2008. Effects of the BDCP process on the Investigation are currently uncertain, but completion of the Investigation Feasibility Report is not dependent upon completion of the BDCP EIS/EIR and associated planning documents.

Delta Vision

The Delta Vision process was initiated by the Governor of California through Executive Order S-17-06 establishing an independent Blue Ribbon Task Force responsible for the development of a durable vision for sustainable management of the Delta (Delta Vision, 2008). As part of the process, a seven-member Cabinet-level Delta Vision Committee was appointed to oversee the process, along with the appointment by the Committee of a 43-member Stakeholder Coordination Group and two Science Advisors. The work of the Task Force included two phases - the Vision, which was completed in December 2007, and the Strategic Plan, that is to be completed by October 2008.

The Vision consists of 12 integrated and linked recommendations that are meant to be implemented together over time. Key recommendations include significant increases in conservation and water system efficiency, new water conveyance and storage facilities, and new governance for the Delta region. The Vision also recommends seven near-term actions which include improving flood protection, ecosystem restoration, and water supply and reliability. As one of four feasibility studies under the CALFED Storage Program, the Investigation is consistent with the Vision recommendations. While all four of the potential CALFED storage projects are mentioned in the Vision as significant to the conveyance and storage link, decisions on whether and how to proceed with any of the alternative plans evaluated in this document are not tied to completion or implementation of the Delta Vision Strategic Plan. Those decisions are part of the CALFED Program evaluation once the four storage feasibility studies have been completed.

Local

Studies, projects, programs, and plans conducted by local agencies are described below.

San Joaquin River Exchange Contractors Water Authority Water Transfer Program

The San Joaquin River Exchange Contractors Authority completed an EIR to support a 10-year program, from 2005 to 2014, to allow the transfer of up to 130 TAF of substitute water from the Exchange Contractors to other water users. A maximum of 80 TAF of water would be developed from conservation measures, including tailwater recovery and groundwater pumping, and a maximum of 50 TAF would be developed from temporary land fallowing. Potential recipients of the water include CVP contractors, Reclamation – for delivery to the San Joaquin Valley wetland habitat areas (wildlife refuges), and Reclamation and/or DWR to support the Environmental Water Account.

San Joaquin River Agreement and Vernalis Adaptive Management Program

The San Joaquin River Agreement (SJRA), adopted in 2000, is a water supply program to provide increased instream flows in the San Joaquin River. The water would provide protective measures for fall-run Chinook salmon in the San Joaquin River under the Vernalis Adaptive Management Program (VAMP). Parties to the SJRA include the following:

- **California Resources Agency Departments** – DWR and DFG.
- **U.S. Department of the Interior Agencies** – Reclamation and USFWS.
- **San Joaquin River Group Authority Agencies** – SJRGA and its member agencies, including the Modesto Irrigation District, Turlock Irrigation District, Merced Irrigation District, South San Joaquin Irrigation District, and Oakdale Irrigation District; the San Joaquin River Exchange Contractors Water Authority and its member agencies, including the Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water District, and Columbia Canal Company; FWUA on behalf of its member agencies; and the City and County of San Francisco.
- **CVP and SWP Contractors** – SWP 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 Southern California (MWDSC).
- **Environmental Interest Groups** – Natural Heritage Institute and the Bay Institute of San Francisco.

VAMP is an experimental study on the impact of flow, nonflow, and export rates on salmon fisheries in the lower San Joaquin River. The primary objective of VAMP is to implement a pulse flow for a 31-day period in the San Joaquin River at Vernalis during April and May to temporarily enhance the river's assimilative capacity for salt, thereby improving water quality for fish, such as spring-run Chinook salmon. Water will be used from 1999 to 2010 and flows will vary annually depending on hydrological and biological conditions. Water for achieving the VAMP 31-day pulse flow (April to May) is provided by the San Joaquin River Group Authority (SJRGA) member agencies. Total water supply to support VAMP is capped at 110 TAF in any year. Reclamation and DWR compensate SJRGA to ensure that water supplies are available for instream flows, as needed, up to prescribed limits.

Additional water in excess of 110 TAF can be acquired from willing sellers who are members of the SJRGA. The additional water would be used for ramping around the pulse flow to assist in protecting salmon redds, controlling any water temperature, and improving water quality. Because the water released would increase instream flows in the lower San Joaquin River, it also would contribute to compliance with the 1995 SWRCB Bay-Delta Water Quality Control Plan (WQCP) Vernalis objectives (SWRCB, 1995) and with the San Joaquin River component of the Delta Smelt Biological Opinion (Reclamation and SJRGA, 1999).

Big Creek Facilities Relicensing

Southern California Edison (SCE) owns and operates seven hydroelectric projects, collectively comprising the Big Creek System, in the eastern portion of the upper San Joaquin River basin upstream from Kerckhoff Lake. SCE is initiating a multiyear collaborative process for relicensing four of its seven Big Creek hydroelectric projects. The Federal Energy Regulatory Commission (FERC) provided approval to SCE on March 15, 2000, to use an Alternative Licensing Process (ALP) to relicense four of the seven projects (SCE, 2000). A settlement agreement, marking the culmination of the 7-year ALP to relicense the Big Creek Hydroelectric Facilities, was signed during April 2007 by SCE and more than 45 diverse stakeholders. The settlement agreement calls for extensive plans to mitigate project-related effects on aquatic, terrestrial, and cultural resources, and improve land and recreation management (SCE, 2007).

Friant Water Users Authority and Metropolitan Water District of Southern California Partnership Studies

FWUA and MWDSC have entered into a partnership, based on an approved set of principles, to investigate the potential of enhancing water supply and affordability in the eastern San Joaquin Valley while improving water quality for Southern California water users. The partnership is based on the desire by both parties to investigate joint water management projects that can be implemented for mutual benefit of the agencies, their members, and water users. Studies include potential enlargement of Mammoth Pool Reservoir and exchange opportunities between Friant Division and Delta water supplies.

The Mammoth Pool Enlargement Study entails (1) revisiting a former SCE proposal to enlarge Mammoth Pool by installing eight 25-foot-high radial gates across the natural rock spillway to raise the maximum lake level, and (2) constructing a 5-foot-high parapet on top of the existing dam to maintain freeboard under emergency storage conditions. Enlarging Mammoth Pool would create 30 TAF of additional water storage.

Additional studies by FWUA and MWDSC considered operations to accomplish exchanges that would deliver high-quality water from the Friant Division to MWDSC in exchange for water supplies delivered from the Delta. Information from these studies provided preliminary operational assumptions for the Investigation related to the integration of Friant Division facilities with other CVP and/or SWP facilities.

Madera County Integrated Regional Water Management Plan

The Madera County Integrated Regional Water Management Plan (IRWMP) is funded by Assembly Bill (AB) 303 and Proposition 50 Study Grants from DWR. The Madera County IRWMP documents the water management strategies of Madera County and its stakeholders to achieve the main objectives of water resource management optimization, evaluating and increasing water supplies, water quality protection and improvement, and flood management planning through 2030. The IRWMP will be used to update Madera County's General Plan and will assist in meeting the goals and objectives of its AB 3030 Groundwater Management Plan.

Chapter 2
Plan Formulation Process

This chapter describes the process for formulating and evaluating potential alternatives consistent with the study authorizations, and describes major water resources problems, needs, and opportunities in the study area. Water resource problems, needs, and opportunities provide a framework for plan formulation and help establish planning objectives for the Investigation. The basic plan formulation process for Federal water resources studies and projects consists of the following iterative steps, consistent with the P&G (WRC, 1983), study authorizations, and pertinent Federal, State, and local laws and policies:

- Specifying water resources problems, needs, and opportunities to be addressed (Chapter 2).
- Developing planning objectives, constraints, considerations, and criteria (Chapter 2); identifying potential management measures (Chapter 4).
- Inventorying, forecasting, and analyzing existing and likely future conditions in the study area (Chapter 3).
- Formulating alternative plans (Chapter 5).
- Evaluating effects of alternative plans (Chapter 5).
- Comparing alternative plans (Chapter 6).

The planning process is led by a multiple-agency planning team of professional water resources planners, engineers, environmental scientists, and experts, and involves the input and participation of concerned stakeholders, advisory groups, regulatory agencies, and members of the general public. Upon completion of the feasibility study, the planning process will be documented in a Feasibility Report and accompanying EIS/EIR as the basis for decision-making by the President and Congress. Cooperating agencies and entities, including the State, will participate in this decision-making.

The plan formulation approach for the Investigation is shown in Figure 2-1.

Following is a description of identified water resources problems, needs, and opportunities, and planning objectives, constraints, considerations, and criteria.

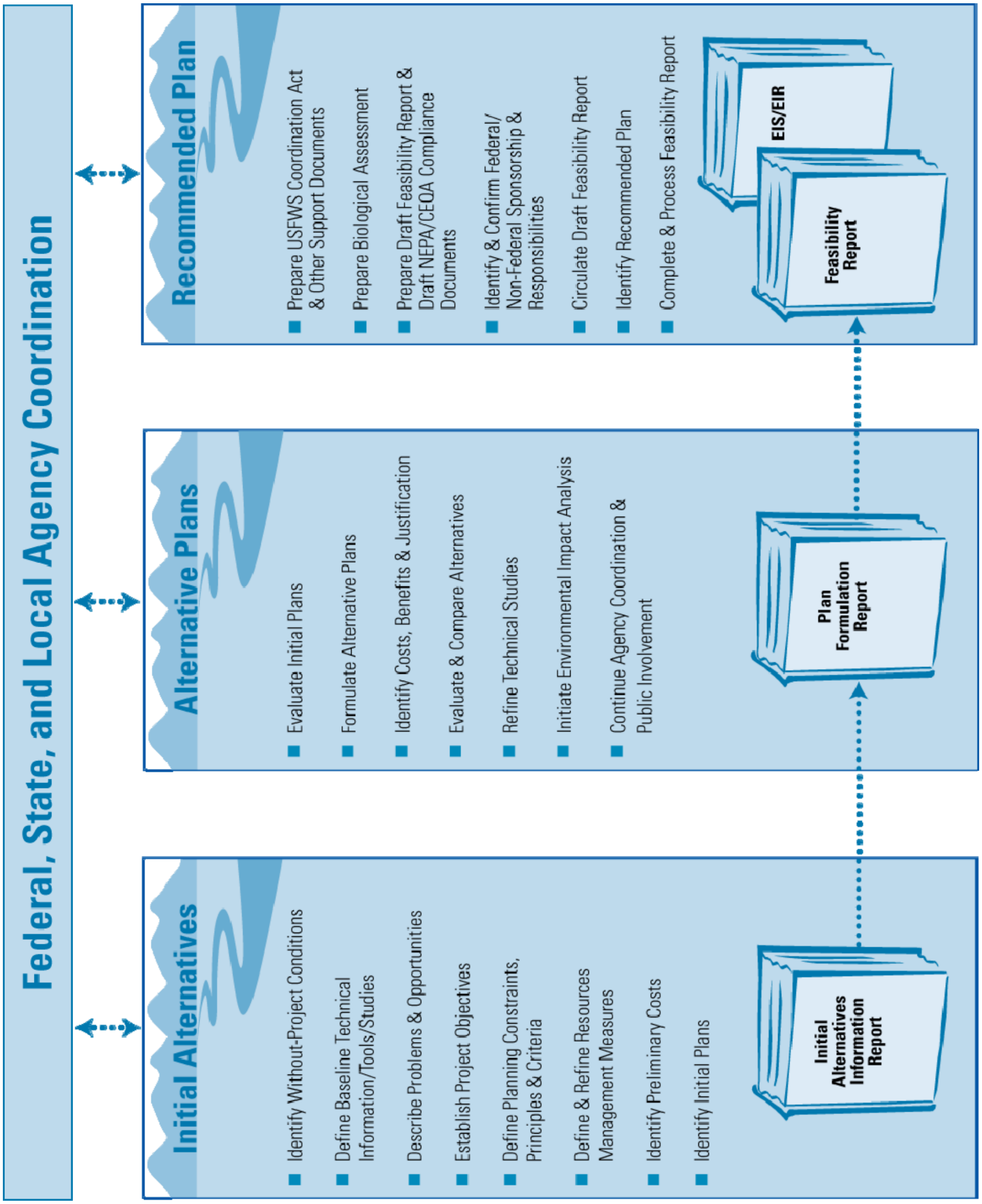


Figure 2-1. Plan Formulation Process

Water and Related Resources Problems, Needs, and Opportunities

Problems and needs to be addressed by the Investigation were identified in the CALFED ROD (2000a) and from stakeholder input. The primary purposes identified in the CALFED ROD for developing and managing additional water supplies from the upper San Joaquin River basin include contributing to restoration of the San Joaquin River; improving water quality in the San Joaquin River; facilitating additional conjunctive water management; and supporting water exchanges that improve the quality of water deliveries to urban communities. These problems and needs formed the basis for initial plan formulation.

The Settlement triggered a substantial change in the without-project conditions for the Investigation. The inclusion of Settlement-stipulated releases from Friant Dam for river restoration as a without-project condition has caused reassessment of the water resources problems, needs, and opportunities for the Investigation.

This section describes water resources problems and needs for the Investigation in greater detail, and is organized by water supply reliability problems and needs, San Joaquin River ecosystem problems and needs, and opportunities.

Water Supply Reliability Problems and Needs

This section includes discussions on water supply reliability problems and needs in the State and Central Valley, and Friant Division of the CVP.

State of California and Central Valley

Predicting expected future water supply demands and/or shortages in the Central Valley of California is difficult. There are numerous variables and, just as important, numerous interpretations associated with these variables. Water supply reliability problems and needs are based on quantities and estimates in the 1998 Water Plan Update (DWR); however, qualitative information in the California Water Plan Update 2005 (DWR) and in the Water Supply and Yield Study Interim Report (Reclamation, 2006) leads to consistent conclusions. Some of the primary conclusions reached in the reports are that California must invest in reliable, high quality, sustainable and affordable water conservation; efficient water management; and development of water supplies to protect public health, and improve California’s economy, environment, and standard of living.

Major factors affecting California’s future water supplies include rapid population growth; agricultural-to-urban land use conversion; and climate change and related uncertainties, including Delta infrastructure, operations criteria, and ecosystem conditions. Uncertainties about the sustainability of the

Delta prompted the appointment of an independent Delta Vision Blue Ribbon Task Force by the Governor of California that will be responsible for developing a strategic plan to support environmental and economic functions that are critical to the people of California. One of 12 integrated and linked recommendations provided to the Governor for development of a durable vision for sustainable management of the Delta is to develop new facilities for conveyance and storage, and a better linkage between the two for managing California's water resources (Delta Vision, 2008).

DWR identified some of the impacts associated with climate change on various water resources areas. Potential impacts due to climate change are many and complex (DWR, 2006a). They range from potential sea level rise, which could impact coastal areas and estuarine water quality, to changes in rainfall runoff relationships important for flood management. Another potential impact may be a reduction in total system storage. Precipitation held in mountain snowpack makes up a substantial quantity of total annual water supplies needed for irrigation, urban, and many environmental uses. In the future, climate change may substantially reduce or change the timing of snowmelt from water held in snowpack in the Sierra Nevada Mountains.

Much of the emphasis in future water planning for the State will be on increasing urban water use efficiency (WUE) and recycling municipal supplies. The Governor of California recently outlined a goal of 20 percent reduction in per capita water use by 2020 (Governor, 2008). WUE will play a large role in actions related to the CALFED ROD (2000a). Even so, it is believed that to avoid major impacts to the economy, overall environment, and standard of living in California, a critically important element in any future water resources plan will be development of additional water supplies (DWR, 2005). These additional supplies are needed to increase the reliability of existing supplies for expanding municipal and industrial (M&I) uses and to maintain adequate supplies for agricultural and environmental purposes.

Even with major efforts by multiple agencies to address the complex water resources issues in the State, demands are expected to exceed supplies in the future. As described in Chapter 3, the CVP and SWP have experienced considerable water shortages in dry years. For the State's water supply system in the year 2050, it is estimated that overall, a dry scenario of climate warming could reduce average annual statewide water availability by 27 percent, resulting in an average annual reduction in water deliveries of 17 percent (California Climate Change Center, 2006).

Friant Division of the Central Valley Project

Water supply reliability problems and needs within the Friant Division, similar to those throughout the State, are associated with large annual hydrologic variations in water availability and the limited capacity of current water storage and conveyance facilities. Projected demands exceed supply for agriculture, urban, and environmental purposes. The Friant Division of the CVP provides surface water supplies to many areas that also rely on groundwater, and was designed and is operated to support conjunctive water management to reduce groundwater overdraft in the eastern San Joaquin Valley.

Annual allocation of water to Friant Division contractors varies widely in response to hydrologic conditions. During dry periods when surface water deliveries are reduced, water contractors rely heavily on groundwater to meet water demands. Although surface water deliveries from Friant Dam help reduce groundwater pumping and contribute to groundwater recharge, the groundwater basins in the eastern San Joaquin Valley remain in a state of overdraft in most years (i.e., more groundwater is pumped out than is replenished either naturally or artificially). The continued general downward trend of groundwater levels reveals that considerable water supply reliability problems remain. Moreover, it is expected that the continued downward trend in groundwater levels may result in localized areas of impaired groundwater quality, and may ultimately reduce water use and irrigated acreage in the San Joaquin Valley.

Additionally, through implementation of the Settlement, average total system water deliveries from Friant Dam, as described in Chapter 3, are expected to be reduced by about 208 TAF per year, or approximately 15 to 19 percent of deliveries under existing conditions. The Settlement does not include specific actions to achieve the Water Management Goal, nor does it identify specific quantities of water supply to be replaced.

San Joaquin River Ecosystem Problems and Needs

The reach of the San Joaquin River from Friant Dam to the Merced River confluence (Figure 2-2) does not currently support a continuous natural riparian and aquatic ecosystem. Friant Dam was authorized and is operated to support two primary purposes: agricultural and M&I water supplies, and flood protection. Since completion of Friant Dam, most of the water in the river has been diverted for agricultural and M&I uses, with the exceptions of releases to satisfy riparian water rights upstream from Gravelly Ford, and flood releases. Consequently, the river reach from Gravelly Ford to Mendota Pool is often dry.

Flow in the San Joaquin River from Mendota Pool to Sack Dam contains Delta water for delivery to the San Luis Canal Company and wildlife refuges. Between Sack Dam and the confluence with Salt Slough, the primary source of flow in the San Joaquin River is groundwater seepage from adjacent agricultural lands. The reach from Sack Dam to Bear Creek is operationally dry, but this reach benefits from managed wetland development, whereas marshes have been drained between Bear Creek and the Merced River. Generally unhealthy ecosystem conditions have resulted from lack of reliable flows and poor water quality in the San Joaquin River.

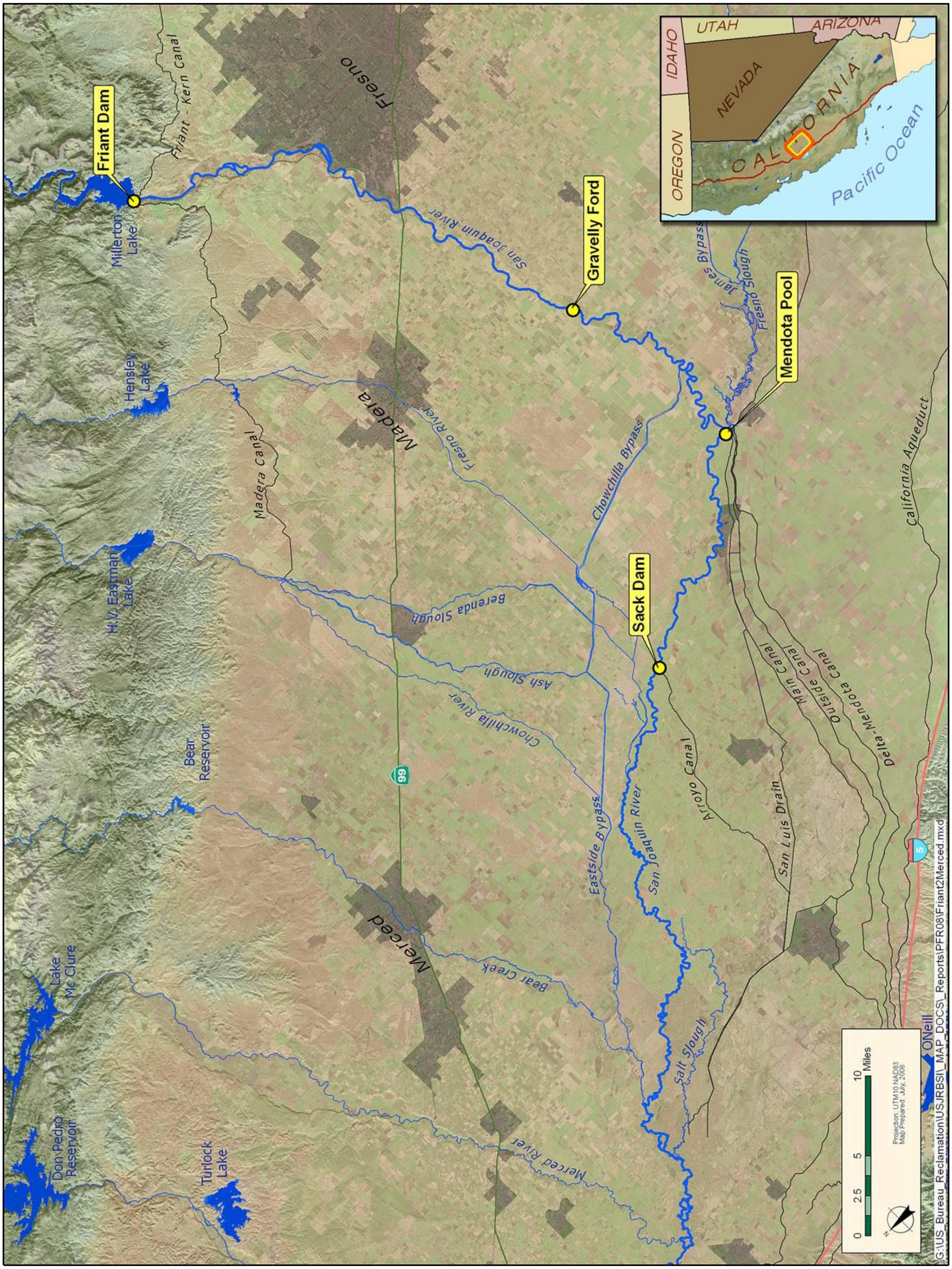


Figure 2-2. San Joaquin River from Friant Dam to Merced River

The Settlement, which is assumed under future without-project conditions, is expected to extensively alter the ecosystem conditions of the San Joaquin River. The Restoration Goal of the Settlement is to provide continuous flows in the San Joaquin River at Friant Dam to sustain naturally reproducing Chinook salmon and other fish populations in the 153-mile-long stretch of river between Friant Dam and the Merced River. Accomplishing this goal will require funding and constructing extensive channel and structural improvements in many areas of the river, including some that have been without flows for decades. The exact nature of these structural improvements, and magnitude and timing of resulting ecosystem improvements, is presently unknown.

The stipulated releases to the San Joaquin River for restoration vary by water year-type. The water year-types from the Settlement are determined based on ranking of annual unimpaired runoff at Friant Dam for water years (October 1 to September 30) from 1922 to 2004. Restoration Flows for the various water year-types are about 556 TAF during wet years, about 356 TAF during normal-wet years, about 248 TAF during normal-dry years, about 184 TAF during dry years, and about 71 TAF during critical-high years. During critical-low years, however, no flow above current riparian releases is prescribed to be released from Friant Dam to the river. There are also provisions for an additional buffer flow of up to 10 percent for release to the river if seepage losses are greater than anticipated, and for flushing flows to enhance gravel conditions for spawning during wet and normal-wet years.

In addition to flow, success of Chinook salmon populations is known to be affected by water temperature. The SJRRP is currently developing information on optimal water temperature requirements for Chinook salmon. Water temperatures that are too high, or in some cases too low, can be detrimental to the various life stages of salmon. Elevated water temperatures can negatively impact spawning adults, egg maturation and viability, and preemergent fry, substantially diminishing the resulting ocean population and next generation of returning spawners. Stress caused by high water temperatures also may reduce the resistance of fish to parasites, disease, and pollutants. Conversely, water that is too cold is detrimental to the rapid growth of some juveniles.

The ability to manage volumes of cold water and to release water from Friant Dam at suitable temperatures, and provide for Restoration Flows during critical-low years, may be challenges to fully meeting the Restoration Goal of the Settlement.

Opportunities

This section describes water resources opportunities that could be addressed through development and management of San Joaquin River supplies. These include flood damage reduction, energy generation and management, recreation, improved San Joaquin River water quality, and improved urban water quality.

Flood Damage Reduction

Flood operations at Friant Dam are based on anticipated precipitation and snowmelt runoff and the operations of upstream reservoirs. Flood releases from Friant Dam are maintained, when possible, at levels that could be safely conveyed through the San Joaquin River and Eastside Bypass. Generally, flood operations target releases at or below 8,000 cubic feet per second (cfs) downstream from Friant Dam. Major storms during the past two decades have demonstrated that Friant Dam, among other Central Valley dams, may not provide the level of flood protection that was intended at the time the flood management system was designed. Further, the level of protection initially provided may not be appropriate for current downstream land uses and development levels. January 1997 flood flows of nearly 60,000 cfs from Friant Dam resulted in levee failures and extensive downstream flooding.

As part of the Comprehensive Study, USACE assessed system performance during major floods in the last two decades. The study found that Friant Dam was effective in reducing damages during floods, but that substantial damages were still experienced during recent flood events (USACE and The Reclamation Board, 2002). The Comprehensive Study also developed a set of system-wide tools to simulate flood system performance for the entire San Joaquin River basin. Under existing conditions, expected annual damages from flooding were estimated as $29.0 million in the San Joaquin River basin. Opportunities to improve flood damage reduction, in association with development and management of additional San Joaquin River supplies, will be considered in the Investigation.

Energy Generation and Management

Hydropower is an important element of power supply in California. On average, hydropower generation constitutes between 10 to 27 percent of California's annual energy supply, depending on the type of water year. The United States receives between 7 and 12 percent of its electricity from hydropower. Due to its ability to rapidly increase and decrease power generation rates, hydropower can be used to support peak power loads in addition to base power loads.

As population, industry, and associated infrastructure growth occurs in the future, demands for power would also increase. Over the next 10 years, California's peak demand for electricity is expected to increase almost 30 percent from about 50,000 to 65,000 megawatts (MW). Although some new power generation capacity likely would be developed in California during the next few decades, it is expected that additional new generation capacity would still be required. The Investigation will consider opportunities for additional hydropower generation capacity in association with the development and management of San Joaquin River water supplies.

Recreation

As the population of the State of California continues to grow, demands would increase for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. Demands for water-based and land-based recreational opportunities in the San Joaquin River basin are high. Some of these demands are served by reservoirs on the western slope of the Sierra Nevada Mountains. In the primary study area, regional population growth is expected to result in increased demand for recreation at Millerton Lake and increased visitation (Reclamation, 2008a). Opportunities for recreation site development and water level management could be potential elements of a plan to help meet future recreation demands.

San Joaquin River Water Quality

Water quality in various segments of the San Joaquin River has been a problem for several decades due to low flow and poor quality discharges from agricultural areas, wildlife refuges, and M&I treatment plants. Over time, regulatory requirements for water quality in the river have become more stringent and the number of locations along the river at which specific water quality objectives are identified and monitored has increased. Water quality conditions in the San Joaquin River would likely improve through implementation of the San Luis Drainage Feature Reevaluation selected alternative, SJRRP actions, and various TMDLs. However, the extent of water quality improvements is difficult to anticipate until water quality monitoring and analyses are completed for these actions.

Urban Water Quality

Water pumped from the Delta is the source of drinking water for approximately 25 million people in California. Delta water supplies generally contain elevated concentrations of bromide and organic carbon during late summer and early fall months. This increases drinking water treatment costs in urban areas and limits the use of Delta supplies for blending with other sources. In addition to conflicts between management of Delta water supplies for environmental, agricultural, and urban uses that reduce the reliability of water deliveries from the Delta, an increasing emphasis on facilitating exchanges and operational flexibility would place additional demands on water supplies and conveyance systems. A complementary action recommended for continued study in the CALFED ROD under the Conveyance and Water Quality programs was to facilitate water quality exchanges and similar programs to make available high-quality Sierra Nevada water in the eastern San Joaquin Valley to urban interests receiving water from the Delta (CALFED, 2000a). Through development and management of San Joaquin River supplies, there may be opportunities to improve the quality of water supplies delivered to urban areas over the range of hydrologic conditions.

Planning Objectives

This section discusses Federal and State planning objectives and objectives specific to the Investigation.

Federal and State Objectives

The Federal objective of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are direct net benefits that accrue in the planning area and the rest of the Nation (WRC, 1983).

Because of its many water management partnerships with the Federal government, DWR has a policy that economic analyses conducted for programs and projects be fundamentally consistent with the Federal planning principles defined in the P&G (WRC, 1983), but can also incorporate innovative methods and tools when appropriate. According to DWR (2008a), the reasons for this policy are as follows:

> This policy is necessary because (a) the P&G has not been updated for more than 20 years, (b) Federal and State planning and economic analyses sometimes have different regional analysis perspectives, and (c) water management projects and programs have become more complex.

CALFED provides a programmatic framework to develop and implement a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system.

Investigation-Specific Planning Objectives

On the basis of the problems, needs, and opportunities identified and defined above, study authorizations, and other pertinent direction, including information contained in the August 2000 CALFED ROD (2000a), the planning objectives below were developed. These objectives guide formulation of alternatives to address the problems, needs, and opportunities, consistent with Federal and State planning guidance:

- **Planning Objectives** – Formulate alternatives specifically to accomplish the following:
  - Increase water supply reliability and system operational flexibility for agricultural, M&I, and environmental purposes in the Friant Division, other San Joaquin Valley areas, and other regions.
  - Enhance water temperature and flow conditions in the San Joaquin River from Friant Dam to the Merced River in support of restoring and maintaining naturally reproducing and self-sustaining anadromous fish (i.e., Settlement reintroduced fall- and/or spring-run Chinook salmon).
- **Opportunities** – To the extent possible, through pursuit of the planning objectives, alternatives will also include features to help address the following:
  - Improve management of flood flows at Friant Dam.
  - Preserve and increase energy generation, and improve energy management in the study area.
  - Preserve and increase recreation opportunities in the study area.
  - Improve San Joaquin River water quality.
  - Improve the quality of water supplies delivered to urban areas.

Planning Constraints and Other Considerations

The P&G provides fundamental guidance for the formulation of Federal water resources projects (WRC, 1983). In addition, basic planning constraints and other considerations specific to the Investigation must be developed and identified. Following is a summary of constraints and considerations being used for the Investigation.

Planning Constraints

Planning constraints are used to help guide a feasibility study. Some planning constraints are more rigid than others. Examples of more rigid constraints include congressional direction; current applicable laws, regulations, and policies; and physical conditions (e.g., topography, hydrology). Other planning constraints may be less restrictive but are still influential in guiding the process. Several major constraints identified for the Investigation are as follows:

- **Study Authorization** – In 2003, Federal authorization was provided to prepare a Feasibility Report for storage in the upper San Joaquin River basin (Public Law 108-7, Division D, Title II, Section 215). Congress again authorized the Secretary to conduct planning and feasibility studies for storage in the upper San Joaquin River basin in Fresno and Madera counties through the October 2004 Water Supply, Reliability, and Environmental Improvement Act (Public Law 108-361). Based on Section 227 of the State of California Water Code, State authorization is in place to study reservoirs or reservoir systems for gathering and distributing flood or other water not under beneficial use in any stream, stream system, lake, or other body of water.

- **CALFED Record of Decision** – The CALFED ROD includes program goals, objectives, and projects primarily to benefit the Bay-Delta system. The storage program element recommends five investigations of potential increased surface storage capabilities at various locations in the Central Valley, including the upper San Joaquin River basin, and various groundwater storage projects to help reduce the discrepancy between water supplies and projected demands. The program also includes numerous other projects to help improve the ecosystem functions of the Bay-Delta system. Alternative plans developed in the Investigation should be cognizant of the goals, objectives, and programs/projects of the CALFED ROD (2000a).

- **Laws, Regulations, and Policies** – Numerous laws, regulations, executive orders, and policies need to be considered, among them the P&G, NEPA, Fish and Wildlife Coordination Act, Clean Air Act, CWA, National Historic Preservation Act, California Public Resources Code, Federal and State ESAs, CEQA, and the CVPIA. Other important laws and regulations are included in Chapter 7.

- **CVPIA Section 3404(a)** – In accordance with Section 3404(a) of the CVPIA, the Secretary shall not enter into any new short-term, temporary, or long-term contracts or agreements for water supply from the CVP for any purpose other than fish and wildlife before the provisions of Subsections 3406(b)-(d) (fish, wildlife, and habitat restoration) are met.

Other Planning Considerations

Other planning considerations were specifically identified to help formulate, evaluate, and compare alternative plans as follows:

- Alternative plans should address, at a minimum, all of the identified planning objectives.
- Measures to address identified opportunities should be either directly or indirectly related to the planning objectives (i.e., plan features should not be independent increments).
- Alternative plans should include integrated features for mitigating impacted hydropower generation through development of replacement hydropower generation facilities in preference to purchasing replacement energy. This consideration is due to private utility preferences for generation capacity, limitations of existing electricity transmission facilities in the region, uncertainty of future power prices, and uncertainty of hydropower mitigation requirements.
- Alternative plans should consider issues raised in coordination with other Federal and State agencies.
- Alternatives should avoid any increases in flood damages or other substantial hydraulic impacts to areas downstream on the San Joaquin River.
- Alternatives should either avoid potential adverse impacts to environmental, cultural, and historical resources or include features to mitigate unavoidable impacts.
- Alternatives should not result in a substantial adverse impact to existing and future water supplies, or related water resources conditions.
- Alternatives should either avoid potential adverse impacts to recreation resources or include features to mitigate unavoidable impacts.
- Alternatives should be formulated and evaluated based on a 100-year period of analysis.
- Construction costs for alternatives should reflect current prices and price levels, and annual costs should include the current Federal discount rate and an allowance for interest during construction (IDC).
- Alternatives should have a high certainty for achieving intended benefits and not depend on long-term actions (past the initial construction period) for success.

Criteria

The Federal planning process in the P&G also includes four specific criteria for consideration in formulating and evaluating alternatives: (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability (WRC, 1983). Completeness is a determination of whether a plan includes all elements necessary to realize planned effects, and the degree that intended benefits of the plan depend on the actions of others. Effectiveness is the extent to which an alternative alleviates problems, achieves objectives, and employs opportunities. Efficiency is the measure of how efficiently an alternative alleviates identified problems while realizing specified objectives and opportunities consistent with protecting the Nation's environment. Acceptability is the workability and viability of a plan with respect to its potential acceptance by other Federal agencies, State and local governments, and public interest groups and individuals. These criteria and how they apply to the planning process are described in Chapter 4.

Chapter 3
Existing and Future Conditions in the Study Area

One of the most important elements of any water resources evaluation is defining existing resource conditions in the affected environment, and how these conditions may change in the future. The magnitude of change not only influences the scope of the problems, needs, and opportunities, but the extent of related resources that could be influenced by possible actions taken to address them. Accordingly, this chapter describes existing and likely future conditions for resources within the study area. Defining the existing and likely future conditions is critical in establishing the basis for comparing potential alternative plans consistent with NEPA and CEQA guidance.

This chapter discusses existing and future physical, biological, cultural, and socioeconomic conditions. The discussion of existing and future conditions in this chapter will focus on the primary study area, but will also provide information about water resources facilities and water deliveries in other portions of the study area. The primary and extended study areas are defined in Chapter 1.

Existing Conditions

This section describes existing conditions in the study area, including existing infrastructure, the physical environment, biological environment, cultural environment, and socioeconomic resources.

Existing Area Infrastructure

This section describes existing conditions for the Friant Division, Friant Dam and Millerton Lake water control facilities, recreation facilities, and other infrastructure in the primary study area.

Friant Division of the Central Valley Project

The reservoir facilities at Millerton Lake are part of the Friant Division of the CVP, and their operation affects flow in the San Joaquin River. Friant Dam is operated to supply water to agricultural and urban areas in the eastern San Joaquin Valley and to provide flood protection to downstream areas. The Friant Division provides water to over 1 million acres of irrigable land on the east side of the southern San Joaquin Valley, from near the Chowchilla River in the north to the Tehachapi Mountains in the south. Principal features of the Friant Division were completed in the 1940s, including Friant Dam and Millerton

Lake, and the Madera and Friant-Kern canals, which convey water north and south to agricultural and urban water contractors. Minimum storage in Millerton Lake for canal diversion is about 130 TAF (135 TAF for the Friant-Kern Canal, 130 TAF for the Madera Canal), resulting in active conservation storage of about 390 TAF.

The limited active conservation storage and the requirement for flood space reservation result in little opportunity for carryover storage. Annual water allocations and release schedules are developed with the intent of drawing reservoir storage to minimum levels by the end of September. When demands are lower, or inflow is greater than typical, end-of-year storage may be above minimum levels, resulting in incidental carryover storage. With the exception of flood operations, water released from Friant Dam to the San Joaquin River is limited to the amount necessary to satisfy riparian water rights along the San Joaquin River between Friant Dam and Gravelly Ford.

Friant Dam and Millerton Lake

Friant Dam is a concrete gravity dam that impounds Millerton Lake on the San Joaquin River. It is located on the border between Fresno and Madera counties, near the community of Friant, about 20 miles northeast of Fresno. Friant Dam, owned and operated by Reclamation, was constructed between 1939 and 1942. Three small saddle dams that close low areas along the reservoir rim are located on the south side of the reservoir. At the top of active storage, elevation 580.6 feet above mean sea level (msl) (elevation 580.6), the reservoir has a storage capacity of 520 TAF. Water deliveries, principally for irrigation, are made through outlet works to the Friant-Kern and Madera canals, which were completed in 1949 and 1944, respectively. Physical data pertaining to Friant Dam and Millerton Lake are presented in Table 3-1.

The spillway consists of an ogee overflow section, chute, and stilling basin at the center of the dam. The spillway is controlled by one 18-foot-high by 100-foot-wide drum gate, and two comparably sized Obermeyer gates. Outlets to the Madera Canal are located on the right abutment; outlets to the Friant-Kern Canal are located on the left abutment. A river outlet works is located to the left of the spillway within the lower portion of the dam.

Three powerhouses, owned and operated by the Friant Power Authority (FPA), are located on the downstream side of Friant Dam. A powerhouse on each canal generates hydroelectricity as water is released to the Friant-Kern and Madera canals for delivery. A third powerhouse, located at the base of the dam adjacent to the spillway, generates hydroelectricity as water is released to the San Joaquin River. The combined capacity of the three powerhouses is 30 MW.

Table 3-1. Pertinent Physical Data – Friant Dam and Millerton Lake

General			
Drainage Areas		**Unimpaired Flows of Friant Dam**	
Friant Dam	1,638 square miles	Mean annual runoff (1873-1977)	1,790,300 acre-feet
Mono Creek at Lake Thomas A. Edison	95.2 square miles	Average flow	2,470 cfs
South Fork San Joaquin River at Florence Lake	171 square miles	Min mean daily inflow (Oct. 10, 1977)	0 cfs
		Max mean daily inflow (Dec. 23, 1955)	61,700 cfs
Big Creek at Huntington Lake	80.5 square miles	Max instantaneous inflow (Dec. 23, 1955)	97,000 cfs
North Fork Willow Creek at Bass Lake	50.4 square miles		
Stevenson Creek at Shaver Lake	29.1 square miles	Max mean daily outflow (June 6, 1969)	12,400 cfs
San Joaquin River at Mammoth Pool Reservoir	1,003 square miles	Min mean daily outflow (Oct. 20, 1940)	5.5 cfs
San Joaquin River at Redinger Lake	1,295 square miles	Spillway design flood	
San Joaquin River at Kerckhoff Diversion	1,461 square miles	Peak inflow	197,000 cfs
San Joaquin River at Mendota	3,943 square miles	Peak outflow	158,500 cfs
Friant Dam and Millerton Lake[1]			
Friant Dam (concrete gravity)		**Millerton Lake**	
Elevation, top of parapet	587.6 feet above msl	Elevations	
Freeboard above spillway flood pool	3.25 feet	Minimum operating level[2]	468.7 feet above msl
Elevation, crown of roadway	583.8 feet above msl	Top of active storage capacity	580.6 feet above msl
Max height, foundation to crown of roadway	319 feet	Spillway flood pool	587.6 feet above msl
Crest Length		Area	
Left abutment, nonoverflow section	1,478 feet	Minimum operating level	2,108 acres
Overflow river section	332 feet	Top of active storage capacity	4,905 acres
Right abutment, nonoverflow section	1,678 feet	Spillway flood pool	5,085 acres
Total length	3,488 feet	Storage capacity	
Width of crest at elevation 581.25	20.0 feet	Minimum operating level[2]	130,740 acre-feet
Total concrete in dam and appurtenances	2,135,000 yd^3	Top of active storage capacity	524,250 acre-feet
		Spillway flood pool	559,300 acre-feet
Spillway (gated ogee)		**Outlets**	
Crest length		River outlets (110-inch dia. w/ 96-inch hollow jet valves)	
Gross	332 feet	Number and elevation	4 @ 382.6 feet above msl
Net	300 feet	Capacity at minimum pool	12,400 cfs
Crest elevation	562.6 feet above msl	Capacity at top of active storage	16,400 cfs
Discharge capacity (height = 18.0 feet)	83,160 cfs	Diversion outlets, Madera Canal (91-inch dia. w/ 86-inch needle valve)	
Crest gates (1 drum and 2 Obermeyer)		Number and elevation	2 @ 448.6 feet above msl
Number and size	3 @ 100 feet by 18 feet	Diversion outlets, Friant-Kern Canal (110-inch dia. w/ 96-inch hollow jet valve)	
Top elevation when lowered	562.6 feet above msl	Number and elevation	4 @ 466.6 feet above msl
Top elevation when raised	580.6 feet above msl		
Friant-Kern Canal		**Madera Canal**	
Length	152 miles	Length	35.9 miles
Operating capacity below Friant Dam	4,000 cfs	Capacity below Friant Dam	1,000 cfs
Operating capacity at terminus of canal	2,000 cfs	Capacity at Chowchilla River	625 cfs

Notes:
[1] Elevations given are in North American Vertical Datum (NAVD) 1988.
[2] Minimum operating level generally corresponds with elevation of Friant-Kern Canal outlets.
Source: USACE, 1955 (revised 1980), with elevations revised to NAVD 1988.

Key:
cfs = cubic feet per second
Dec. = December
dia. = diameter
elevation xxx = elevation in feet above mean sea level
hp = horsepower
kW = kilowatt
msl = mean sea level
Oct. = October
yd^3 = cubic yard

Recreation Facilities and Other Reservoir Area Infrastructure

Lands around Millerton Lake have been developed for recreational, residential, and power development purposes. The general locations of facilities and developed lands around Millerton Lake are shown in Figure 1-2.

The Millerton Lake SRA, managed by the DPR, contains numerous recreation facilities, including 10 camping areas, six boat ramps, a privately operated marina, 11 picnic and day-use areas, five trails, and parking, telephone, and toilet facilities.

The SJRGMA, administered by the BLM, is situated upstream from the SRA. It contains a replicated Native American village, trails, a footbridge across the San Joaquin River, and a primitive campground. The most prominent trail is the San Joaquin River Gorge Trail. Information regarding use of recreation facilities and public access within the Millerton Lake SRA and SJRGMA is found in later sections.

The Fresno County Courthouse was removed from an area now within Millerton Lake at the time of Friant Dam construction, and now overlooks the lake from a site on the south side of the reservoir. Several residential areas have been established around Millerton Lake. Three residential developments are located in Fresno County (Lakeview Estates, Winchell Bay, and Sky Harbor); one major development (Hidden View Estates) is located in Madera County. Each of these residential areas includes developed and undeveloped parcels. Other residential sites include two homes in the Temperance Flat area.

Several roads in the Millerton Lake area provide access to residential areas and recreation facilities. Millerton Road skirts the south side of the reservoir, connecting the community of Friant with Auberry Road. Winchell Cove Road and Sky Harbor Road extend from Millerton Road north into residential areas. Sky Harbor Road continues to the South Fine Gold picnic area within the SRA. Madera County Road 206 and Road 145 on the north side of the lake lead to recreational facilities in the SRA. County Road 216 provides access from north of Millerton Lake to the Hidden View residential area near the confluence of Fine Gold Creek and Millerton Lake.

Two Pacific Gas and Electric (PG&E) powerhouses, the Kerckhoff Powerhouse and Kerckhoff No. 2 Powerhouse, are located within 1 mile of the upstream end of Millerton Lake (Figure 1-2). Water is diverted from Kerckhoff Lake at Kerckhoff Dam and conveyed through tunnels and penstocks to serve the powerhouses. The Kerckhoff Powerhouse was commissioned in 1920, has a generation capacity just under 40 MW, and is located on the San Joaquin River at River Mile (RM) 284.5, about a mile upstream from the upper limit of Millerton Lake. The Kerckhoff No. 2 Powerhouse was commissioned in 1983, with a capacity of 155 MW, and discharges directly to the upstream portion of Millerton Lake at RM 282.5.

Flood Management

Friant Dam is the principal flood storage facility on the San Joaquin River, with a dedicated flood management pool of 170 TAF during the flood season of October through March. Under present operating rules, up to 85 TAF of the flood storage required in Millerton Lake may be provided by an equal amount of space in Mammoth Pool. During flood conditions, Friant Dam is operated to maintain releases to the San Joaquin River at or below a flow objective of 8,000 cfs. Several flood events in the past few decades resulted in flows greater than 8,000 cfs downstream from Friant Dam and, in some cases, flood damages resulted. Other flood management facilities of the San Joaquin River basin include levees along the San Joaquin River, Chowchilla Canal Bypass, and Eastside Bypass; levees along the lower portions of the Fresno River and Ash and Berenda sloughs; Bear Creek; and the Merced, Tuolumne, and Stanislaus rivers.

Physical Environment

Elements of the physical environment in the upper San Joaquin River basin are described in this section, and include topography, geology and soils, climate, geomorphology, sedimentation and erosion, hydrology, water quality, groundwater resources, air quality, and noise.

Topography

Regional topography consists of the nearly level floor of the San Joaquin Valley rising abruptly to moderately steep, northwest-trending foothills with rounded canyons. Millerton Lake is set in the lower foothills of the Sierras and extends from a relatively broad open portion near Friant Dam to a long, narrow reach upstream into the upper San Joaquin River. Elevations in the immediate area of Millerton Lake range from about elevation 310 at Friant Dam to over elevation 2,100 at the upper end of the reservoir.

Farther east, the terrain becomes steeper and the canyons become more incised. The canyons were cut by southwest- to west-flowing rivers and associated large tributaries. The topography of the San Joaquin River basin rises to over elevation 12,000 in the upper watershed, located in the Sierra Nevada.

Geology and Soils

The Investigation study area is located along the western border of the central portion of the Sierra Nevada Province at its boundary with the eastern edge of the Great Valley province of California. The Sierra Nevada batholith comprises predominately intrusive rocks, including granite and granodiorite, with some metamorphosed granite and granite gneiss. Intrusive Sierra Nevada batholith rocks underlie most of Millerton Lake and the Temperance Flat dam sites. Occasional remnants of lava flows and layered tuff are present in the area at the highest elevations.

Friant Dam is founded on metamorphic rocks consisting of quartz biotite schist intruded by aplite and pegmatite dikes and by inclusions of dioritic rocks. Erosion has resulted in thin colluvial cover (Reclamation, 2002). The San Joaquin River above Millerton Lake passes through medium-fine-grained metamorphosed granodiorite. Surface weathering has produced some decomposed granite and soils. Coarse-grained granitic dikes are abundant in this region (PG&E, 1986).

The primary study area for the Investigation is in the Upland Soils Physiographic Region of the Central Valley. Upland soils are found on hilly to mountainous topography on the perimeter of the Central Valley and are formed in place through the decomposition and disintegration of the underlying parent material.

Four soil associations are dominant in the primary study area. Temperance Flat and Millerton Bottoms are flanked by the Ahwahnee-Vista Association to the north and by the similar Ahwahnee-Auberry Association to the south. These associations are very similar, differing in the Auberry Series, which has finer textured subsurface horizons and consequently is characterized by slower drainage and runoff. In addition, the Trimmer-Trabuco Association lies along the southwest portion of the reach. These soils are rocky loam and loam with depths ranging from a few inches to nearly 7 feet. The Trabuco Series has hard clay subsoil and as a result, these soils have slow internal drainage. The association has medium to very rapid runoff and low to moderately low permeability.

The San Joaquin River upstream from Millerton Bottoms is in a region dominated by the Ahwahnee-Auberry Association in the south and by the Coarsegold-Trabuco Association in the north below Kerckhoff Dam. The Coarsegold-Trabuco Association is formed on metasedimentary rocks and granite. These soils are fine-loamy in texture and range from less than 2 feet to nearly 7 feet in depth to weathered bedrock. The association exhibits medium to very rapid runoff with moderately low permeability (USDA, 2006).

Climate

The climate of the San Joaquin River Valley is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures on the valley floor often exceed 100 degrees Fahrenheit (°F) for extended periods of time, while winter temperatures only occasionally fall below freezing. Higher elevation portions of the watershed have distinct wet and dry seasons. Most of the precipitation falls from November to April, with rain at the lower elevations and snow in the higher regions. On the valley floor, average annual precipitation decreases from north to south, ranging from 14 inches in Stockton to 8 inches at Mendota.

Geomorphology

The narrow and steep-sided Big Bend area, also referred to as upper Millerton Lake, is immediately downstream from Temperance Flat. The shoreline in much of this portion of the reservoir is steep-sided and rocky, with little vegetation. Temperance Flat is the only substantial area in upper Millerton Lake with a gently sloping shoreline, shallow water, and well-developed shoreline vegetation. The stretch of the river downstream from the Kerckhoff powerhouses, flowing into Temperance Flat, is referred to as Millerton Bottoms. Big Sandy Creek and a few small, unnamed tributaries provide minor flow contributions to Millerton Lake in this reach.

The San Joaquin River upstream from Temperance Flat lies in a steep and narrow canyon that is particularly steep in the upper portion, and is known as the Patterson Bend reach. The 9-mile reach of the San Joaquin River between Kerckhoff Dam and Millerton Lake has a bedrock channel with an overall average gradient of about 1 percent, many long narrow pools, and an occasional steep cascade. The river gorge has a steep eastern side and steeper western side, capped extensively on the western side, and somewhat less extensively on the eastern side, by volcanic tables (PG&E, 1986). Several small, ephemeral streams enter the San Joaquin River in this reach. The river margins in this reach are steep and rocky and flood flows frequently scour the channel.

Sedimentation and Erosion

The substrate in the streams and river originating from direct erosion and mass wasting of resistant granite in the upper San Joaquin River watershed is generally composed of large boulders, cobbles of 4 inches or larger diameter, and fine sand, with a small number of intermediate size gravels (SCE, 2003). Since natural and cut slopes in decomposed granite erode readily and produce these coarse materials, soil erosion potential is high (FERC, 2002). In the past, sluicing to remove sediments from Kerckhoff Lake resulted in extremely high levels of sediment in the San Joaquin River downstream from Kerckhoff Dam, but flood flows in high water years may have flushed these sediments from the river into Millerton Lake. The lack of favorable conditions for chemical weathering in the watershed results in the absence of fine-grained silts and clays. Land disturbing activities, such as road building and timber harvesting, have the greatest potential to increase erosion, resulting in sedimentation in watercourses (SCE, 2003).

Hydrology

This section describes the existing hydrology of the primary study area and portions of the extended study area, including the San Joaquin River and Millerton Lake.

San Joaquin River The San Joaquin River originates in the Sierra Nevada at an elevation of over 12,000 feet and flows into the San Joaquin Valley at Friant Dam. Large areas of high elevation watershed supply snowmelt run off during the late spring and early summer months, which is the main contributor to flow in the upper San Joaquin River. Downstream from Friant Dam, the river flows westward toward the center of the valley floor, where it turns sharply northward and flows through the San Joaquin Valley to the Delta. Along the valley floor, the San Joaquin River receives additional flow from the Merced, Tuolumne, and Stanislaus rivers and numerous smaller tributaries.

Upper San Joaquin River flows have been greatly affected by storage and releases of power projects, including the SCE Big Creek Project, the PG&E Crane Valley Project, and the PG&E Kerckhoff Project. In addition to hydropower generation, reservoirs associated with these projects provide storage, flood management capacity, and recreational opportunities.

The California Data Exchange Center (CDEC) maintains estimates of unimpaired flow (flow that would occur at a specific location if upstream facilities were not in place) at various locations in the upper San Joaquin River basin. Annual unimpaired runoff from the upper San Joaquin River basin (at Friant Dam) varies widely, ranging from about 362 TAF in 1977 to 4,642 TAF in 1983, with an average of 1,818 TAF.

The reach of the San Joaquin River downstream from Friant Dam and upstream from the confluence with the Merced River was historically fed by runoff from the upper San Joaquin River. During the past 100 years, development in the region resulted in groundwater overdraft conditions, causing the river to lose much of its flow in this reach through percolation. However, implementation of the SJRRP is restoring flow in this reach, as described in more detail under the Likely Future Conditions section. In the reach between Friant Dam and Gravelly Ford, flow is influenced by releases from Friant Dam, with minor contributions from agricultural and urban return flows. Releases from Friant Dam to the San Joaquin River since 1941 are generally limited to minimum releases to satisfy water rights and provide instream flows above Gravelly Ford, and flood management releases.

Millerton Lake Millerton Lake is formed behind Friant Dam and has a capacity of 520 TAF. At full pool, the reservoir has a maximum depth of 287 feet. Above Friant Dam, the San Joaquin River drains an area of approximately 1,676 square miles. Several reservoirs in the upper portion of the San Joaquin River watershed, including Mammoth Pool and Shaver Lake, are used primarily for hydroelectric power generation. Operation of these reservoirs affects the inflow to Millerton Lake.

Water Quality

Most of Millerton Lake becomes thermally stratified during spring and summer months. Complete mixing of the water column likely occurs during winter months. Water temperatures in Kerckhoff Lake rarely exceed 68ºF. Summer water temperatures in the San Joaquin River below Kerckhoff Dam often exceed 75ºF because of low streamflow and warming of the FERC-mandated releases from Kerckhoff Dam. During summer, cold water outflows from the

Kerckhoff and Kerckhoff No. 2 powerhouses, which bypass an 8- and 9.5-mile portion of the San Joaquin River through tunnels from Kerckhoff Lake, travel downstream to the upper portion of Millerton Lake. The colder, denser river inflow submerges at a location referred to as the "plunge point," and continues to flow downstream below the warmer reservoir surface layer (Ford, 1990; PG&E, 2001). The distance in the reservoir to the plunge point is a function of the volume and temperature of San Joaquin River inflow, storage elevation of Millerton Lake, and water temperature of the reservoir surface layer. When inflow is high, the plunge point is often located near the upper end of Temperance Flat (PG&E, 1990).

Water quality in the San Joaquin River varies considerably along the river's length. Above Millerton Lake and downstream towards Mendota Pool, water quality is generally excellent. The upper reaches of the rivers draining to the San Joaquin River basin originate in large drainage areas high on the west side of the Sierra Nevada. The water in these rivers is generally soft, with low mineral concentrations. Water is nutrient- and mineral-poor due to the insolubility of the granite substrate.

As the San Joaquin River flows from the Sierra Nevada foothills below Friant Dam across the eastern valley floor, mineral concentrations steadily increase, largely as a result of depleted freshwater flows, M&I wastewater discharges, salt loads in agricultural drainage and runoff, and loads of other constituents associated with agricultural irrigation and production (DWR, 2005). These constituents include nutrients, selenium, boron, organophosphate pesticides, such as diazinon and chlorpyrifos, and toxicity of unknown origin.

Downstream from the primary study area, the reach from Gravelly Ford to Mendota Pool (about 17 miles) has been frequently dry historically, except during flood releases. However, the Settlement will increase releases from Friant Dam compared to historical operations to ensure that the reach between Friant Dam and the Merced River confluence has continuous flow dedicated to environmental purposes, which will improve water quality in this reach.

During the irrigation season, most of the water released from the Mendota Pool to the San Joaquin River is imported from the Delta via the Delta-Mendota Canal, and generally has higher concentrations of total dissolved solids (TDS) than water in the upper reaches of the San Joaquin River. Most of the water released from the Mendota Pool to the San Joaquin River is diverted at or above Sack Dam for agricultural uses. Historically, the San Joaquin River has been often dry between Sack Dam and the confluence with Salt Slough. From Salt Slough to Fremont Ford, most of the flow in the San Joaquin River is derived from irrigation return flows carried by Salt and Mud sloughs. This reach typically has the poorest water quality of any reach of the river. As the San Joaquin River flows downstream from Fremont Ford, water quality generally improves at successive confluences, specifically at those with the Merced, Tuolumne, and Stanislaus rivers.

Groundwater Resources

Within the primary study area, the majority of groundwater occurs in fractured bedrock. Localized alluvial material and weathered bedrock have potential to provide groundwater in the area, but large volumes of these materials were not identified within the Auberry-Prather area during a regional study of groundwater resources in eastern Fresno County (Fresno County, 2006).

Figure 3-1 shows the locations of groundwater subbasins underlying the San Joaquin Valley within the primary and extended study areas. Groundwater quality throughout the region is suitable for most urban and agricultural uses. Local water quality impairments do exist for such constituents as TDS, nitrate, boron, chloride, and organic compounds (DWR, 2003).

Air Quality

Air quality in the San Joaquin Valley Air Basin (SJVAB) is regulated by the San Joaquin Valley Air Pollution Control District (SJVAPCD), which consists of Merced, Madera, Fresno, Kern, Kings, San Joaquin, Stanislaus, and Tulare counties. The entire SJVAB is designated nonattainment with respect to the national 8-hour and State 1-hour ozone (O_3) standards, national and State and particulate matter (PM) standards of 10 microns in aerometric diameter or less (PM^{10}) and 2.5 microns or less ($PM^{2.5}$). Urban areas of Fresno, Modesto, and Stockton are "nonattainment" for the national and State carbon monoxide (CO) standards (ARB, 1996).

Noise

Noise levels in densely populated areas of the State are influenced predominantly by the presence of limited-access highways carrying extremely high volumes of traffic, particularly heavy trucks. Noise in rural areas, where traffic generally is low to moderate, is measured at considerably lower decibels. Noise at Millerton Lake is generally affected by the presence of boats and personal watercraft.

Figure 3-1. San Joaquin Valley Groundwater Subbasins

Biological Environment

Elements of the aquatic and terrestrial biological environment in the upper San Joaquin River basin are described in this section. The discussion focuses on habitat and species, including special-status species.

Aquatic and Fishery Resources

The following sections discuss existing aquatic and fishery resources habitat and species in the primary study area.

Habitat Under current reservoir operations, Millerton Lake water levels change by 1 foot or more per day almost 50 percent of days, and change by 2 feet or more about 10 percent of days. Extreme water-level fluctuation in reservoirs resulting from reservoir management priorities is perhaps the most important environmental factor affecting reservoir fish population productivity. The direct and indirect effects of fluctuating water levels are also responsible for other fishery management issues, such as limited cover habitat, limited littoral habitat, and shoreline erosion.

Riparian vegetation along most of the San Joaquin River from Kerckhoff Dam to Millerton Lake is poorly developed because the river margins are steep and rocky, and flood flows frequently scour the channel. Some riparian vegetation occurs at the confluence of small streams in the upper portion of this reach.

Most of Millerton Lake becomes thermally stratified during spring and summer months and, therefore, potentially supports a two-stage fishery, with cold-water species residing in deep water and warm-water species inhabiting surface waters and shallow areas near shore. When thermal stratification occurs, the largest temperature difference in Millerton Lake can be observed, particularly in the summer months, when the surface temperature can reach as high as 80°F while the temperature at the bottom of the reservoir stays as low as 50°F. During late fall and winter months, the differences in temperatures between the surface and bottom of the reservoir may vary as little as 3°F. Shallow shoreline areas, particularly in protected coves, are likely to warm and cool more quickly in response to changes in air temperatures and solar heating than the rest of the reservoir, although water temperatures of tributary streams may also affect these areas when inflows are substantial.

Species Most of the commonly occurring species in Millerton Lake are introduced game or forage species (Table 3-2). The principal game species are spotted bass, largemouth bass, smallmouth bass (collectively referred to as black bass), bluegill, black crappie, and striped bass. The principal forage species for most of the game fishes is threadfin shad. Rainbow trout, also an important game species, is frequently abundant in the upper San Joaquin River reach between Millerton Lake and Kerckhoff Dam. Several native nongame species have been collected from the reservoir, including Sacramento sucker, Sacramento pikeminnow, Sacramento blackfish, hitch, hardhead, and white sturgeon. However, most of the native species have been extirpated in recent years (Mitchell, pers. com., 2006). Aquatic species reported in the primary study area are listed in Table 3-2.

Table 3-2. Fishes Occurring Within the Investigation Primary Study Area

Common Name	Scientific Name	Study Area Distribution	Native or Introduced
Hardhead	*Mylopharodon conocephalus*	San Joaquin River	Native
Kern brook lamprey[1]	*Lampetra hubbsi*	San Joaquin River	Native
Sacramento sucker	*Catostomus occidentalis*	Millerton Lake & San Joaquin River	Native
Sacramento pikeminnow	*Ptychocheilus grandis*	Millerton Lake & San Joaquin River	Native
Sacramento blackfish	*Orthodon microlepidotus*	Millerton Lake	Native
White sturgeon	*Acipenser transmontanus*	Millerton Lake	Native
Striped bass	*Morone saxatilis*	Millerton Lake	Introduced
Largemouth bass	*Micropterus salmoides*	Millerton Lake	Introduced
Spotted bass	*Micropterus punctulatus*	Millerton Lake	Introduced
Smallmouth bass	*Micropterus dolomieui*	Millerton Lake	Introduced
Bluegill	*Lepomis macrochirus*	Millerton Lake	Introduced
Black crappie	*Pomoxis nigromaculatus*	Millerton Lake	Introduced
Rainbow trout	*Oncorhynchus mykiss*	San Joaquin River	Native
American shad	*Alosa sapidissima*	Millerton Lake	Introduced
Threadfin shad	*Dorosoma pretense*	Millerton Lake	Introduced
Hitch	*Lavinia exilicauda*	Fine Gold Creek & Millerton Lake	Native
Green sunfish	*Lepomis cyanellus*	Fine Gold Creek, Millerton Lake & San Joaquin River	Introduced

Note:
[1] Presence of Kern brook lamprey is uncertain.

American shad, which was introduced to Millerton Lake in the 1950s, has marginal value as a sport fish in Millerton Lake, but is highly sought after as a sport fish by anglers in some regions of California and other states, and is an important prey item for adult striped bass (California Striped Bass Association, pers. com., 2006). The Millerton Lake population of American shad is the only known successfully spawning, landlocked population. Because of its unique status, the population has attracted scientific interest and has been intensively studied in connection with PG&E's FERC licensing studies for the Kerckhoff No. 2 Hydroelectric Project (PG&E, 1986; 2001).

The San Joaquin River between Millerton Lake and Kerckhoff Dam has spawning habitat for American shad and striped bass. Native fish species in the reach include hardhead, Sacramento pikeminnow, Sacramento sucker, and rainbow trout. Nonnative fish species include smallmouth bass and green sunfish. Kern brook lamprey, endemic to the east side of the San Joaquin Valley, has been reported as potentially present in the San Joaquin River between Kerckhoff Dam and Millerton Lake, although its current status in the area is uncertain (Wang, 1986). In addition to fish, beds of the large, freshwater pearlshell clam (*Margaritifera* spp.) have been found on the river bottom in this reach but the distribution and abundance of this clam are poorly known. The clam is listed as a "Special Animal" by DFG, with its status in California classified as uncertain.

No aquatic species in the primary study area are Federally or State-listed as threatened or endangered. Three species have special Federal and/or State status because they are relatively rare or are declining in abundance and/or distribution: hardhead, hitch, and Kern brook lamprey.

Terrestrial Biological Resources

The following sections discuss existing terrestrial biological resource habitat and species in the study area.

Habitat Vegetation around Millerton Lake is a mosaic of habitat types, specifically annual grassland, oak woodland, and foothill pine oak woodland. Nonnative annual grassland is common on the north side of the reservoir near Friant Dam, and grades into oak woodland and foothill pine oak woodland pine to the east. The south side of Millerton Lake near Friant Dam supports more forest land than the north side but also contains small patches of grassland and urban areas. Foothill pine oak woodland is found throughout the primary study area, especially in ravines and on north- and east-facing slopes. It intergrades with blue oak woodland, which is more frequent on drier, less shaded sites, most commonly occurring on the north side of Millerton Lake. Interior live oak woodland occurs at the higher elevation limits of the primary study area on steep and rocky, north-facing slopes and becomes more abundant just outside of the primary study area. Buckbrush chaparral is the most common shrub-dominated habitat type in the study area; bush lupine scrub also occurs in the area.

Various riparian communities occur in the area, dominated by species that include white alder, sycamore, willow, cottonwood, and buttonbrush, and nonnative species such as Himalayan blackberry, fig, and Spanish broom. Riparian vegetation occurs along the San Joaquin River and its intermittent and ephemeral tributaries.

Historically, the area has been affected by manmade and natural disturbances. A number of nonnative species have been intentionally or inadvertently introduced in the course of human settlement in the region, including invasive plants and game fish and wildlife species. Cattle grazing, a traditional land use managed by BLM, is pervasive on public and private lands in the area. Ecosystems in the basin have been extensively affected by fires, and many plant and wildlife species are fire-adapted. Historical records indicate that over half of the upper San Joaquin River watershed had burned before the 1950s. Since then, fire suppression has decreased the number of fires in the study area to infrequent, random events triggered by natural causes (lightning).

Species A number of rare and listed plant species are known to occur in the primary study area. These include Ewan's larkspur, Michael's piperia, tree anemone, and Madera leptosiphon. Two plant species, the elderberry and California pipevine, which serve as hosts for invertebrates of interest, are also known to occur in the area. California pipevine is the obligate host plant for the pipevine swallowtail, a butterfly species of management concern in the primary study area because it is one of only two known nonmigratory populations. The elderberry (*Sambucus* sp.) shrub is the host plant of the valley elderberry longhorn beetle, Federally listed as threatened.

The primary study area hosts a diverse wildlife community, both resident and seasonal. A relatively diverse community of reptile and amphibian species exists in the study area. The presence of the nonnative bullfrog has changed, and continues to dramatically alter, the extant reptile and amphibian community through predation and because of its ability to out-compete native species. The western pond turtle, a California Species of Special Concern, is known to occur in several portions of the primary study area. Bullfrogs have specifically been cited as a factor in western pond turtle decline in many areas because of their predation of hatchling turtles. The Federally listed California tiger salamander has also been reported in the vicinity of the primary study area, and Critical Habitat has been designated for this species near, but outside of, the primary study area. Limited areas of potential breeding habitat for California tiger salamander have been identified in the San Joaquin River Gorge. These are primarily stock ponds dominated by nonnative species.

The bird community in the primary study area has a number of specialist species that are primarily limited to specific habitat types, while other generalist species range throughout the area using a number of habitats. For example, some species are associated with water and riparian habitats, while others are more independent of available water. Bald eagles, recently Federally delisted and currently State-listed, use roost trees near open water for foraging. Bald eagles are known to winter around Millerton Lake, and a pair has recently been observed nesting in the primary study area. Several species associated with riparian habitats, including the least Bell's vireo and willow flycatcher, have been known to occur historically in the primary study area, but have not been recently documented. As in the reptile and amphibian community, a number of nonnative birds are present in the primary study area that influence the native bird community through competition (e.g., European starlings) and nest parasitism (e.g., brown-headed cowbird). Cowbird brood parasitism has specifically been identified as a major factor in the decline of least Bell's vireo.

The mammalian community has been affected by considerable habitat change associated with livestock grazing; increased residential development; the impact of recreational activity, such as noise from boating and recreational users and the increased number of trails into more remote areas used by hikers, mountain bikers, and hunters; and suppression of the natural fire regime, which maintains suitable habitat structure and elements. A number of special-status bat species have potential to occur in the primary study area, and suitable roost sites occur throughout the area. Other special-status species that may occur in the primary study area include the ringtail, American badger, and San Joaquin pocket mouse.

Important game species also occur in the primary study area, specifically mule deer, California quail, wild turkey, and feral pigs. The region provides winter range and migratory routes for the San Joaquin deer herd. Hunting of these species contributes substantially to the local economy.

Socioeconomic Resources

This section describes socioeconomic resources in the study area, including water resources, power/energy, land use, traffic and transportation, and recreation and public access. This section will focus on socioeconomic resources of the primary study area, but include the extended study area where relevant.

Water Resources

The east side of the San Joaquin Valley includes numerous streams and rivers that drain the western slope of the Sierra Nevada Mountains and flow into the Central Valley. During the past 50 years, water resources of all major rivers have been developed through construction of dams and reservoirs for water supply, flood damage reduction, and hydropower generation. Table 3-3 summarizes the major reservoirs in the eastern San Joaquin Valley and their purposes. With the exception of the San Joaquin River, the table lists only the largest reservoir on each river. Figure 3-2 shows the reservoirs upstream from Friant Dam in the upper San Joaquin River basin.

Table 3-3. Reservoirs on the East Side of the San Joaquin Valley

Name	River or Creek	Owner	Storage (TAF)	Year Built	Operational Objectives				
					FDR	WS	HP	RF	WQ
Reservoirs in the Upper San Joaquin River Watershed									
Millerton	San Joaquin	Reclamation	520	1942	X	X		X[1]	
Kerckhoff	San Joaquin	PG&E	4	1920			X	X	
Redinger	San Joaquin	SCE	35	1951			X	X	
Florence	South Fork San Joaquin	SCE	64	1926			X	X	
Huntington	Big Creek	SCE	89	1917			X	X	
Shaver	Stevenson Creek	SCE	135	1927			X	X	
Thomas Edison	Mono Creek	SCE	125	1954			X	X	
Mammoth Pool	San Joaquin	SCE	123	1960			X	X	
Reservoirs in Other San Joaquin Valley Watersheds									
New Melones	Stanislaus	Reclamation	2,420	1978	X	X	X	X	X
Don Pedro	Tuolumne	MID/TID	2,030	1970	X	X	X	X	
Lake McClure	Merced	MID	1,025	1967	X	X	X	X	
Eastman	Chowchilla	USACE	150	1975	X	X			
Hensley	Fresno	USACE	90	1975	X	X			
Pine Flat	Kings	USACE	1,000	1954	X	X			
Kaweah[2]	Kaweah	USACE	143	1962	X	X			
Success[2]	Tule	USACE	82	1961	X	X			
Isabella	Kern	USACE	568	1953	X	X			

Notes:

[1] Per the San Joaquin River Settlement (*NRDC et al. v. Kirk Rodgers et al.*, 2006), interim restoration flows from Friant Dam will in begin in late 2009, reintroduction of fall- and/or spring-run Chinook salmon will occur by December 31, 2012, and full restoration flows will begin on January 1, 2014.

[2] Enlargement of Kaweah and Success reservoirs has been authorized. Existing capacity listed.

Key:

Owners

MID = Merced Irrigation District
MID/TID = Modesto Irrigation District/Turlock Irrigation District
PG&E = Pacific Gas and Electric
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
SCE = Southern California Edison
USACE = U.S. Army Corps of Engineers

Operational Objectives

FDR = Flood damage reduction (these reservoirs have dedicated flood storage space)
HP = Hydropower generation
RF = Downstream river instream flow requirements, as mandated by operating agreements or licenses (e.g., Federal Energy Regulatory Commission, Reclamation)
TAF = thousand acre-feet
WQ = Sacramento-San Joaquin Delta water quality
WS = Water supply for irrigation, domestic, municipal, and industrial uses

Figure 3-2. Reservoirs Upstream from Friant Dam

Groundwater is a major source of agricultural and urban water supplies in the extended study area. Expansion of agricultural practices between 1920 and 1950 caused declines in groundwater levels in many areas of the San Joaquin River hydrologic region. Along the east side of the region, declines in groundwater levels have ranged between 40 and 80 feet since predevelopment conditions (1860) (Williamson et al., 1989). Groundwater levels declined substantially in the Madera County area, which depends heavily on groundwater for irrigation (Williamson et al., 1989). The cities of Fresno and Visalia are largely dependent on groundwater supplies, with Fresno being the second largest city in the United States predominantly reliant on groundwater (DWR, 2003). Typical groundwater production conditions for each subbasin are listed in Table 3-4 based on information from DWR Bulletin 160-98 (1998). At a 1995 level of development, annual average groundwater overdraft is estimated at about 240 TAF per year in the San Joaquin River hydrologic region and at about 820 TAF per year in the Tulare Lake hydrologic region (DWR, 1998). Historical groundwater use has resulted in land subsidence in the southwest portion of the region.

Table 3-4. Production Conditions in San Joaquin Valley Groundwater Subbasins

Subbasin Number[1]	Subbasin Name[1]	Extraction (TAF/year)[2]	Well Yields (gpm)[1]	Pumping Lifts (feet)[2]
San Joaquin River Hydrologic Region				
5-22.02	Modesto	230	1,000 – 2,000	90
5-22.03	Turlock	450	1,000 – 2,000	90
5-22.04	Merced	560	1,500 – 1,900	110
5-22.05	Chowchilla	260	750 – 2,000	110
5-22.06	Madera	570	750 – 2,000	160
5-22.07	Delta-Mendota	510	800 – 2,000	35 – 150
Tulare Lake Hydrologic Region				
5-22.08	Kings	1,790	500 – 1,500	150
5-22.09	Westside	210	1,100	200 – 800
5-22.10	Pleasant Valley	100	35 – 3,300	350
5-22.11	Kaweah	760	100 – 2,500	125 – 250
5-22.12	Tulare Lake	670	300 – 1,000	270
5-22.13	Tule	660	50 – 3,000	150 – 200
5-22.14	Kern County	1,400	1,200 – 1,500	200 – 250

Sources:
[1] *DWR. 2003. Bulletin 118-03. October.*
[2] *DWR. 1998. Bulletin 160-98. November.*

Key:
gpm = gallons per minute
TAF = thousand acre-feet

Central Valley Project The CVP, approved by President Franklin Roosevelt on December 2, 1935, is the largest surface water storage and delivery system in California, with a geographic area covering 35 of the State's 58 counties. The project includes 18 reservoirs with a combined storage capacity of approximately 11 MAF; eight powerhouses and two pump-generating plants, with a combined generation capacity of approximately 2 million kilowatts (kW); and approximately 500 miles of major canals and aqueducts. Figure 3-3 shows locations of major CVP and SWP facilities. Table 3-5 lists major CVP water storage facilities.

Figure 3-3. Major Central Valley Project and State Water Project Facilities

Table 3-5. Central Valley Project Water Storage Facilities

Storage Facility Name	CVP Division	CVP Storage Capacity (acre-feet)
Clair Engle Lake	Trinity River	2,447,700
Lewiston Lake	Trinity River	14,660
Whiskeytown Lake	Trinity River	241,100
Spring Creek Reservoir	Trinity River	5,900
Shasta Lake	Shasta	4,552,005
Keswick Reservoir	Shasta	23,800
Red Bluff Diversion	Sacramento River	3,920
Black Butte Reservoir	Sacramento River	143,700
Folsom Lake	American River	976,960
Lake Natoma	American River	9,030
New Melones Lake	East Side	2,420,000
San Justo Reservoir	San Felipe	9,906
Millerton Lake	Friant	520,500
San Luis Reservoir	West San Joaquin	2,040,600
O'Neill Forebay	West San Joaquin	56,400
Los Banos Reservoir	West San Joaquin	34,560
Little Panoche Reservoir	West San Joaquin	5,580
Contra Loma Reservoir	Delta	2,100

Source: Reclamation. 2008b. Central Valley Operations Office, Report of Operations. January.

Central Valley Project Operations CVP operations are divided into nine divisions. Operations north of the Delta include the Trinity, Shasta, Sacramento River, and American River divisions, known collectively as the Northern CVP System. Those south of the Delta, the Delta, West San Joaquin, and San Felipe divisions, are known collectively as the Southern CVP System. Operations of the Eastside and Friant divisions of the CVP differ from the divisions in the Northern and Southern CVP systems in that their water deliveries are not linked to Delta pumping operations.

Northern and Southern Central Valley Project Contractors and Contract Types The Northern CVP and Southern CVP supply irrigation, M&I, and refuge water to more than 250 long-term water contractors in the Central Valley, Santa Clara Valley, and Bay Area. For most water users, water service contracts represent a supply supplemental to local sources, including groundwater. Northern and Southern CVP water service contracts total 3,326 TAF/year (DWR and Reclamation, 2007).

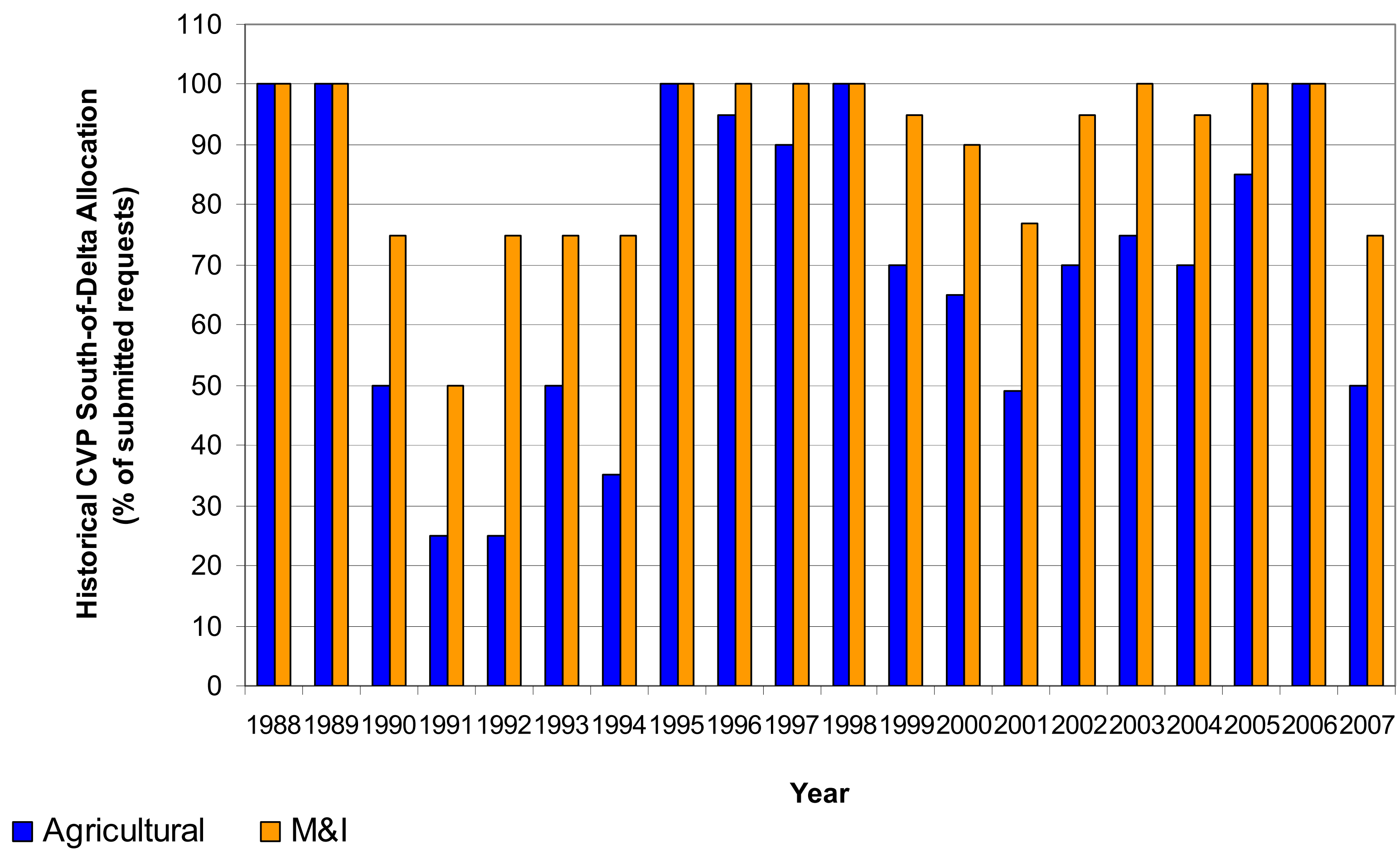
During development of the CVP, the United States entered into two types of long-term agreements with many major water right holders: the Sacramento River Settlement Contractors, and San Joaquin River Exchange Contractors. Sacramento River Settlement Contractors primarily claim water rights on the Sacramento River. Because of the major influence of Shasta Dam operations on flows in the Sacramento River, these water right claimants entered into contracts with Reclamation. Most of the agreements established the quantities of water the contractors are allowed to divert from April through October without payment to Reclamation, and a supplemental CVP supply allocated by Reclamation. CVP contracts with the Sacramento River Settlement Contractors total 2,194 TAF/year (DWR and Reclamation, 2007).

The San Joaquin River Exchange Contractors are contractors who receive CVP water from the Delta via the Mendota Pool. Under exchange contracts, the parties agreed not to exercise their San Joaquin River water rights in exchange for a substitute CVP water supply from the Delta. These exchanges allow water to be diverted from the San Joaquin River at Friant Dam for use by water service contractors in the eastern San Joaquin Valley and Tulare Lake basin. CVP contracts with the San Joaquin River Exchange Contractors total 840 TAF/year (DWR and Reclamation, 2007).

Water Deliveries The CVP irrigates about 3.25 million acres of farmland, supplies water to more than 2 million consumers, and is also the primary source of water for much of California's wetlands. Annually, the CVP has the potential to supply about 6.2 MAF for agricultural uses, 0.5 MAF for urban uses, and 0.3 MAF for wildlife refuges. The Northern and Southern CVP systems allocated an annual average of 5,734 TAF between 1998 and 2007 (Reclamation, 2008b; DWR and Reclamation, 2007).

When deficiencies in the ability of the system to deliver full contract amounts occur, deliveries are reduced by varying percentages based on demand type (e.g., refuges, settlement contracts, and CVP contracts). For north-of-Delta (NOD) and SOD operations, priority deliveries include water for wildlife refuges and water required by the CVP Exchange and Settlement Contractors. Discretionary deliveries, which can be shorted considerably depending on the type of water year, include agricultural and M&I water service contractors both north and south of the Delta. Figure 3-4 shows the historical CVP SOD allocations for M&I and agricultural uses from 1988 through 2007 (Reclamation, 2008b).

Water supply reliability is a key component of the CVP. The CVP's water supply depends on rainfall, snowpack, runoff, reservoir storage, pumping capacity from the Delta, and regulatory and environmental constraints on project operations. Since 2000, CVP water deliveries have been limited because of insufficient supply, lack of conveyance capacity, and/or operational constraints on Delta pumping resulting from either endangered species protection or implementation of CVPIA actions using a portion of the CVP yield (Reclamation and DWR, 2004).



Source: Reclamation. 2008b. Central Valley Operations Office, Water Allocations_(Historical): Summary of Water Allocations.

Figure 3-4. Historical Central Valley Project Allocations for South of Delta M&I and Agricultural Uses from 1988 Through 2007

Friant Division Operations The Friant Division encompasses Friant Dam and Millerton Lake, and the Madera and Friant-Kern canals, which convey water north and south, respectively, to agricultural and urban water contractors. Friant Dam is operated as an annual reservoir, meaning all water supplies available in a given year are allocated with the expectation of delivery. River releases are made to satisfy downstream water rights and contract diversions. Under current conditions, specific releases are not made to the San Joaquin River to maintain fishery conditions downstream from Friant Dam. Consequently, Millerton Lake is not operated with objectives to manage the release of water at desired temperatures or provide carryover for use in subsequent years.

Contractors and Contract Types The Friant Division was designed and is operated to support conjunctive water management in an area that was subject to groundwater overdraft before construction of Friant Dam. The area supplied by the Friant Division remains in a state of groundwater overdraft today. Reclamation employs a two-class system of water allocation to take advantage of water during wetter years. Figure 3-5 shows the locations and acreage of the 28 long-term Friant Division water service contractors. Table 3-6 lists the total Friant Division contract amounts for each contractor.

Class 1 contracts, which are based on a firm water supply, are generally assigned to M&I and agricultural water users who have limited access to good quality groundwater. Lands served by Class 1 contracts primarily include upslope areas planted in citrus or deciduous fruit trees. During project operations, the first 800 TAF of annual water supply are delivered under Class 1 contracts.

Class 2 water is a supplemental supply and is delivered directly for agricultural use or for groundwater recharge, generally in areas that experience groundwater overdraft. Class 2 contractors typically have access to good quality groundwater supplies and can use groundwater during periods of surface water deficiency. Many Class 2 contractors are in areas with high groundwater recharge capability and operate dedicated groundwater recharge facilities.

In addition to Class 1 and Class 2 water deliveries, Reclamation Reform Act of 1982 water is provided in Section 215 of the Act, which authorizes the delivery of unstorable irrigation water that would be released in accordance with flood management criteria or unmanaged flood flows. Delivery of Section 215 water has enabled groundwater replenishment at levels higher than otherwise could be supported with Class 1 and Class 2 contract deliveries.

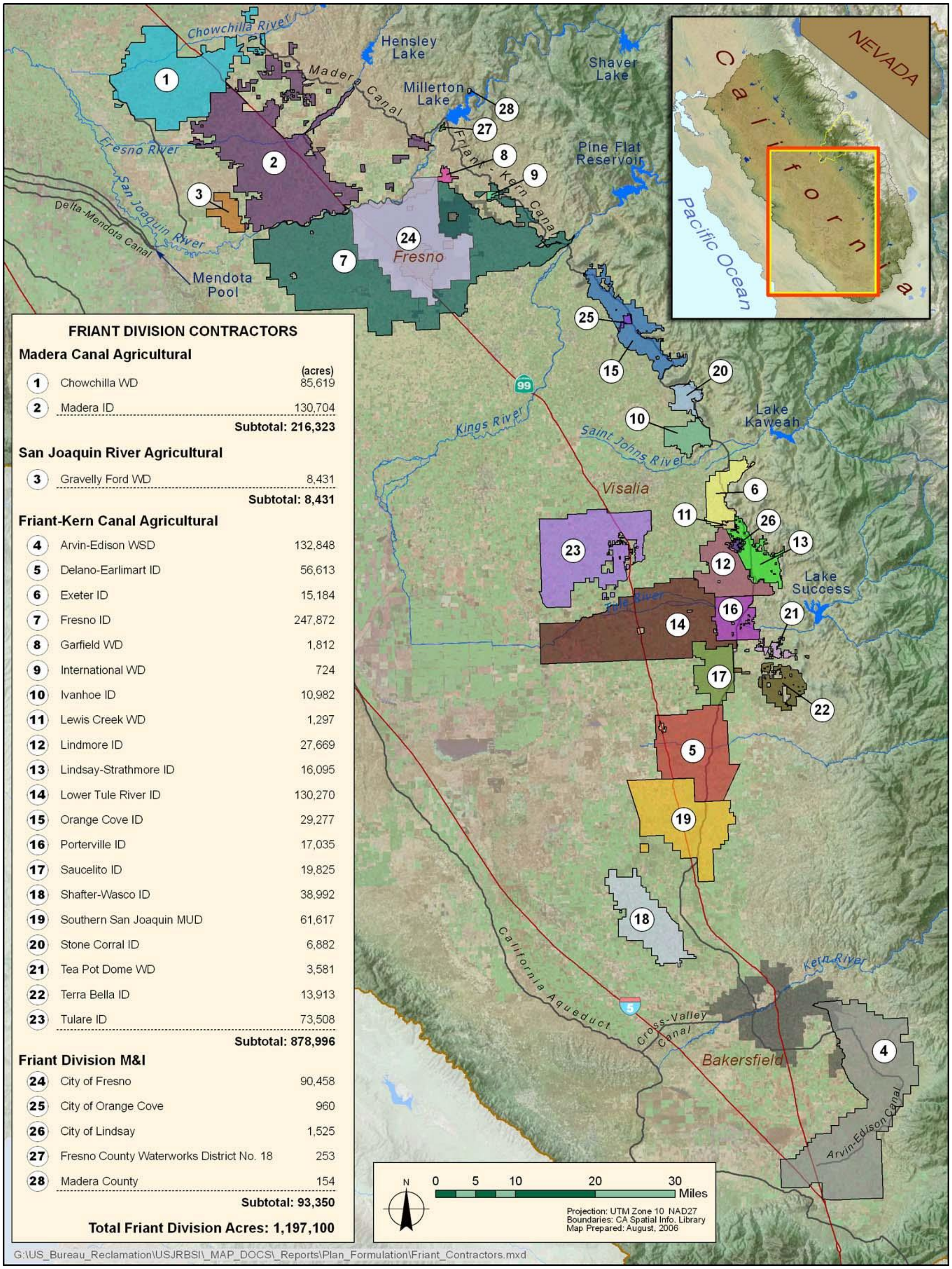


Figure 3-5. Friant Division Contractors

Table 3-6. Total Friant Division Long-Term Contracts

Contract Type/Contractor	Class 1 (acre-feet)	Class 2 (acre-feet)	Cross-Valley (acre-feet)
Friant Division Agriculture			
Madera Canal Agricultural			
Chowchilla WD	55,000	160,000	
Madera ID	85,000	186,000	
Total Madera Canal Agricultural	**140,000**	**346,000**	
San Joaquin River Agricultural			
Gravelly Ford WD	0	14,000	
Total San Joaquin River Agricultural	**0**	**14,000**	
Friant-Kern Canal Agricultural			
Arvin-Edison WSD	40,000	311,675	
Delano-Earlimart ID	108,800	74,500	
Exeter ID	11,500	19,000	
Fresno ID	0	75,000	
Garfield WD	3,500	0	
International WD	1,200	0	
Ivanhoe ID	7,700	7,900	
Lewis Creek WD	1,450	0	
Lindmore ID	33,000	22,000	
Lindsay-Strathmore ID	27,500	0	
Lower Tule River ID	61,200	238,000	
Orange Cove ID	39,200	0	
Porterville ID	16,000	30,000	
Saucelito ID	21,200	32,800	
Shafter-Wasco ID	50,000	39,600	
Southern San Joaquin MUD	97,000	50,000	
Stone Corral ID	10,000	0	
Tea Pot Dome WD	7,500	0	
Terra Bella ID	29,000	0	
Tulare ID	30,000	141,000	
Total Friant-Kern Canal Agricultural	**595,750**	**1,041,475**	
Total Friant Division Agricultural	**735,750**	**1,401,475**	
Friant Division M&I			
City of Fresno	60,000		
City of Orange Cove	1,400		
City of Lindsay	2,500		
Fresno County Waterworks District No. 18	150		
Madera County	200		
Total Friant Division M&I	**64,250**		
Total Friant Division Contracts	**800,000**	**1,401,475**	
Cross-Valley Canal Exchange			
Fresno County			3,000
Tulare County			5,308
Hills Valley ID			3,346
Kern-Tulare WD			40,000
Lower Tule River ID			31,102
Pixley ID			31,102
Rag Gulch WD			13,300
Tri-Valley WD			1,142
Total Cross-Valley Canal Exchange			**128,300**

Source: Friant Water Users Authority Informational Report, n.d. Information on Friant Division Water Deliveries.

Key:
ID = Irrigation District
M&I = municipal and industrial
MUD Municipal Utility District
WD = Water District
WSD Water Storage District

Water Deliveries Historically, the Friant Division has delivered an average of about 1,300 TAF of water annually. Since 1949, Reclamation has made annual releases of 117 TAF from Friant Dam to the San Joaquin River to meet downstream water right diversions above Gravelly Ford. Additional flows occur during years when releases are made to the San Joaquin River for flood management purposes.

Figure 3-6 shows the historical allocation of water to Friant Division contractors. As shown, annual allocation of Class 1 and Class 2 water varies widely in response to hydrologic conditions. It is important to note that average allocation percentages in the future would likely be less than the historical data presented because of implementation of the Settlement (which will be discussed in a subsequent section of this chapter).

From 1957 through 2007, annual allocations of Class 1 water were typically at or above 75 percent of contract amounts, except in 3 extremely dry years. In this same period, full allocation of Class 2 water supplies occurred in about one-fourth of the years. During the extended drought from 1987 through 1992, no Class 2 water was available and Class 1 allocations were below full contract amounts, except in 1 year. During this and other historical drought periods, water contractors relied heavily on groundwater to meet water demands.

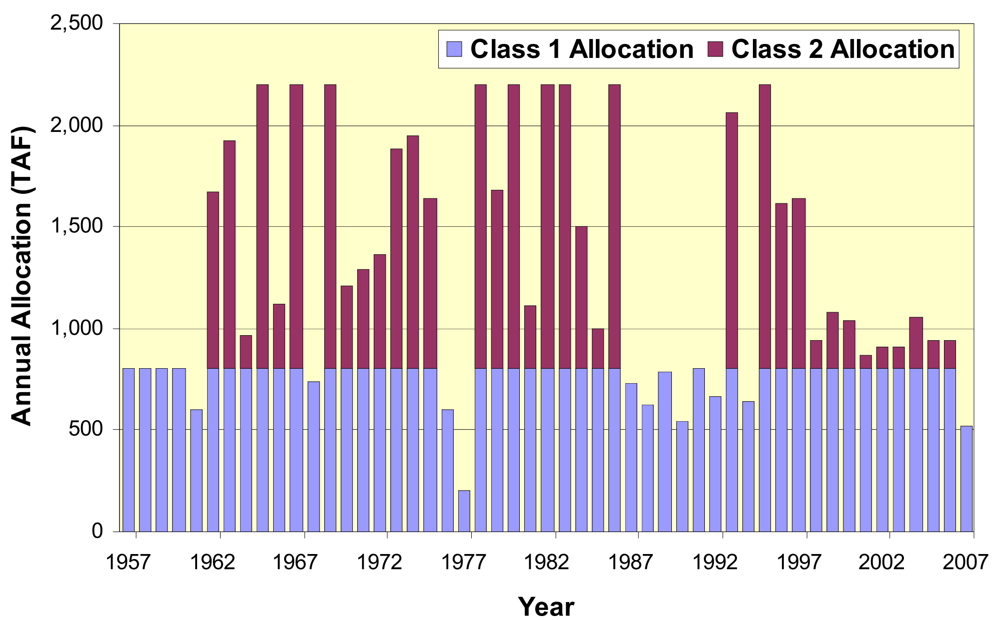


Figure 3-6. Historical Allocation to Friant Division Contractors

In addition to the Class 1, Class 2, and conjunctive management aspects of Friant Division operations, a productive program of transfers between districts takes place annually. This program provides opportunities to improve water management within the Friant Division service area. In wet years, water surplus to one district's need can be transferred to other districts with the ability to recharge groundwater. Conversely, in dry years, water is returned to districts with little or no groundwater supply, thereby providing an ongoing informal groundwater banking program within the Friant Division.

The Cross-Valley Canal, a locally financed facility completed in 1975, enables delivery of water from the California Aqueduct to the east side of the southern San Joaquin Valley near the City of Bakersfield. A complex series of water purchase, transport, and exchange agreements allows the exchange of equivalent amounts of water between Arvin-Edison Water Storage District, near Bakersfield, and eight entities with contracts for CVP water exported from the Delta. When conditions permit, water is delivered to Arvin-Edison from the California Aqueduct in exchange for water that would have been delivered from Millerton Lake.

State Water Project The SWP, planned and operated by DWR, was originally designed to deliver irrigation water to Southern California and to large San Joaquin Valley farms. It provided water to farmers in the San Joaquin Valley that were ineligible for CVP water because of acreage limitations in Federal reclamation law. Funding for the SWP was authorized by the California Legislature in 1959 and approved by the voters in 1960 through the Burns-Porter Act. Construction of the first SWP facilities, Oroville Dam and Reservoir, actually began in May 1957 because of emergency appropriations in response to previous flooding. The SWP provides water to 23 million Californians and 755,000 acres of irrigated farmland (DWR, 2008b). SWP deliveries are allocated 70 percent to M&I use and 30 percent to agricultural use (DWR, 2008c).

The SWP includes 32 storage facilities, reservoirs, and lakes; 17 pumping plants; three pumping-generating plants; five hydroelectric powerhouses; and about 660 miles of open canals and pipelines (DWR, 2008b). The locations of major SWP facilities are shown in Figure 3-3. The SWP's 20 major reservoirs have a total water storage capacity of 5.8 MAF. Storage capacities for SWP water storage facilities are provided in Table 3-7. Major SWP aqueducts include the North Bay and South Bay aqueducts, the California Aqueduct, and the West and Coastal branches of the California Aqueduct. Project water supply comes from storage at Oroville Reservoir and high runoff flows in the Delta.

Table 3-7. Major State Water Project Storage Facilities

Storage Facility Name	SWP Contracting Agency Region	SWP Storage Capacity (acre-feet)
Antelope Lake	Upper Feather River	22,600
Frenchman Lake	Upper Feather River	55,500
Lake Davis	Upper Feather River	84, 400
Lake Oroville	Oroville	3,537,600
Thermalito Afterbay	Oroville	57,000
Thermalito Diversion Pool	Oroville	13,400
Thermalito Forebay	Oroville	11,700
Bethany Reservoir	South Bay	5,100
Clifton Court Forebay	South Bay	31,300
Lake Del Valle	South Bay	77,100
Los Banos Reservoir	San Luis	34,600
O'Neill Forebay	San Luis	29,500[1]
San Luis Reservoir	San Luis	1,062,183[1]
Kern Water Bank Fan Element	South San Joaquin	1,000,000
Castaic Lake	West Branch	324,000
Elderberry Forebay	West Branch	33,000
Pyramid Lake	West Branch	171,200
Quail Lake	West Branch	7,600
Lake Perris	East Branch	131,000
Silverwood Lake	East Branch	75,000

Source: DWR. 2006b. Management of the California State Water Project Bulletin 132-05. December.

Note:
[1] Does not include Central Valley Project storage.

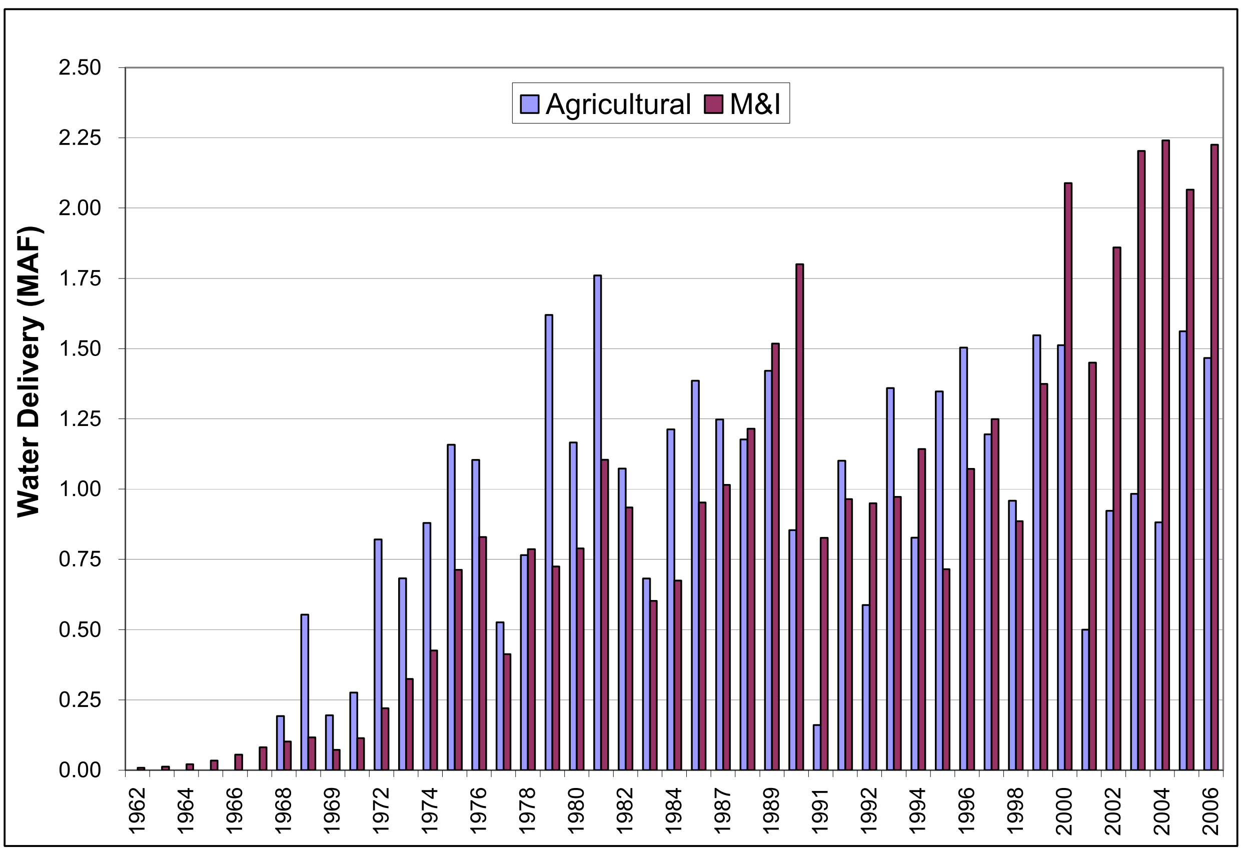
Key:
SWP = State Water Project

Contractors and Contract Types The SWP delivers water under long-term contracts to 29 public water agencies throughout the State, including the San Joaquin Valley, Tulare basin, and Southern California service areas. The public water agencies, in turn, either deliver water to water wholesalers or retailers or deliver it directly to agricultural and urban water users. Five contractors use SWP water primarily for agricultural purposes (mainly in the southern San Joaquin Valley), and the remaining 24 use the water primarily for municipal purposes.

The SWP has contracted a total of 4.23 MAF for average annual delivery. About 2.5 MAF/year are contracted for the Southern California Transfer Area, nearly 1.36 MAF/year for the San Joaquin Valley, and the remaining 370 TAF/year for the San Francisco Bay, the Central Coast, and Feather River areas.

The contracts between DWR and the 29 SWP water contractors define the terms and conditions governing the water delivery and cost repayment for the SWP. SWP contract types include Table A, Article 21, Article 56, and carryover water. The Table A amount is the maximum contractual amount that SWP contractors can request each year, and is given the first priority of delivery. Under shortage conditions, the current SWP policy is to equally impact all Table A water contractors.

Water Deliveries Figure 3-7 shows annual SWP water deliveries since the inception of the SWP. Between 1997 and 2006, annual water deliveries to SWP contractors averaged 2.92 MAF/year, and as little as 1.8 MAF/year in dry years (although the SWP was built with a capacity to deliver about 4.2 MAF of water per year) (DWR, 2008b). From 2000 through 2006, annual requests of Table A water by SWP Contractors were only met during 2006. Only 39 percent of requested Table A water allocations were delivered in 2001, which was a historically dry year. Water supply reliability for the SWP depends on many issues, including possible future regulatory standards in the Delta, population growth, water conservation and recycling efforts, and water transfers (DWR, 2008d). Two important factors that are anticipated to impact future water supply reliability to SWP contractors are pumping restrictions and climate change (DWR, 2008d).



Source: DWR. 2006b. Bulletin 132-05 (Data Provided by Paul Mendoza).

Figure 3-7. State Water Project Annual Water Deliveries

Power/Energy

The San Joaquin River watershed upstream from Millerton Lake is extensively developed for hydroelectric generation. In this area, PG&E and SCE own and operate several hydropower generation facilities, as shown in Figure 3-8. Hydropower also is generated by the FPA at the Friant Power Project; water is released from Friant Dam to the Friant-Kern Canal, Madera Canal, and San Joaquin River. In total, the upper San Joaquin River basin has 19 powerhouses with an installed capacity of almost 1,300 MW, which represents approximately 9 percent of the hydropower generation capacity in California. Table 3-8 summarizes generation capacity, date of installation, and reported annual energy generation for the PG&E Kerckhoff Project powerhouses located just upstream from Millerton Lake. As indicated by minimum and maximum values, annual energy generation varies widely.

Demographics

Based on U.S. Census 2000 data, Fresno and Madera counties have lower population densities than the California average (U.S. Census Bureau, 2008). In 2006, Hispanics made up 48 and 49 percent of the total populations of Fresno and Madera counties, respectively. Both counties have lower income levels, higher poverty levels, and lower education levels than State averages.

Employment and Labor Force

The unemployment rate for Fresno County was 9.9 percent in December 2007; Madera County's unemployment rate was 8.5 percent during the same period. These rates are both higher than the December 2007 unemployment rate for California (5.9 percent) and the Nation (4.8 percent) (California Employment Development Department, 2008). The total number of jobs increased in both counties between December 2006 and December 2007. In Fresno County, the greatest growth occurred in the trade, transportation, and utilities sectors, with the majority of the jobs concentrated in the retail trade. The government sector was responsible for the greatest job increase in Madera County during the same period (California Employment Development Department, 2008).

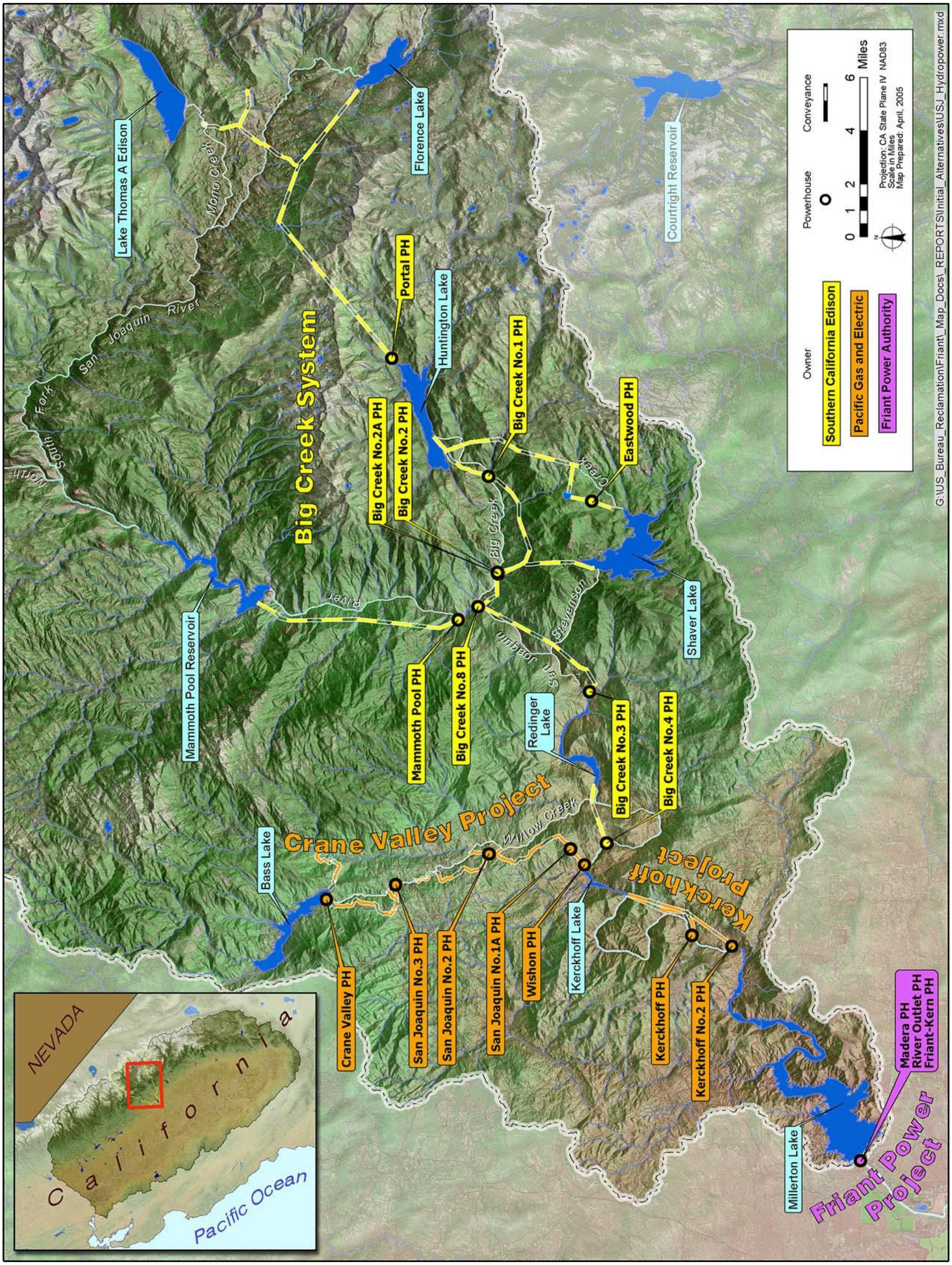


Figure 3-8. Existing Hydropower Facilities at and Upstream from Friant Dam

Table 3-8. Recent Hydroelectric Generation at PG&E Kerckhoff Project Powerhouses

Item	Pacific Gas and Electric Company	
	Kerckhoff Powerhouse	Kerckhoff No. 2 Powerhouse
Number & Type of Units	3 – Francis	1 – Francis
Capacity (MW)	38	155
Year Constructed	1920	1983
Reported Annual Generation (MWh)[1]		
1994	10,348	275,752
1995	115,930	803,490
1996	52,273	696,653
1997	72,350	695,775
1998	75,657	735,830
1999	31,959	410,567
2000	37,632	482,279
2001	10,768	316,602
2002	19,639	368,396
2003	18,850	423,974
2004	15,833	362,974
2005	51,662	670,639
2006	55,192	640,116
Minimum 1994-2006	**10,348**	**275,752**
Maximum 1994-2006	**115,930**	**803,490**
Average 1994-2006	**43,699**	**529,465**

Note:
1 Exclusive of plant use, data source is annual FERC Form 1.
Key:
FERC = Federal Energy Regulatory Commission
MW = megawatt
MWh = megawatt-hour

Lands

The primary study area, all within Fresno or Madera counties, is composed predominantly of publicly owned lands, although it also comprises private lands, including lands specifically set aside for conservation purposes. Land management in the primary study area is shown in Figure 3-9. Land use categories across private properties in the primary study area include pasture, agricultural miscellaneous, vacant residential, and single family residential.

Lands in the lower portion of Millerton Lake, near Friant Dam, are either within the Millerton Lake SRA, managed by DPR, or parcels that are privately held. Several residential areas have been established around Millerton Lake and include a total of more than 440 parcels. Further upstream from Friant Dam, most of the lands surrounding Millerton Lake are managed by Reclamation or DPR. Lands are also managed by DFG. Private properties in the area include the Sierra Foothill Conservancy (McKenzie Preserve at Table Mountain), some undeveloped parcels, and a few residences. Most lands along the San Joaquin River from Millerton Lake to Kerckhoff Dam are managed by BLM as the SJRGMA. Private lands in this area include parcels associated with the PG&E power facilities, and vacant agricultural land used for cattle grazing.

The Fine Gold Creek watershed appears to be largely undeveloped and grazed by cattle. Some scattered single-family homes, related farm structures, and access roads are present in the area. About 175 privately owned parcels, ranging in size from less than 1 to 280 acres, are located within the Fine Gold Creek watershed area encompassed by the primary study area for the Investigation. Within the lower portion of the Fine Gold Creek watershed, the Sierra Foothill Conservancy owns and manages the 718-acre Austin & Mary Ewell Memorial Preserve on Fine Gold Creek. The Sierra Foothill Conservancy holds a conservation easement for the preserve in favor of DFG to protect Fine Gold Creek and Willow Creek, preserve sensitive plant and wildlife species of the Central Valley floor and Sierra Nevada Foothills, and to maintain existing wildlife corridors (WCB, 2005).

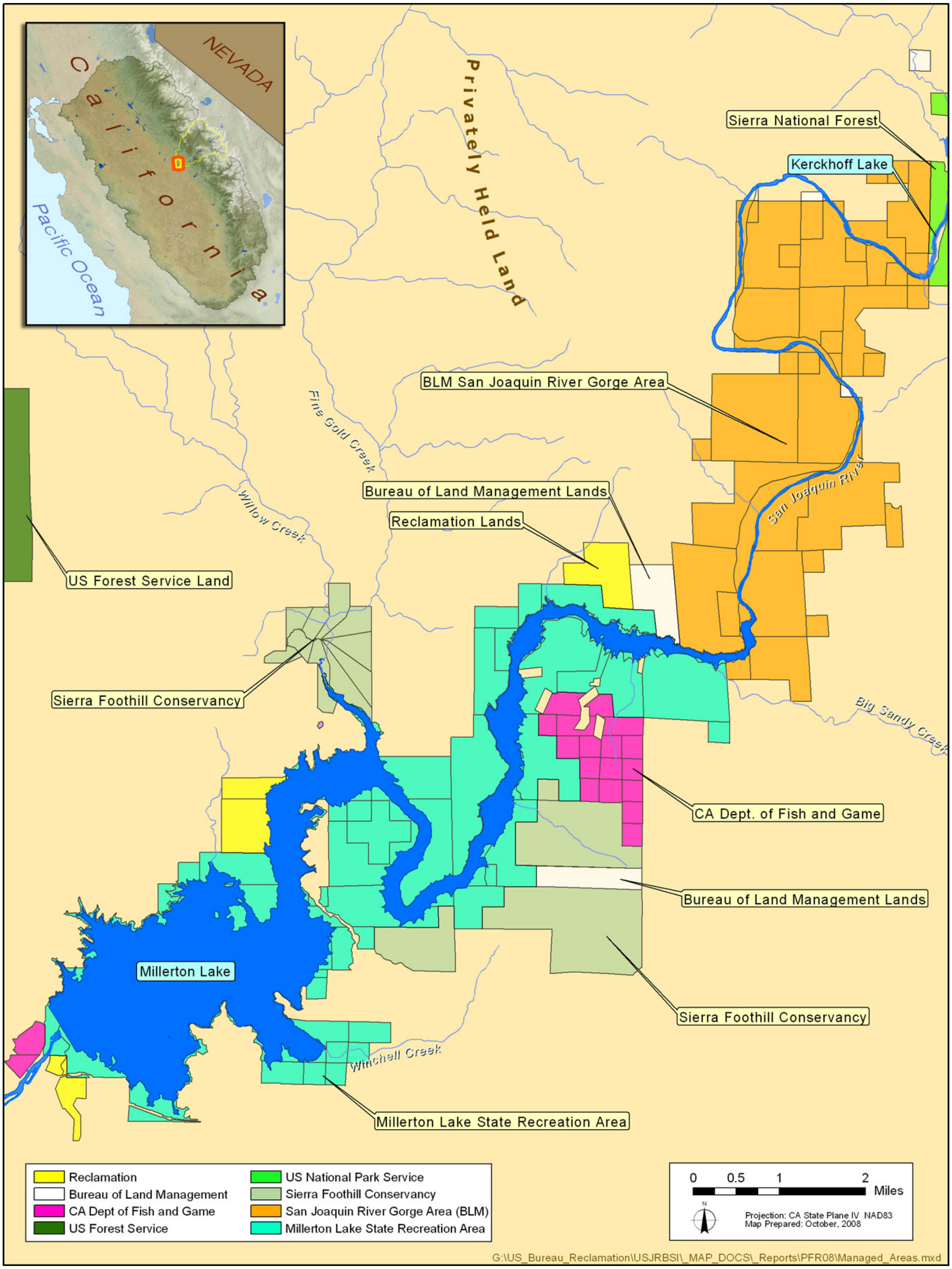


Figure 3-9. Land Management in the Primary Study Area

Traffic and Transportation

Wellbarn Road, extending to Spearhead Road from Auberry Road, provides access to Temperance Flat. Smalley Road, which spurs off Auberry Road, provides the main access to the SJRGMA and to the PG&E powerhouses, Kerckhoff and Kerckhoff No. 2. Smalley Road, a paved road, also provides access to the Kerckhoff Powerhouse switchyard, BLM primitive campground, and San Joaquin River Trail.

Powerhouse Road and Bridge connect Fresno and Madera counties across Kerckhoff Lake. Extending from Auberry Road in Fresno County to Road 222 in Madera County, the road and bridge provide access to Wishon Powerhouse for PG&E staff in Fresno County, and to schools in Fresno County for residents in the North Fork area.

Recreation and Public Access

This section provides detailed descriptions of the recreation uses in two publicly managed areas.

Millerton Lake State Recreation Area The Millerton Lake State SRA contains about 10,500 acres in total and is one of the most popular recreation areas in the San Joaquin Valley. Millerton Lake, the centerpiece of the SRA, is more than 15 miles in length, has a surface area of about 4,900 acres, and a shoreline of about 63 miles at top of active storage.

From 1996 to 2006, the SRA received an average of 440,000 visits per year, with the highest use occurring in May, June, and July. Motorboating, sailing, water skiing, jet skiing, swimming, and fishing are the primary activities. Shoreline activities include picnicking, hiking, biking, camping, and nature watching. Fall and spring are the most popular periods for activities such as hiking and mountain biking and some types of angling. Special recreation events that have been held at the lake include sailing regattas, water-ski competitions, and triathlons.

The SRA provides several recreation facilities to support these activities, most of which are located on the gently sloping southern and northern shores of the lower portion of the reservoir, closest to population centers. Facilities include boat ramps, picnic areas, campgrounds, a marina, and an historic courthouse. Year-round, visitors can take advantage of several trails for hiking, biking, and equestrian use. In addition to developed facilities, both the North Shore and South Shore areas offer a substantial amount of vehicular and pedestrian shoreline access within the fluctuation zone of the reservoir. These areas are used as informal beaches by both land-based and boating visitors and attract many visitors throughout summer. Several popular swim areas are marked with buoy lines to exclude boats.

Angling is a popular activity from both the shore and boats, with several popular game species available, including largemouth, smallmouth, and spotted bass; striped bass; rainbow and brown trout; and catfish, crappie, and bluegill. Angling is typically done in spring and early summer on the shoreline of Millerton Lake, when the lake is high enough to reach into the SJRGMA, and on the accessible portions of the river. The fishing season is open year-round and occasionally bass fishing tournaments are held on the lake.

Wildlife viewing within the SRA is enhanced by the biological diversity of the area and the variety of plant and animal species present. The lake has the largest population of wintering bald eagles in the San Joaquin Valley. Nesting bald eagle pairs have been sighted in the area along with resident golden eagles and many migratory birds that pass through the area. Other wildlife in the area includes deer, coyote, mountain lion, cottontail rabbit, and opossum.

San Joaquin River Gorge Management Area Located 5 miles northwest of Auberry, the BLM SJRGMA covers approximately 6,700 acres of land on both the north and south sides of the San Joaquin River. The area ranges from 750 feet to 2,200 feet in elevation, and is characterized by the rugged and steep-walled river canyon surrounded by hills covered with chaparral and oak woodland. The SJRGMA has experienced a rapid increase in visitation, from historical levels of about 20,000 recreation visits per year, to 60,000 to 70,000 visits the last few years. The SJRGMA offers several educational and recreational facilities, concentrated in the Squaw Leap area on the south side of the river, accessible via Smalley Road from Auberry. Various trails are available for hiking, mountain biking, and horseback riding. Other features of interest in the SJRGMA include three whitewater boating runs and the Millerton Lake Caves along Big Sandy Creek, which are situated just above the high water mark of Millerton Lake.

Hunting of game species is permitted in the SJRGMA. The hunting season lasts for 4 to 5 months in fall and winter for deer, bear, and pigs; turkeys are hunted in spring. No target shooting is available on these lands. The wide variety of flora and fauna in the SJRGMA provides many opportunities for nature study and appreciation. In the northern portion of the management area, no vehicle access exists and the river is accessible only on foot or via boat.

Cultural Environment

This section describes existing historic, prehistoric, and ethnographic cultural resources conditions in the primary study area for the Investigation. The extent of the primary study area for cultural resources evaluations during plan formulation encompasses the current top of active storage capacity elevation of Millerton Lake (elevation 580.6) to the maximum potentially affected area for all of the initial surface water storage alternatives locations, including the potential reservoir pool and a buffer around the pool equal to 50 feet vertically, or 0.25-mile laterally, whichever is less. In total, the primary study area for cultural resources evaluations during plan formulation includes 13,472 acres.

Based on combined records search results, 33 cultural resources studies have been conducted within the primary study area. These studies comprise two overviews (one that includes a reconnaissance survey), one historical structure report, 27 survey reports, one combined survey/testing report, and two eligibility-related documents. A total of 17.8 percent (2,401.4 acres) of the primary study area for cultural resources evaluations has been surveyed for archaeological resources, with the extent varying widely within the primary study area. As a result, the study area has not been subject to either comprehensive inventory or systematic sample surveys.

Archaeological and Historical Structures

The current inventory of cultural resources is largely the product of archaeological surveys, and hence it is biased toward sites, as opposed to the built environment. Sixty archaeological sites are documented within the primary study area. These include 48 prehistoric sites, six historic-era sites, and six sites with both components. Three isolates have also been recorded, including two historic-era stone walls and one prehistoric biface. Sites are considered localities where prior inhabitants of the region conducted extensive activities as opposed to isolates, which represent brief moments in time where, by and large, inconsequential activities took place. Isolated finds are considered categorically not eligible for nomination to the National Register of Historic Places (NRHP) and will not be discussed further. None of the 60 archaeological sites within the primary study area are currently listed on the NRHP. In addition, eight historic-era structures have been formally recorded within the primary study area, including five buildings, two water tanks, and Friant Dam.

The study area encompasses portions of the Squaw Leap Archaeological District, within the SJRGMA managed by BLM. The district was determined to be eligible by the Keeper of the National Register on May 5, 1980, but never formally listed. The final district boundary comprises two discontinuous areas: an upland meadow area on the Madera County side of the river and a plateau area on the Fresno County side. The Squaw Leap Archaeological District was defined based on its ability to contribute to prehistoric research issues, and includes 20 sites that are mainly bedrock milling locations, along with some residential sites. About 700 acres of this district and 11 sites are situated within the primary study area for cultural resources evaluations.

Prehistoric Resources The local prehistoric record in the study area is poorly understood because archaeological investigations within the primary study area have been largely limited to surveys. Since the primary study area lies at the interface of the Central Valley and the western Sierra Nevada, it is important to recognize the potential role that occupants of the Central Valley may have played in creating the archaeological record of this lower foothill region, and the primary study area in particular (Fredrickson and Grossman, 1973; Rosenthal et al., in press). Based on more detailed studies in the general region, it appears that much of the documented prehistoric record dates to the last 3,000 years (Moratto, 1972; 1984).

Within the primary study area for cultural resources evaluations, a total of 54 recorded sites have evidence of prehistoric occupation. These include 35 bedrock milling localities, 17 residential sites (defined by the presence of midden deposits), one lithic scatter, and one lithic scatter/bedrock milling locality. Many of the residential sites have surface evidence of house pits as well as bedrock milling features, while bedrock milling sites typically contain numerous milling elements on multiple outcrops.

Twenty of the prehistoric sites, including five residential sites, were documented along the margins of Millerton Lake downstream from Fine Gold Creek, within an area that was intensively surveyed. Only three prehistoric sites are documented along Millerton Lake near RM 274 to RM 279. The stretch of the primary study area immediately upstream from RM 279 to Kerckhoff Powerhouse contains 24 documented sites, including 11 sites that are part of the NRHP-eligible Squaw Leap Archaeological District. No prehistoric sites are documented further upstream. Minimal surveys in the Fine Gold Creek watershed documented three prehistoric sites.

An additional 19 recorded prehistoric sites lie below the current top of active storage capacity of Millerton Lake and above the low water level elevation of 500 feet (Theodoratus and Crain, 1962), including 13 bedrock milling sites, four residential sites, and one lithic scatter. An additional two sites, large prehistoric residential sites recorded by Hewes (1941) in the 1930s, were fully inundated by Millerton Lake.

Historic-Era Resources The 200-year-long historic-era in the lower foothills began in the early 1800s with initial contact between Native Americans and Europeans (first the Spanish and then other European explorers). Subsequently, prospectors rushed to the lands of the southern Sierra to find gold. Temperance Flat was one of the primary gold mining districts within the general area. Then the region began to experience urban development, as goods were funneled to the various mining districts. In the latter half of the nineteenth century and early twentieth century, the region witnessed the rise of ranching, agricultural, and rural settlements. Another notable regional development near the onset of the twentieth century was the rise of hydroelectric power companies and facilities.

A recent evaluation of Reclamation-owned buildings and structures constructed prior to 1957 in the Millerton Lake SRA near Friant Dam, and downstream from the reservoir, represents the only known study of historic-era buildings within the survey area (JRP, 2003). Eight structures were formally recorded during the study, including five buildings, two water tanks, and Friant Dam. Friant Dam and its associated outlet gates are the only historical structures recommended as eligible for listing on the NRHP.

The historic-era sites and historic-era components in the primary study area include six mining locales, two residential sites, two artifact scatters, and two Native American sites with indications of historic-era occupation. None of these 12 historic-era sites have intact standing structures.

Two of the historic-era sites are located near Millerton Lake and south of Fine Gold Creek. Only one site was recorded in the area along Millerton Lake between RM 274 and RM 279. Six historic-era sites are formally recorded immediately upstream from near RM 279 to Kerckhoff Powerhouse. In addition, Theodoratus and Crain (1962) described, but did not formally record, eight historic-era mining localities in the Temperance Flat area. Six of these localities (including several arrastras and building remnants) appear to be within the study area, mostly on the Madera County side of the river. These mining sites were given only approximate locations (to the quarter-quarter section) and, hence, cannot be integrated into this study. Based on review of known sites in the Temperance Flat area, none appears to have been formally recorded during later surveys in the area. No historic-era sites are documented further upstream along the San Joaquin River to Kerckhoff Dam.

Native American Resources

The San Joaquin River defines a topographic, political, and cultural frontier in the primary study area, where a variety of religious, economic, historic, and other values can be identified for Native American groups. Ethnohistorical investigations indicate that at the end of the prehistoric era and into the historic era, the primary study area was at the territorial boundary, or within a zone of overlapping use, for several Native American populations. Principal among these are various tribes of Foothill Yokuts (Spier R., 1954; Spier L., 1978a) and bands of Nim or Western Mono (Gayton, 1948; Spier L., 1978b). Other groups who may have used this area include Valley Yokutsan tribelets (Wallace, 1978) and the Southern Sierra Me-Wuk (Smith, 1978). Therefore, the study area was a contested landscape when Euro-Americans arrived during the latter half of the nineteenth century (Stammerjohan, 1979).

Sixteen groups, including those listed by the Native American Heritage Commission (NAHC), represent Native American interests in the study area: the Big Sandy Rancheria of Western Mono Indians; Choinumni Tribe; Cold Springs Rancheria of Mono Indians; Dumna Tribal Government; the Dumna Wo-Wah Tribal Government; Dunlap Band of Mono Indians; North Fork Mono Tribe; North Fork Rancheria; Nototonme/North Valley Yokut Tribe, Inc.; Picayune Rancheria of the Chukchansi Indians; Santa Rosa Rancheria; Sierra Nevada Native American Coalition; Southern Sierra Miwuk Nation; Table Mountain Rancheria; Tule River Tribe; and the Traditional Choinumni Tribe.

Based largely on ethnohistoric literature, 22 mostly named, historic-era Native American villages have been identified in the general region that includes the primary study area. The NAHC reviewed its sacred lands file and identified a sacred land filing within the primary study area; its location is confidential.

Initial interviews with local Native Americans have provided preliminary insight into their perspectives on the primary study area. Some of the Native Americans interviewed said that the entire study area of all reservoir alternatives from the river up to the maximum pool lines, and higher up the hill slope and cliff side, was important, including village sites, burial grounds, gathering areas, religious areas, and especially the landscape.

Native American experts who supplied information for the Investigation were largely unwilling to identify important locations within the primary study area during plan formulation. Some individuals pointed out general areas of sensitivity. No information was provided to identify the sensitivity or resource concerns within these locales (e.g., burial grounds, ancient villages, locations of important ceremonies, resource gathering areas) and all specified locations are currently treated with equal weight. These areas, depicted as large circles on maps, provide initial insight into the magnitude of modern Native American resources within the primary study area.

Forty-two sensitive areas were identified by Native Americans as of August 1, 2006, including six directly adjacent to the study area, six within the current boundaries of Millerton Lake, and 30 within the primary study area, for cultural resources evaluations. Six areas of sensitivity are located near the margins of Millerton Lake downstream from Fine Gold Creek. None are noted further upstream in the project area until above RM 279. From near RM 279 to the Kerckhoff Powerhouse, 14 areas of sensitivity were identified. Five sensitive areas are within the area along the San Joaquin River upstream to Kerckhoff Dam.

Indian Trust Assets

Indian Trust Assets (ITA) are legal interests in property held in trust by the United States for Federally recognized Indian tribes or individual Indians. The most common assets are Indian reservations, rancherias, and public domain allotments. An Indian trust has three components: (1) the trustee, (2) the beneficiary, and (3) the trust asset. ITAs can include land, minerals, Federally reserved hunting and fishing rights, Federally reserved water rights, and instream flows associated with Indian trust land.

Actions that could affect ITAs include interference with the exercise of a reserved water right; degradation of water quality where there is a water right; impacts to fish and wildlife where there are hunting or fishing rights; or noise near a land asset where the noise adversely impacts uses of the reserved land.

No Indian reservations are located within the primary study area. The nearest reservations include the Table Mountain Rancheria near Friant, Big Sandy Rancheria of Western Mono Indians near Auberry, and Cold Spring Rancheria of Mono Indians near Tollhouse. The location and number of public domain allotments within the region are unknown.

Likely Future Conditions

This section describes the changes in the environment (physical, biological, socioeconomic, and cultural) expected in the primary and extended study areas, assuming that no Federal (or State) actions are implemented to develop and manage additional water supplies in the upper San Joaquin River basin to address the stated planning objectives (described in Chapter 2). This section begins with a discussion of likely future conditions to be used in the Investigation. Identification of the magnitude of potential water resources and related problems, needs, and opportunities in the primary and extended study areas is based not only on the existing conditions described in this chapter, but also on an estimate of how these conditions may change in the future.

Two regulatory requirements were considered in describing environmental resources in the primary and extended study areas and for use in identifying the relative effects of alternative plans on these resources:

- **National Environmental Policy Act –** This act requires comparisons between the assumed "No-Action" Alternative and proposed actions. For the Investigation, the NEPA condition is important for developing an EIS to meet the requirements of NEPA.

- **California Environmental Quality Act –** This act requires comparisons between assumed "No-Project" conditions and proposed actions. A demarcation date of 2004 was established for the Investigation to address the intent of CEQA requirements.

The likely future condition includes actions reasonably expected to occur in the future. This includes projects and actions that are currently authorized, funded, and permitted. Predicting future changes to the physical, biological, socioeconomic, and cultural environments in the primary and extended study areas is complicated by implementation of the SJRRP, as well as ongoing programs and projects primarily related to CALFED and the CVPIA. Several ecosystem restoration, water quality, water supply, and levee improvement projects are likely to be implemented in the future. Collectively, these efforts may result in changes to San Joaquin River habitat and water quality, Delta water quality, water supply, and levees.

For the purposes of the Investigation, the future without-project conditions include SJRRP completion of river restoration construction and the release of full Restoration Flows, but do not include any specific projects or actions under the Water Management Goal of the Settlement. As information regarding implementation of the SJRRP is developed, these assumptions will be revised accordingly in subsequent Investigation documents.

Several projects are being implemented or are expected to be implemented in the future in the primary and extended study areas. Table 3-9 lists projects either being implemented or expected to be implemented, and an explanation of how each project is being considered for the Investigation. This list of projects will be described and will continue to be refined as the feasibility study progresses.

Table 3-9. Projects Considered in Likely Future Conditions

Project (lead agency or organization)	Without-Project Future Conditions	Cumulative Impacts Analysis
San Joaquin River Restoration Program (Reclamation)	X[1]	X[2]
Millerton Lake State Recreation Area Resource Management Plan (Reclamation and DPR)[3]		X
San Luis Drainage Reevaluation Program (Reclamation)		X
Water Use Efficiency (CALFED)[3]	X[4]	
South Delta Improvements Program (Reclamation and DWR)	X[5]	
2004 OCAP (Reclamation)	X	
Arvin-Edison South Canal Expansion (Arvin-Edison Water Storage District)	X	
Upgrade of Shafter-Wasco Irrigation District Interconnection Facilities (Shafter-Wasco Irrigation District)	X	
Cross-Valley Canal Expansion	X	
Big Creek Hydroelectic System Alternative Licensing Process (SCE)		X
Environmental Water Account (Reclamation and DWR)	X	
Friant Dam Fish Water Release Powerhouse (FPA and Orange Cove Irrigation District)[3]		X
CVP Contract Renewals (Reclamation)	X	
Further Implementation of CVPIA (b)(2) Water Accounting (Reclamation)	X	
Fresno County HCP (Fresno County)		X
New Land Development Projects (various)		X

Notes:

[1] Includes Restoration goal actions.
[2] Includes Water Management goal actions.
[3] Also considered as a potential management measure to address planning objectives and opportunities of the Investigation.
[4] Includes Common Assumptions.
[5] Water operations modeling performed for the Investigation to date assumes 6,680 cfs pumping capacity at Banks Pumping Plant.

Key:
cfs = cubic feet per second
DPR = California Department of Parks and Recreation
DWR = California Department of Water Resources
HCP = Habitat Conservation Plan
OCAP = Operations Criteria and Plan
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
SCE = Southern California Edison Company

Various other projects and programs are expected to be implemented in the future, including CVP contract renewals and further implementation of CVPIA(b)(2) water accounting, and land development plans and projects in the primary and extended study areas. There are several other potentially relevant developing studies and priorities that are not currently included in the Investigation likely future conditions, including Delta Vision recommendations, the Bay-Delta Conservation Plan, and Delta conveyance. Other emerging concerns and trends such as climate change may also influence the likely future conditions.

The remainder of this chapter describes some of the future changes in physical, environmental, socioeconomic, and cultural conditions expected to occur in the primary and extended study areas.

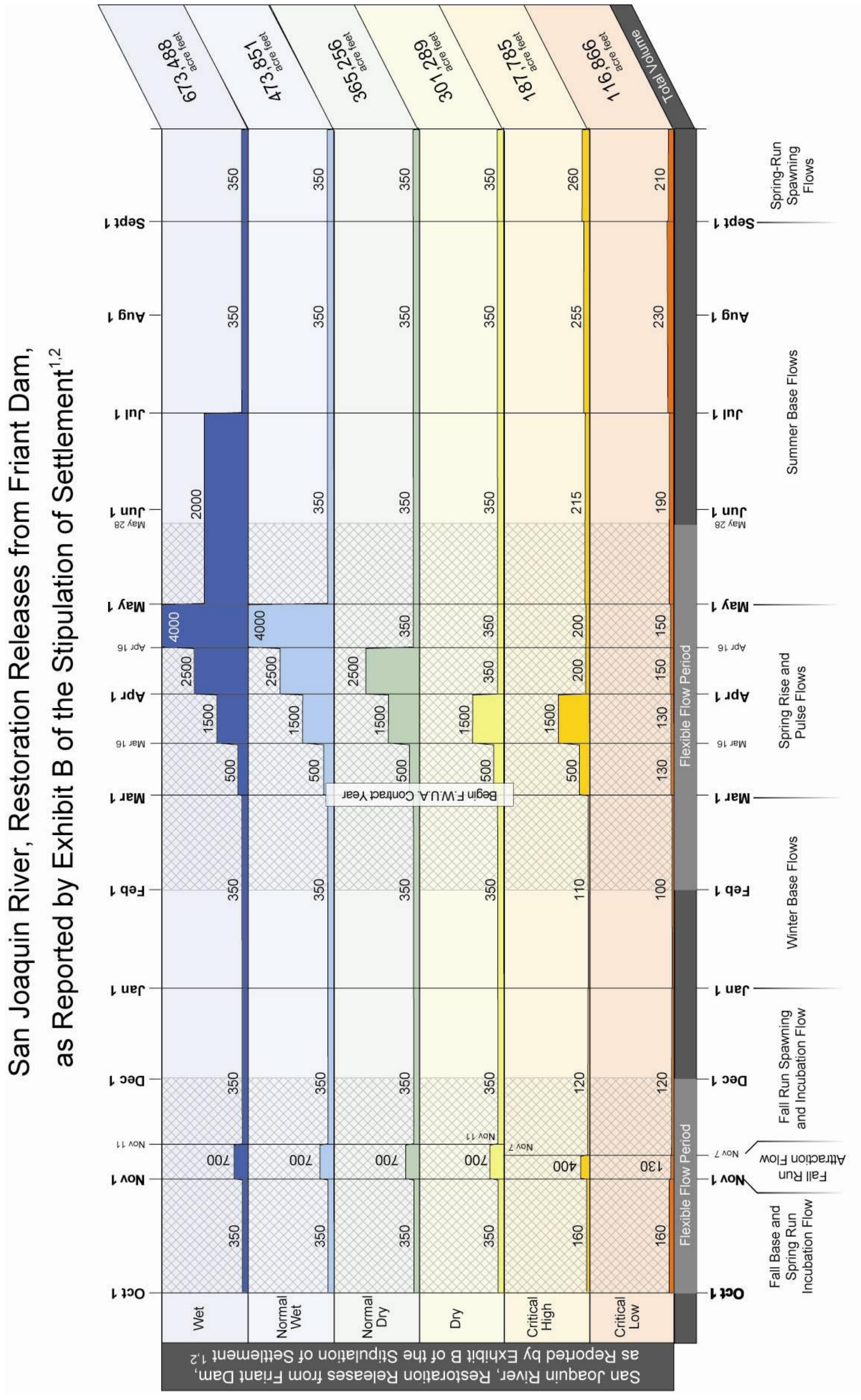
Physical Environment

Implementation of the SJRRP will result in changes in hydrologic conditions in the San Joaquin River below Friant Dam through changed releases to the San Joaquin River. The Settlement includes a set of six different Restoration Flow hydrographs that vary in shape and volume according to annual unimpaired runoff in the basin (SJRRP, 2007a). Graphically, the Restoration Flow regimes for all year-types are shown in Figure 3-10, representing period-identified constant flow values for a potentially daily varying or ramped flow regime. Average annual flood releases from Friant Dam are also anticipated to decrease through implementation of SJRRP actions. Water year-type definitions are currently under refinement, but the most recent definitions are as follows, based on annual October-through-September unimpaired flow below Friant Dam:

- Wet, equal to or greater than 2,500,000 acre-feet
- Normal-wet, equal to or greater than 1,450,000 acre-feet
- Normal-dry, equal to or greater than 930,000 acre-feet
- Dry, equal to or greater than 670,000 acre-feet
- Critical-high, equal to or greater than 400,000 acre-feet
- Critical-low, less than 400,000 acre-feet

Physical changes to the San Joaquin River from Friant Dam to the Merced River are expected to be implemented through the SJRRP. These changes include levee modifications associated with improving habitat conditions in the San Joaquin River, and channel capacity changes to accommodate Restoration Flows.

Physical conditions in the primary study area are expected to remain relatively unchanged in the future. No changes to area topography, geology, or soils are foreseen. Without major physical changes to the river systems upstream from Friant Dam (which are unlikely), hydrologic conditions would probably remain unchanged. Some speculation exists that regional hydrology would be altered should there be substantial changes in global climatic conditions. Scientific work by others in this field of study is continuing.



1 - NRDC v Rodgers, Stipulation of Settlement, CIV NO. S-88-1658 - LKK/GGH, Exhibit B, September 13, 2006
2 - Hydrographs reflect assumptions about seepage losses and tributary inflows which are specified in the settlement

Figure 3-10. San Joaquin Restoration Program Hydrograph at Friant Dam – All Year-Types

A serious consequence of long-term groundwater overdraft in the San Joaquin and Tulare Lake hydrologic regions is land subsidence, or a drop in the natural land surface. Land subsidence results in a loss of aquifer storage space and may cause damage to public facilities such as canals, utilities, pipelines, and roads. With additional flows discharged from Friant Dam due to the Settlement, and continued increased demands on the groundwater system without new surface water supplies, continued groundwater overdraft is expected in the future.

Much effort has been expended to control the levels and types of herbicides, fungicides, and pesticides that can be used in the environment. Further, efforts are underway to better manage the quality of runoff from urban environments to major stream systems. Water quality conditions in the future without-project conditions upstream from Friant Dam are expected to generally remain unchanged and similar to existing conditions. However, with implementation of the San Luis Drainage Feature Reevaluation selected alternative, SJRRP actions, and various TMDLs, water quality conditions downstream from Friant Dam in the future are expected to improve over existing conditions.

Most of the air pollutants in the primary and extended study areas would continue to be influenced by both urban and agricultural land uses. As the population continues to grow, with about 4 million additional people expected in the Central Valley by 2030, and agricultural lands converted to urban centers, a general degradation of air quality conditions could occur.

Biological Environment

As described earlier, the SJRRP will include plans to implement Settlement goals, including the Restoration Goal to restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish (NRDC et al., 2006). Additional efforts are underway by numerous agencies and groups to restore various biological conditions throughout the study area. Accordingly, major areas of wildlife habitat, including wetlands and riparian vegetation areas, are expected to be protected and restored. However, as population and urban growth continues and land uses are converted to urban centers, wildlife and plants dependent on native habitat types may be adversely affected.

Through the efforts of Federal and State wildlife agencies, populations of special-status species in the riverine and nearby areas are estimated to generally remain as under existing conditions. Although increases in anadromous and resident fish populations in the San Joaquin River are likely to occur through implementation of projects such as the SJRRP, some degradation may occur through actions that reduce San Joaquin River flows or elevate water temperatures.

Socioeconomic Resources

California's population is estimated to increase from about 34 million in 2000 to about 47.5 million by 2020 (DWR, 1998). In the San Joaquin River basin, the population is expected to nearly double from about 1.8 million to nearly 3.0 million by 2020 (DWR, 1998). Population increases in Fresno and Madera counties are expected to be much higher than the State average through 2050. The Fresno County population is predicted to grow at a rate of 49 percent between 2000 and 2020; the Madera County population is predicted to increase by 71 percent in the same period (California Department of Finance, 2007). The ongoing rapid rate of urbanization in the region would generate major land and water use challenges for the entire San Joaquin Valley.

Increases in population would increase demands for electric, natural gas, and wastewater utilities; public services such as fire, police protection, and emergency services; and water-related and communication infrastructure. The increase in population, and the aging "baby boomer" generation would increase the need for health services. The region's superior outdoor recreational opportunities and moderate housing cost are expected to attract increasing numbers of retirees from outside the region and the State. An increasing population would produce employment gains, particularly in retail sales, personal services, finance, insurance, and real estate. Recreation is expected to remain an important element of the community and regional economy.

Anticipated increases in population growth in the Central Valley would also increase demands on water resources systems for additional and reliable water supplies, energy supplies, water-related facilities, recreational facilities, and flood management facilities. Table 3-10 summarizes estimated water demands (applied water), supplies, and potential shortages for 2020 levels of demand in the Sacramento River and San Joaquin River basins and for California. As shown in the table, estimated future shortages of water supplies in drought years are expected to be substantial. Increases in population and water demand are expected to continue well beyond the planning horizon of the Investigation.

Potential water shortages under 2020 demands, however, may be greater than shown in Table 3-10. With implementation of the Settlement, the Restoration Flows will be treated as required releases and consequently will affect the amount of water available for Friant Division deliveries, although Friant Division contract amounts will remain unchanged. Diversions to the Friant-Kern and Madera canals will be reduced with implementation of the Settlement. Total canal diversions for existing operations are simulated to average 1,344,000 acre-feet per year during the 1922 through 2004 period of analysis, while canal diversions with Settlement Restoration Flow conditions are simulated to average 1,136,000 acre-feet per year (SJRRP, 2007a). This indicates that an annual average reduction in canal diversions of 208,000 acre-feet per year would occur with the Settlement compared to current operations. The Settlement does not include specific actions to achieve the Water Management Goal, nor does it specify quantities of water supply to be replaced.

Table 3-10. Estimated Water Demands, Supplies, and Shortages for 2020

Item	Sacramento and San Joaquin Hydrologic Basins – Two-Basin Total		State of California	
	Average Year	Drought Year	Average Year	Drought Year
Population (million)	6.8		47.5	
Urban Use Rate (GPCPD)	274	288	226	233
Acres In Production (million)	4.1		9.2	
Agricultural Use (AFPA)	3.6	3.9	3.4	3.5
Applied Water (MAF)				
Urban	2.1	2.2	12.0	12.4
Agricultural	14.4	15.5	31.5	32.3
Environmental	9.3	6.1	37.0	21.3
Total	***25.8***	***23.9***	***80.5***	***66.0***
Water Supply (MAF)				
Surface Water	20.7	16.0	65.0	43.3
Groundwater	4.9	6.2	12.7	16.0
Recycled/Desalted	0	0	0.4	0.4
Total	**25.6**	**22.2**	**78.1**	**59.7**
Shortage (MAF)	**0.2**	**1.7**	**2.4**	**6.3**

Source: DWR. 1998. California Water Plan Update, DWR Bulletin 160-98. November.
Key:
AFPA = acre-feet per acre
GPCPD = gallons per capita per day
MAF = million acre-feet

The reduction in canal diversions mirrors the increase in total river releases. On a long-term average basis, the increases in river releases would be met with a comparable reduction in canal diversions. Releases to the San Joaquin River include minimum release requirements and flood releases.

Table 3-11 expresses simulated deliveries with Restoration Flows in terms of total system water deliveries by year-type. An average annual delivery of 1,073,000 acre-feet is for the Restoration Flow condition (SJRRP, 2007a).

It is anticipated that implementing Settlement Restoration Flows would affect water levels at Millerton Lake. The effects of these changes on recreation use at Millerton Lake have not been evaluated to date.

It is anticipated that implementing Settlement Restoration Flows would affect FPA power generation at Friant Dam, but would not affect power generation at PG&E or SCE powerhouses upstream from Millerton Lake. Based on preliminary monthly hydropower modeling simulations, average annual power generation for the Friant Power Project would be about 71 gigawatt-hours/year, compared to a historical average (1986 through 2003) of about 79 gigawatt-hours/year.

In April 2006, Orange Cove Irrigation District filed an application with FERC to augment the generating capacity of a small turbine on a river outlet diversion to a fish hatchery by using Restoration Flow releases from Friant Dam. In March 2008, Orange Cove Irrigation District informed FERC of a partnership with the FPA to construct the new powerhouse. The proposal adds 1.8 MW in capacity, although this may increase in the future. This potential increase in generation from the Investigation has not been evaluated to date.

Table 3-11. Average Friant Dam Simulated Water Deliveries by Year-Type

Year Type	Total System Water Deliveries (TAF)		
	Existing	Future Without-Project	Change in Deliveries
Wet	1,904	1,739	-165
Normal-Wet	1,564	1,276	-288
Normal-Dry	1,032	828	-204
Dry	715	564	-151
Critical-High	462	336	-126
Critical-Low	259	257	-2
All Yrs Avg.	**1,281**	**1,073**	**-208**

Source: SJRRP. 2007a. Water Operations Existing and Future Without-Project Conditions Draft Technical Memorandum. December.

Note:
Values are reported for contract-year (March-February) period.

Key:
Avg. = average
TAF = thousand acre-feet
Yrs = years

Cultural Resources

The cultural resources currently situated between the high-water and low-water levels of Millerton Lake would continue to be impacted by erosion due to reservoir fluctuations. These archaeological sites, and others situated around the perimeter of the existing reservoir, and other accessible locations within the primary study area (both documented and undocumented), would continue to be subject to collection and occasional inadvertent impacts from recreation. The Native American community members would continue their ceremonies within the primary study area and would be able to maintain their traditional spiritual connection to the primary study area. They would also continue to gather plant and animal species from historically important areas. Similarly, conditions related to the cultural environment downstream from Friant Dam are unlikely to change considerably, other than potential changes that may result from implementing SJRRP actions, which are yet to be determined.

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Chapter 4
Management Measures and Initial Alternatives

Once water resources problems, needs, and opportunities have been identified, and planning objectives, constraints, considerations, and criteria have been developed, the next major elements of the plan formulation process are (1) identifying management measures, (2) formulating alternative plans to meet planning objectives, and (3) comparing and evaluating alternative plans. Described below are management measures considered in the Investigation, refinement of initial alternative plans formulated, and evaluation of surface water storage measures in refined initial alternatives.

As described in Chapter 2, plan formulation is an iterative process. In this document, use of the term initial alternatives refers to the alternatives identified in the IAIR (Reclamation, 2005). The term alternative plan refers to alternatives described in Chapter 5. During the plan formulation phase, the initial alternatives were subject to further refinement and comparison, resulting in a reduction in the surface water storage measures retained for the formulation of alternative plans. The complete feasibility study process for the Investigation, including identification and evaluation of management measures, and formulation, evaluation, and comparison of alternatives, is illustrated in Figure 4-1.

The first interim planning document, the Phase 1 Investigation Report, completed in October 2003 (Reclamation), identified and addressed 17 possible reservoir sites in the eastern San Joaquin Valley and selected six for continued study. The second interim planning document, the IAIR was completed in June 2005 (Reclamation). Twenty-four reservoir measures (based on location and size), many with multiple alternative hydropower generation options, were evaluated in the IAIR. The evaluations considered construction cost, potential new water supply that could be developed, hydropower impacts, potential replacement power generation, and preliminary environmental impacts. In addition, several initial water operations scenarios that could address various study objectives were identified and evaluated at a preliminary level of detail. The IAIR recommended continued study of four reservoir sites that, when combined with a set of operating rules, constitute initial alternatives.

This chapter describes management measures considered for initial alternatives to address the planning objectives and opportunities of the Investigation, refinement of initial alternatives, and evaluation of surface water storage measures in refined initial alternatives. As the Investigation continues, it is likely that additional management measures will be identified, incorporated, and addressed in the Feasibility Report and EIS/EIR.

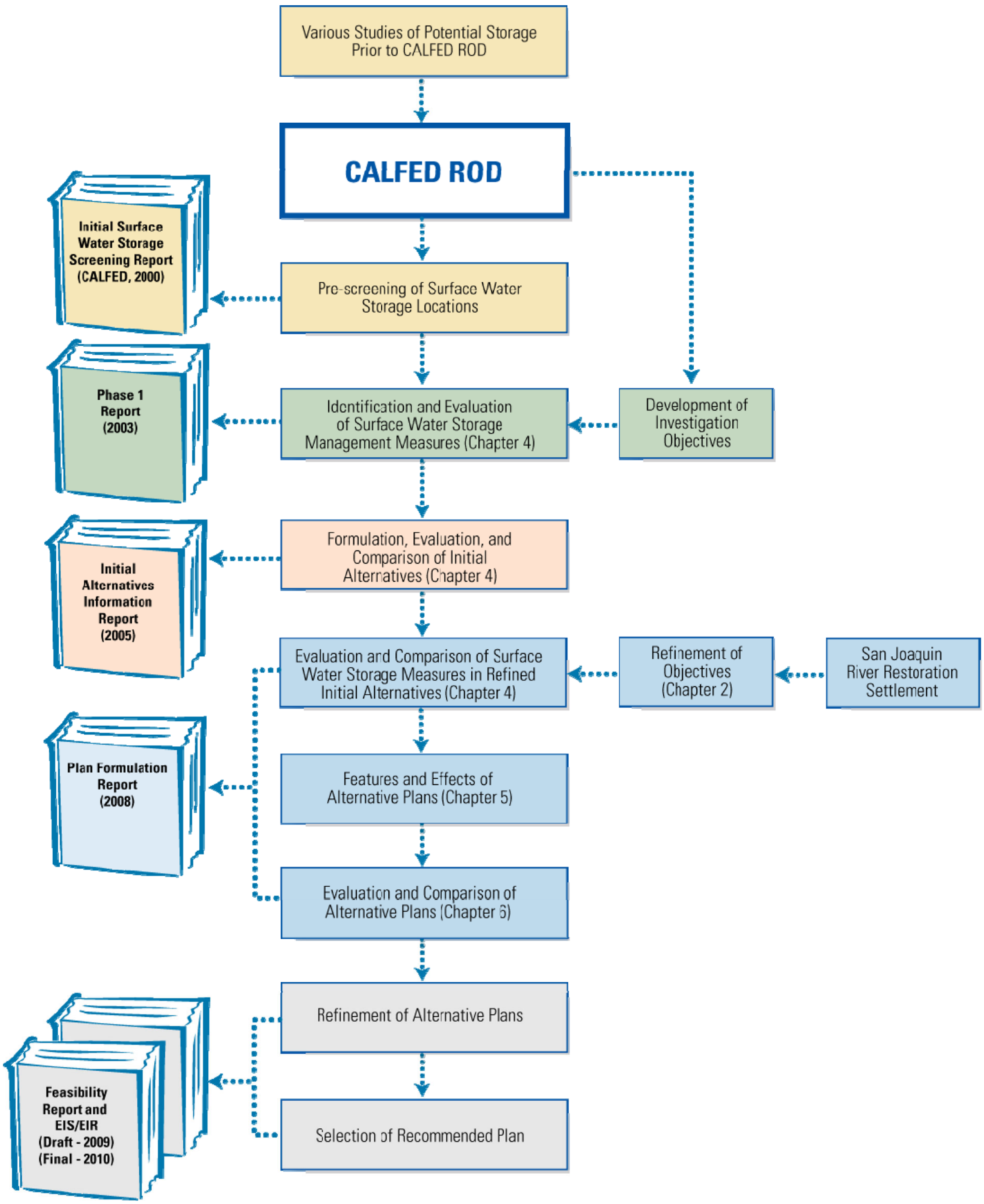

Figure 4-1. Feasibility Study Process for the Investigation

Management Measures

A management measure is any structural or nonstructural action or feature that could address the planning objectives and satisfy the other planning constraints, considerations, and criteria. Alternative plans are formulated by combining the most applicable measures that address the planning objectives, and adding measures that address opportunities. Following is a summary of measures initially considered and those selected for further development into alternative plans for the Investigation.

Measures Considered

Numerous potential measures were identified based on information from previous studies, environmental scoping, and outreach that could address the planning objectives. Measures were reviewed and refined through Study Management Team (SMT) meetings, field inspections, and coordination with stakeholders. Of the measures considered, several were selected for development into initial alternatives and alternative plans. Identification of management measures for the Investigation was limited by the planning constraints and considerations described in Chapter 3.

During Phase 1, several surface water storage measures were deleted because of potential unmitigable environmental impacts, lack of necessary participation by non-Federal entities, or cost in comparison to other measures with similar accomplishments (Reclamation, 2003). The IAIR presented incremental and comparative evaluations of surface water storage measures using cost, power generation and use, and environmental impacts criteria (Reclamation, 2005).

Tables 4-1 and 4-2 list all management measures considered during previous phases of the Investigation and during plan formulation that address the planning objectives of enhancing water temperature and flow conditions in the San Joaquin River, and improving water supply reliability, respectively. Many measures were deleted during Phase 1 and the initial alternatives phase of the Investigation, and will not be reconsidered in this PFR, but are summarized in this chapter.

Following are descriptions of management measures considered for the Investigation, and the rationale for retaining or deleting each measure from the Investigation.

Measures to Address Planning Objectives

Measures to address the planning objectives are described below. These measures include the following:

- Enhance water temperature and flow conditions in the San Joaquin River (31 measures)
- Increase water supply reliability and system operational flexibility (37 measures)

Table 4-1. Management Measures Addressing Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River

Measure	Status	Rationale
Perform Reservoir Operations and Water Management		
Balance water storage in Millerton Lake and new upstream reservoirs	**Retained**	Balancing water storage levels between multiple reservoirs could improve water temperature management and affect hydropower generation and recreation.
Modify storage and release operations at Friant Dam	**Retained**	Potential to combine with other measures involving development of San Joaquin River supplies. Consistent with other planning objective and opportunities. Consistent with CALFED goals.
Increase conservation storage in Millerton Lake by encroaching on dam freeboard	Deleted	Operable gates on the spillway allow for storage in the portion of the top of active storage capacity above the spillway crest. The remaining height to the top of the parapet walls is about 7.5 feet, providing very limited potential to encroach on existing freeboard.
Increase conservation storage in Millerton Lake by reducing flood space	Deleted	The flood management capacity of Friant Dam is lower than originally anticipated. Evaluations suggest that additional flood space would be beneficial in reducing flood damages in downstream areas. Reducing flood space would increase flood damages.
Increase Surface Water Storage in the Upper San Joaquin River Basin		
Enlarge Millerton Lake by raising Friant Dam	**Retained**	Raises of up to 140 feet (920 TAF additional storage) were considered. Retained maximum raise of 25 feet (130 TAF additional storage) in IAIR because higher raises would result in extensive residential relocation, power generation losses, and environmental impacts along the San Joaquin River and in the Fine Gold Creek watershed, and were not considered cost effective compared to other retained water storage measures.
Enlarge Millerton Lake by dredging lake bottom	Deleted	Very high cost and substantial environmental impacts for a small potential benefit.
Construct Temperance Flat RM 274 Reservoir	**Retained**	Reservoir sizes up to elevation 1,100 feet (2,110 TAF additional storage) at this site were considered. Retained maximum size at about elevation 985 (1,260 TAF new storage capacity) in IAIR because the incremental new water supply did not appear justified because of substantial additional impacts to environmental resources, additional impacts to hydropower generation, and higher construction costs.
Construct Temperance Flat RM 279 Reservoir	**Retained**	Reservoir sizes up to elevation 1,300 feet (2,740 TAF additional storage) at this site were considered. Retained maximum size at about elevation 985 (690 TAF new storage capacity) in IAIR because the incremental new water supply did not appear justified because of substantial additional impacts to environmental resources, additional impacts to hydropower generation, and higher construction costs.
Construct Temperance Flat RM 280 Reservoir	Deleted	Similar to Temperance Flat RM 279 Reservoir. Would result in similar effects on environmental resources, hydropower generation, and water supplies. Total storage capacity would be less and cost would be greater than at RM 279.
Construct Temperance Flat RM 286 Reservoir	Deleted	Reservoir sizes up to elevation 1,400 feet (1,360 TAF additional storage) at this site were considered. Deleted because environmental impacts and net impacts to hydropower generation would be greater and construction costs would be similar to comparable storage capacities at other Temperance Flat locations.

Table 4-1. Management Measures Addressing Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River (continued)

Measure	Status	Rationale
Increase Surface Water Storage in the Upper San Joaquin River Basin (continued)		
Construct Fine Gold Reservoir	**Retained**	A configuration that includes pumpback from Millerton Lake of up to 800 TAF of new storage capacity was retained in IAIR. A configuration that would involve diversion from San Joaquin River in combination with additional upstream storage was deleted because of substantial impacts to environmental resources and high cost of water supply.
Enlarge Mammoth Pool Reservoir	Retained in Concept Only	Under study by the Friant Water Users Authority and Metropolitan Water District of Southern California in study of water quality exchange opportunities. Retained in concept only. Could contribute to opportunities of flood damage reduction and hydropower generation.
Construct RM 315 Reservoir	Deleted	This reservoir, with a maximum storage capacity of about 200 TAF, would cause greater environmental impacts and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as water supply measure.
Construct Granite Project reservoirs	Deleted	Total storage capacity of about 110 TAF from multiple dams and reservoirs would cause greater environmental impacts and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as water supply measure.
Construct Jackass and Chiquito Creek reservoirs	Deleted	Total storage capacity of about 180 TAF from multiple dams and reservoirs would cause greater environmental impacts and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as water supply measure.
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds		
Construct Montgomery Reservoir	Deleted	An offstream reservoir with a storage capacity of up to about 240 TAF on Dry Creek would store water diverted from the Merced River and provide water in exchange for Friant Division deliveries. Potential exchange partners were not interested in a water supply with potential water quality problems, such as algae, associated with warm water.
Modify Big Dry Creek Reservoir for water storage	Deleted	An offstream reservoir with a storage capacity up to about 240 TAF on Dry Creek would store water diverted from the Merced River and provide water in exchange for Friant Division deliveries. Potential exchange partners were not interested in a water supply with potential water quality problems, such as algae, associated with warm water.
Enlarge Pine Flat Lake by raising Pine Flat Dam	Deleted	Water stored in about 120 TAF of additional storage space in Pine Flat Lake would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights.
Construct reservoir on Mill Creek	Deleted	Water diverted from Pine Flat Reservoir and stored in this new offstream reservoir with a storage capacity of up to 200 TAF would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure could cause immitigable environmental impacts to sycamore alluvial woodland habitat.

Table 4-1. Management Measures Addressing Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River (continued)

Measure	Status	Rationale
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds (continued)		
Construct Rogers Crossing Reservoir on the Kings River	Deleted	Water stored in Rogers Crossing Reservoir, with a storage capacity of up to 950 TAF, would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure would inundate a Federally designated Wild and Scenic River and a California-designated Wild Trout Fishery.
Construct Dinkey Creek Reservoir on a tributary to the Kings River	Deleted	Water stored in Dinkey Creek Reservoir, with a storage capacity of up to 90 TAF, would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure would cause substantial impacts to regional transportation and adversely affect high value fishery areas in downstream areas.
Construct Dry Creek Reservoir on a tributary to the Kaweah River	Deleted	Water diverted from Lake Kaweah and stored in a 70 TAF offstream reservoir would be exchanged for Friant Division deliveries. This measure could cause immitigable environmental impacts to sycamore alluvial woodland habitat.
Raise Terminus Dam	Deleted	Previously authorized for construction by the U.S. Army Corps of Engineers.
Raise Success Dam	Deleted	Previously authorized for construction by the U.S. Army Corps of Engineers.
Increase Surface Water Storage off the Friant-Kern Canal		
Construct reservoir in Yokohl Valley	Deleted	A new reservoir with a capacity of up to about 800 TAF would store water conveyed from Millerton Lake via the Friant-Kern Canal. Deleted because of conveyance limitations in the Friant-Kern Canal, potential that water quality problems associated with warm water would preclude water transfers, potential environmental impacts, and likely low willingness of local landowners to participate.
Construct Hungry Hollow Reservoir on Deer Creek	Deleted	A new reservoir with a capacity of up to about 800 TAF would store water conveyed from Millerton Lake via the Friant-Kern Canal. Deleted because of potential high costs associated with poor foundation conditions, conveyance limitations in the Friant-Kern Canal, and the presence of a potentially immitigable sycamore alluvial woodland habitat.
Construct Water Temperature Management Devices		
Construct temperature control devices on Friant Dam canal outlets	**Retained**	Selective withdrawal for releases to the Madera and Friant-Kern canals from upper levels of Millerton Lake could preserve cold water in Millerton Lake.
Construct temperature control device on Friant Dam river outlet	**Retained**	Selective withdrawal for releases to the San Joaquin River could improve the management of cold water in Millerton Lake.
Construct selective level intake structures on new upstream dams	**Retained**	Selective withdrawal for releases to Millerton Lake from new upstream reservoirs could help manage cold water in Millerton Lake.

Table 4-1. Management Measures Addressing Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River (continued)

Measure	Status	Rationale
Increase Groundwater Storage		
Increase conjunctive management of water in the Friant Division	Retained in Concept Only	Conjunctive management in the Friant Division occurs by increasing groundwater recharge with additional Class 2 deliveries or the development of local surface water supplies. Potential to combine with other measures involving development of San Joaquin River supplies, such as increasing surface water storage in the upper San Joaquin River basin. Because specific potential conjunctive management projects have not been identified, this measure is retained in concept only.
Construct and operate groundwater banks in the Friant Division	Retained in Concept Only	Groundwater banks operated as allocable water supplies in the Friant Division could provide water for river releases. Because specific potential projects have not been identified, this measure is retained in concept only.

Key:
CALFED = CALFED Bay-Delta Program
elevation xxxx = elevation in feet above mean sea level
IAIR = Initial Alternatives Information Report
RM = river mile
TAF = thousand acre-feet

Table 4-2. Management Measures Addressing Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility

Measure	Status	Rationale
Perform Reservoir Operations and Water Management		
Modify storage and release operations at Friant Dam	**Retained**	Same as described in Table 4-1.
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division	**Retained**	Integrating operations of Friant Division facilities with SWP and/or CVP facilities through water exchanges could improve water supply reliability and urban water quality. Opportunities with existing facilities are limited. Potential to combine with other measures relating to increasing surface water storage in the upper San Joaquin River basin and increasing transvalley conveyance capacity.
Modify diversion to Madera and Friant-Kern canals	Retained in Concept Only	Modifying the timing and quantity of water diverted to Madera and Friant-Kern canals would increase water supply reliability to Friant Division contractors and may provide opportunities for groundwater banking. Would support planning objectives. Because specific operations for groundwater banking have not been defined, this measure is retained in concept only.
Capture downstream San Joaquin River flow released from Friant Dam	Retained in Concept Only	Downstream capture of regulated San Joaquin River flows could increase water supply reliability in the Friant Division. Currently under separate evaluation by the SJRRP. Because specific operations have not been developed to date, this measure is retained in concept only.
Increase conservation storage in Millerton Lake by encroaching on dam freeboard	Deleted	Same as described in Table 4-1.
Increase conservation storage in Millerton Lake by reducing flood space	Deleted	Same as described in Table 4-1.
Increase Surface Water Storage in the Upper San Joaquin River Basin		
Enlarge Millerton Lake by raising Friant Dam	**Retained**	Same as described in Table 4-1.
Enlarge Millerton Lake by dredging lake bottom	Deleted	Same as described in Table 4-1.
Construct Temperance Flat RM 274 Reservoir	**Retained**	Same as described in Table 4-1.
Construct Temperance Flat RM 279 Reservoir	**Retained**	Same as described in Table 4-1.
Construct Temperance Flat RM 280 Reservoir	Deleted	Same as described in Table 4-1.
Construct Temperance Flat RM 286 Reservoir	Deleted	Same as described in Table 4-1.

Table 4-2. Management Measures Addressing Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility (continued)

Measure	Status	Rationale
Increase Surface Water Storage in the Upper San Joaquin River Basin (continued)		
Construct Fine Gold Reservoir	**Retained**	Same as described in Table 4-1.
Enlarge Mammoth Pool Reservoir	Retained in Concept Only	Same as described in Table 4-1.
Construct RM 315 Reservoir	Deleted	Same as described in Table 4-1.
Construct Granite Project reservoirs	Deleted	Same as described in Table 4-1.
Construct Jackass and Chiquito Creek project reservoirs	Deleted	Same as described in Table 4-1.
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds		
Construct Montgomery Reservoir	Deleted	Same as described in Table 4-1.
Modify Big Dry Creek Reservoir for water storage	Deleted	Same as described in Table 4-1.
Enlarge Pine Flat Lake by raising Pine Flat Dam	Deleted	Same as described in Table 4-1.
Construct Reservoir on Mill Creek	Deleted	Same as described in Table 4-1.
Construct Rogers Crossing Reservoir on the Kings River	Deleted	Same as described in Table 4-1.
Construct Dinkey Creek Reservoir on a tributary to the Kings River	Deleted	Same as described in Table 4-1.
Construct Dry Creek Reservoir on a tributary to the Kaweah River	Deleted	Same as described in Table 4-1.
Raise Terminus Dam	Deleted	Same as described in Table 4-1.
Raise Success Dam	Deleted	Same as described in Table 4-1.
Increase Surface Water Storage off the Friant-Kern Canal		
Construct reservoir in Yokohl Valley	Deleted	Same as described in Table 4-1.
Construct Hungry Hollow Reservoir on Deer Creek	Deleted	Same as described in Table 4-1.
Increase Groundwater Storage		
Increase conjunctive management of water in the Friant Division	Retained in Concept Only	Conjunctive management in the Friant Division occurs by increasing groundwater recharge with additional Class 2 deliveries or the development of local surface water supplies. Under the SJRRP, Class 2 deliveries will decrease. Potential to combine with other measures involving development of San Joaquin River supplies. Because specific potential projects have not been identified, this measure is retained in concept only.

Table 4-2. Management Measures Addressing Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility (continued)

Measure	Status	Rationale
Increase Groundwater Storage (continued)		
Construct and operate groundwater banks in the Friant Division	Retained in Concept Only	Groundwater banks operated as allocable water supplies in the Friant Division could provide water additional water storage, but Friant Division water supplies are projected to decrease through implementation of the SJRRP. Potential to combine with other measures involving development of San Joaquin River supplies. Because specific potential projects have not been identified, this measure is retained in concept only.
Reduce Water Demand		
Implement water conservation and water use efficiency methods in excess of those in the Without-Project Condition	Deleted	Opportunities to apply large-scale water conservation measures in the Friant Division are limited because conveyance losses and excess water application returns to groundwater for use in subsequent years.
Retire agricultural lands	Deleted	Does not address planning objectives and consideration/criteria. On a large scale, could have substantial negative impacts on agricultural industry.
Increase Transvalley Conveyance Capacity		
Construct Trans Valley Canal	**Retained**	Potential to combine with other measures, including integration of Friant Dam operations with CVP and SWP, and increasing surface water storage in the upper San Joaquin River basin.
Perform Water Transfers and Purchases		
Transfer water between Friant Division water users	Deleted	Does not address planning objectives or considerations/criteria. An ongoing practice among Friant Division water users to maximize use of Friant Division water deliveries.
Enhance Delta Export and Conveyance		
Expand Banks Pumping Plant	Deleted	Does not address planning objectives or considerations/criteria. Would likely be accomplished with or without additional efforts to develop new sources.
Construct DMC/CA Intertie	Deleted	Does not address planning objectives or considerations/criteria. Would likely be accomplished with or without additional efforts to develop new sources.
Improve Delta export and conveyance capability through coordinated CVP and SWP operations	Deleted	JPOD is being actively pursued in other programs.

Key:
CA = California Aqueduct
CVP = Central Valley Project
JPOD = joint point of diversion
RM = river mile
SJRRP = San Joaquin River Restoration Program
SWP = State Water Project

Enhance Water Temperature and Flow Conditions in the San Joaquin River As mentioned, 31 potential management measures were identified to address water temperature and flow conditions in the San Joaquin River. These measures were separated into six categories: (1) perform reservoir operations and water management, (2) increase surface water storage in the upper San Joaquin River basin, (3) increase surface water storage in other eastern Sierra Nevada watersheds, (4) increase surface water storage off the Friant-Kern Canal, (5) construct water temperature management devices, and (6) increase groundwater storage. Of the 31 measures identified specifically to address the planning objective of enhancing water temperature and flow conditions in the San Joaquin River, as shown in Table 4-1, three measures were retained in concept only, and nine measures were retained for initial alternative plan formulation.

Increase Water Supply Reliability and System Operational Flexibility Within the study area, geographic regions that may be targeted for increasing water supply reliability include the Friant Division of the CVP, non-Friant Division contractors in the eastern San Joaquin Valley, the lower San Joaquin River area, and areas served by Delta exports (CVP and SWP SOD). The scope of management measures addressing water supply reliability are limited by planning constraints and considerations described in Chapter 2.

Broad categories of management measures for the Investigation that may increase water supply reliability include (1) perform reservoir operations and water management, (2) increase surface water storage in the upper San Joaquin River basin, (3) increase surface water storage in other eastern Sierra Nevada watersheds, (4) increase surface water storage off the Friant-Kern Canal, (5) increase groundwater storage, (6) reduce water demand, (7) increase transvalley conveyance capacity, (8) perform water transfers and purchases, and (9) enhance Delta export and conveyance. Many of the specific management measures identified in Table 4-1 for enhancing water temperature and flow conditions in the San Joaquin River are common to measures provided for improving water supply reliability. Of the 37 measures identified to increase water supply reliability, as shown in Table 4-2, five measures were retained in concept only, and seven measures were retained for alternative plan formulation.

Measures to Address Opportunities

Numerous potential measures were identified that could contribute to the opportunities of (1) improving management of flood flows at Friant Dam, (2) preserving and increasing energy generation and improving energy management, (3) preserving and increasing recreation opportunities in the study area, (4) improving San Joaquin River water quality, and (5) improving quality of water supplies delivered to urban areas. Management measures that address opportunities that could be implemented in coordination with measures that address planning objectives are listed in Table 4-3. Descriptions of each measure and details of the rationale for retaining or deleting the measure from the Investigation follow.

Improve Management of Flood Flows at Friant Dam Flood damage reduction measures in general involve several types of actions, including improving the management of flood flows at dams by changing objective flows or adding flood storage space, improving the reliability of downstream flood conveyance channels, or removing damageable property from floodplain areas. For the Investigation, it is recognized that the SJRRP will include numerous modifications to downstream flood conveyance channels, but that these modifications have not yet been identified. Because this opportunity is being considered to the extent that it can be implemented in conjunction with actions to achieve objectives, it is limited to modifications to reservoir operations at Friant Dam to the extent that these changes would improve the management of flood flows at Friant Dam to the San Joaquin River. Measures that could contribute to improving the management of flood flows at Friant Dam are listed in Table 4-3.

Preserve and Increase Energy Generation and Improve Energy Generation Management As described in Chapter 3, the upper San Joaquin River basin has been highly developed for hydropower generation with projects that serve base and peak loads in the San Joaquin Valley and Southern California. The development and management of additional water supplies in the upper San Joaquin River basin provide an opportunity to add hydropower generation capacity and improve energy generation management in the study area. Management measures to preserve and increase energy generation and improve energy generation management are shown in Table 4-3.

Preserve and Increase Recreation Opportunities in the Study Area Two management measures were identified to preserve and increase recreation opportunities at Millerton Lake and within the upper San Joaquin River basin. Additionally, the management measure to balance water storage in Millerton Lake and new upstream reservoirs, described in Table 4-1, may also increase recreation opportunities in the study area.

Table 4-3. Management Measures Addressing Opportunities

Measure	Status	Rationale
Opportunity – Improve Management of Flood Flows at Friant Dam		
Change objective flood release from Friant Dam	Retained in Concept Only	Could be compatible with any potential new storage measure. Would not conflict with other opportunities or planning constraints/criteria. Because specific operations have not been defined, this measure was retained in concept only.
Increase flood storage space in or upstream from Millerton Lake	**Retained**	May be compatible with the planning objectives. Would not conflict with other opportunities or planning constraints/criteria.
Opportunity – Preserve and Increase Energy Generation and Improve Energy Generation Management		
Modify existing or construct new generation facilities at Friant Dam canal outlets	**Retained**	Would only be combined with raising Friant Dam to utilize potential increased water elevation generation head.
Modify existing or construct new generation facilities at Friant Dam river outlet	Deleted	Orange Cove Irrigation District filed on April 19, 2006, requesting Federal Energy Regulatory Commission approval of an amendment of license for the Fishwater Release Project to add a powerhouse with a single turbine generator with a capacity of 1.8 megawatts.
Construct new hydropower generation facilities on retained new surface water storage measures	**Retained**	Would increase the capability to recover lost generation capacity at each retained Temperance Flat Reservoir site and recover pumping energy at Fine Gold Reservoir. Would not conflict with other opportunities or planning constraints/criteria.
Extend Kerckhoff No. 2 tunnel around new surface water storage measures	**Retained**	Would involve extending the Kerckhoff No. 2 tunnel and constructing a new powerhouse downstream from either the Temperance Flat RM 279 or RM 274 dam sites. Would increase capability to recover lost generation. Would not conflict with other opportunities or planning constraints/criteria.
Construct pumped-storage facilities	Retained in Concept Only	Could be combined with hydropower generation facilities associated with Temperance Flat and Fine Gold reservoirs. Would not conflict with other opportunities or planning constraints/criteria. This measure was retained in concept only because specific operations have not been defined, it would add additional cost, and it would require participation by a non-Federal sponsor with an interest in power development and management. Pumped-storage could be added to an alternative plan at a later time if it is determined to be a beneficial increment.
Opportunity – Preserve and Increase Recreation Opportunities in the Study Area		
Replace or upgrade recreation facilities	**Retained**	Compatible with any potential modification of Millerton Lake. Would be consistent with established planning guidelines for Federal water storage projects and with existing recreation uses at Millerton Lake State Recreation Area.
Develop new management plan for Millerton Lake State Recreation Area	Deleted	Management plan update under development by Reclamation under separate study.

Table 4-3. Management Measures Addressing Opportunities (continued)

Measure	Status	Rationale
Opportunity – Improve San Joaquin River Water Quality		
Reduce salt discharge to San Joaquin River	Deleted	Currently being implemented under the San Joaquin Valley Drainage Management Program.
Recirculate Delta-Mendota Canal deliveries to the San Joaquin River	Deleted	Would increase flows and could improve water quality from Mendota Pool to the Delta. Would not provide flows in the reach from Friant Dam to Mendota Pool. Independent ongoing study authorized by Public Law 108-573.
Increase flows in tributaries to lower San Joaquin River	Deleted	Would increase flows and improve water quality from Mendota Pool to the Delta, but would not provide flows to the reach from Friant Dam to Mendota Pool.
Release water from Friant Dam during the late irrigation season to improve river water quality	Deleted	Conflicts with planning objective of increasing water supply reliability.
Opportunity – Improve Quality of Water Supplies Delivered to Urban Areas		
Treat poor quality groundwater	Deleted	High implementation costs, limited application and benefits.
Integrate Friant Dam operations with State Water Project and/or Central Valley Project outside the Friant Division	**Retained**	Same as described in Table 4-2. The operations of this measure would be formulated for water supply benefits but would also have incidental urban water quality benefits.
Construct desalination facility	Deleted	Limited application as a dry-year supply, high unit cost, and potential environmental impacts from treatment byproducts.

Key:
Delta = Sacramento-San Joaquin Delta
RM = river mile

Improve San Joaquin River Water Quality All three management measures identified to improve San Joaquin River water quality were not retained for further consideration. Reclamation is currently implementing measures to eliminate salt discharge from drainage-impaired lands to the San Joaquin River under the San Joaquin Valley Drainage Management Program. Because the measure to recirculate Delta-Mendota Canal deliveries is being implemented under a separate authority, it was deleted from further consideration in the Investigation. Settlement Restoration Flows are also anticipated to result in improved water quality conditions in the San Joaquin River below Friant Dam to the Merced River confluence.

Improve Quality of Water Supplies Delivered to Urban Areas Three management measures were identified to improve water quality delivered to urban areas. These measures were identified to reduce the levels of constituents that can cause health concerns in drinking water.

Measures Retained for Further Development

Measures retained for further development are summarized below, including measures to address planning objectives and opportunities.

Measures Retained Addressing Planning Objectives

Following is a brief description of the management measures retained for initial alternatives and potential further consideration in alternative plans that specifically address the planning objectives of the Investigation. Additionally, measures to increase groundwater storage retained in concept only are described in more detail. The remaining measures retained in concept only are not discussed because they are either under evaluation in another study or have unspecified operations, as mentioned in Tables 4-1 and 4-2.

Perform Reservoir Operations and Water Management Reservoir operations and water management measures retained for further consideration are described below.

Balance Water Storage in Millerton Lake and New Upstream Reservoirs
The management of water supplies between Millerton Lake and additional upstream surface water storage in the upper San Joaquin River basin could affect water temperature management, hydropower generation, and recreation. Reservoir balancing scenarios were developed for inclusion in alternatives that also include additional upstream storage. Separate reservoir balancing scenarios were developed for surface water storage measures in the upper San Joaquin River basin, as described below:

- **Millerton Lake Baseline Scenario –** This balancing scenario strives to maintain storage levels in Millerton Lake similar to levels in the without-project condition. It is believed this scenario would have the minimum effect on changes to recreation conditions at Millerton Lake.

- **Millerton Lake High Scenario –** This balancing scenario strives to maintain high storage levels in Millerton Lake throughout the summer season. It is believed this scenario would provide the least hydropower generation at potential upstream reservoirs and enhance recreation opportunities at Millerton Lake.

These reservoir balancing scenarios will continue to be refined as operational studies proceed in the feasibility study.

Modify Storage and Release Operations at Friant Dam Modifications to storage and release operations at Friant Dam may be combined with other measures involving developing water supplies in the upper San Joaquin River basin to enhance San Joaquin River water temperature and flow conditions and increase water supply reliability.

Integrate Friant Dam Operations with State Water Project and/or Central Valley Project Outside Friant Division Integration of Friant Dam operations with the SWP and CVP outside the Friant Division could provide opportunities for exchange of water supplies, allowing greater optimization of system operations for improved water supply reliability. The extent to which water supply reliability improvements can be realized may be limited by available conveyance capacity in existing transvalley conveyance facilities and available SOD storage capacity. Increasing surface water storage in the upper San Joaquin River basin, along with expansion of existing conveyance facilities and/or construction of additional transvalley conveyance, would substantially increase potential water supply.

Increase Surface Water Storage in the Upper San Joaquin River Basin
During Phase 1 and the Initial Alternatives Phase of the Investigation, several potential surface water storage sites in the upper San Joaquin River basin were identified and evaluated for potential inclusion in alternatives (Reclamation, 2003; 2005). At many sites, multiple sizes and configurations were considered. Evaluations considered water supply operations, general environmental consequences, construction costs, and energy generation and use. General locations of each measure considered are shown in Figure 4-2. Following is a brief description of each measure retained in the IAIR for plan formulation. These measures were subjected to further evaluation and comparison during the plan formulation phase, as described later in this chapter.

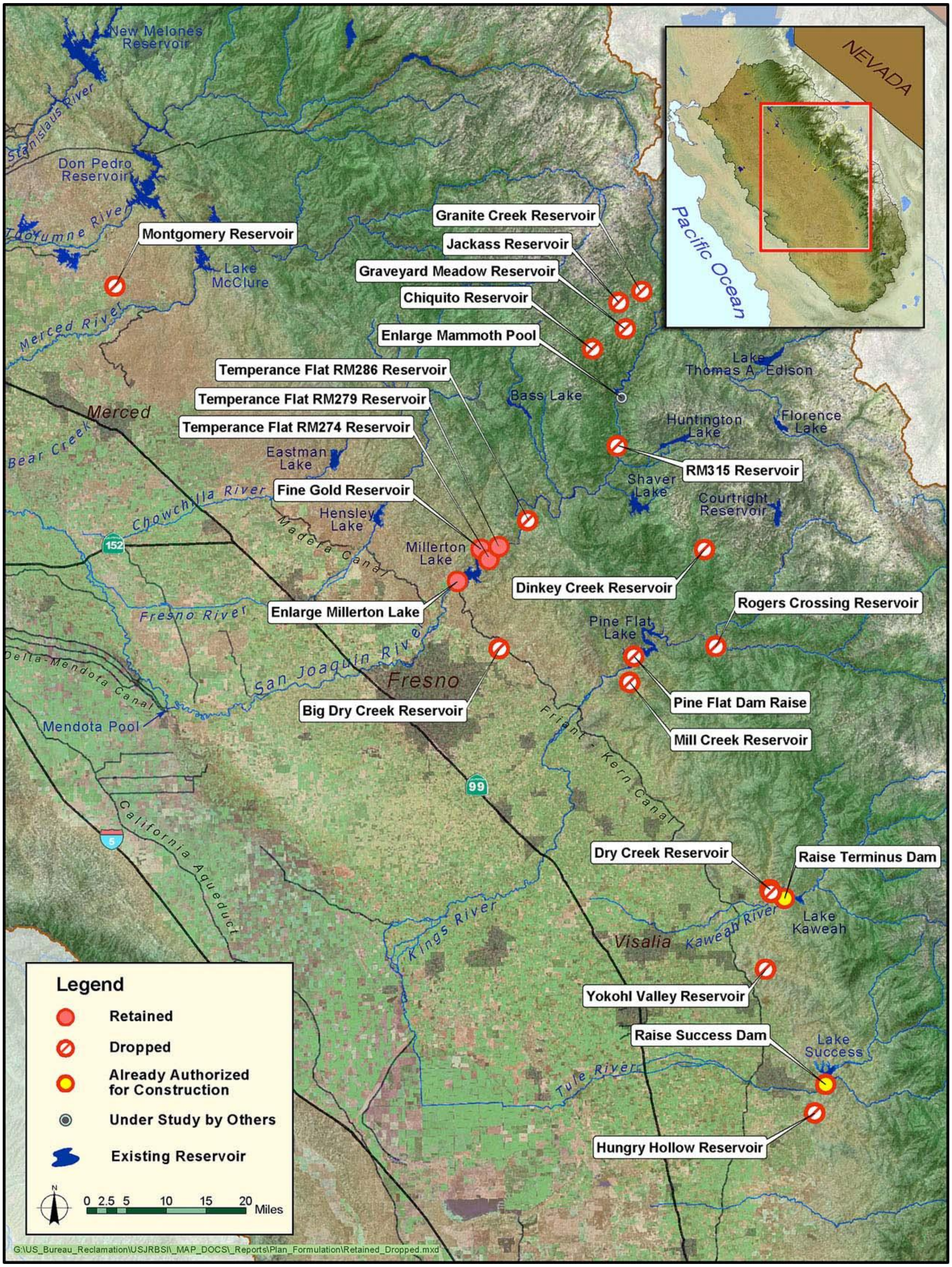

Figure 4-2. Surface Water Storage Measures Considered

Enlarge Millerton Lake by Raising Friant Dam This measure would involve raising the height of Friant Dam and constructing necessary saddle dams to enlarge Millerton Lake. The enlargement retained in the IAIR was a 25-foot raise of Friant Dam, which would increase reservoir storage capacity in Millerton Lake by 120 TAF. Friant Dam would be raised by adding an overlay of roller-compacted concrete (RCC) on the downstream face of the dam, and enlarging two earthfill saddle dams. Evaluations completed during the Initial Alternatives Phase of the Investigation concluded that this measure would not be carried forward as a stand-alone alternative because the new water supply that could be developed would not likely contribute to river restoration or water supply reliability (Reclamation, 2005).

Construct Temperance Flat RM 274 Reservoir Temperance Flat RM 274 Reservoir would be created through construction of a dam in the upstream portion of Millerton Lake at RM 274. The dam site is located approximately 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. Reservoir sizes up to elevation 1,100 at this site were considered in previous phases of the Investigation. Sizes corresponding to elevations higher than 985 were not retained because the incremental new water supply provided did not appear justified in light of substantial additional impacts to environmental resources, additional impacts to hydropower generation, and higher construction costs (Reclamation, 2005). The retained measure, a reservoir with a top of active storage capacity at elevation 985, would provide 1,260 TAF of new storage capacity and extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. At top of active storage capacity, the reservoir level would reach about 12 feet below the crest of Kerckhoff Dam.

Construct Temperance Flat RM 279 Reservoir Temperance Flat RM 279 Reservoir would be created through construction of a dam in the upstream portion of Millerton Lake at RM 279. The dam site is located approximately 11.6 miles upstream from Friant Dam. Reservoir sizes up to elevation 1,300 at this site were considered in previous phases of the Investigation (Reclamation, 2005). Sizes corresponding to elevations higher than 985 were not retained because the incremental new water supply provided did not appear justified in light of substantial additional impacts to environmental resources, additional impacts to hydropower generation, and higher construction costs. The retained measure, a reservoir with a top of active storage capacity at elevation 985, would provide 690 TAF of new storage capacity and extend about 13.6 miles upstream from RM 279 to Kerckhoff Dam. At top of active storage capacity, the reservoir level would reach about 12 feet below the crest of Kerckhoff Dam.

Construct Fine Gold Reservoir Constructing a dam on Fine Gold Creek would create a reservoir with a storage capacity of 780 TAF that could store water pumped from Millerton Lake. Water would be pumped from Millerton Lake to create additional storage capacity in Millerton Lake. Water would be released from Fine Gold Creek Reservoir to Millerton Lake during periods of highest demand for releases from Friant Dam to the San Joaquin River and Friant-Kern and Madera canals.

Construct Water Temperature Management Devices Installation of water temperature management devices could assist in the management of cold water in Millerton Lake or new upstream reservoirs and thereby contribute to restoration of the San Joaquin River through enhancing temperature conditions for species that require cold water during specific life stages.

Construct Temperature Control Devices on Friant Dam Canal Outlets Temperature control devices (TCD) could be constructed on each of the canal outlets to allow the diversion of water from upper levels of the reservoir to preserve colder water for release to the river. Similar designs of steel TCDs could be installed on either the current configuration or a raised Friant Dam.

Construct Temperature Control Device on Friant Dam River Outlet A TCD could be constructed on the river outlet of Friant Dam to enable withdrawal of water that meets release objectives from the highest possible level in the reservoir, thereby preserving cold water for a longer period.

Construct Selective Level Intake Structures on New Upstream Dams Selective level intake structures (SLIS) could be constructed on the intakes for dams associated with measures to increase surface water storage in the upper San Joaquin River basin. The SLIS would allow selective withdrawal of water from these upper reservoirs for temperature management and discharged into Millerton Lake.

Increase Groundwater Storage During Phase 1 of the Investigation, a theoretical evaluation was completed to assess if groundwater storage was a measure that should be further considered. The analysis focused on estimating the amount of water that could be made available at Friant Dam for groundwater recharge if adequate recharge facilities were in place. The analysis did not consider the subsequent withdrawal and use of water stored in groundwater basins. Several assumptions were applied to assess the reasonable amount of additional water from Millerton Lake that could be stored in San Joaquin Valley groundwater basins with no additional surface water storage. When canal conveyance limitations and exhibited historical preferences for delivery of water during wet conditions were represented, it was found that an upper limit of about 50 TAF/year of additional groundwater recharge could be possible. The outcome of the evaluation, as presented in the Phase 1 Investigation Report, demonstrated that additional groundwater storage could be possible if additional recharge capacity were developed to receive water when it is available (Reclamation, 2003). Because specific facilities had not been identified, it was not possible to determine the extent to which groundwater storage could contribute to Investigation objectives. It should be noted that local stakeholders have indicated a preference to use conjunctive management projects to meet local water needs first, a preference that is also stated in the CALFED ROD (2000a).

Following completion of the theoretical analysis, DWR initiated a review of potential projects and programs in the San Joaquin River and Tulare Lake hydrologic regions that could provide additional groundwater storage. Groundwater subbasins in the San Joaquin Valley that possess the greatest potential for groundwater recharge were identified and potential conjunctive management opportunities within these regions were assessed. Results from this assessment were provided in the IAIR (Reclamation, 2005).

During plan formulation, DWR conducted a San Joaquin Valley Conjunctive Water Management Opportunities analysis and identified several potential conjunctive management or groundwater storage projects in the San Joaquin Valley that could be considered in any regional water resources study (DWR, 2006c). Fifteen potential groundwater storage projects in the San Joaquin Valley were identified that appear to have high potential for implementation. As shown in Figure 4-3, recommended potential conjunctive management and groundwater storage projects are located in the Madera, Kings, and Kern county groundwater basins (DWR, 2006c). These potential projects have not yet been evaluated to determine their ability to contribute to Investigation objectives, and would require considerable additional data development for site-specific analysis. Thus, the measures described below related to increasing groundwater storage were retained in concept only.

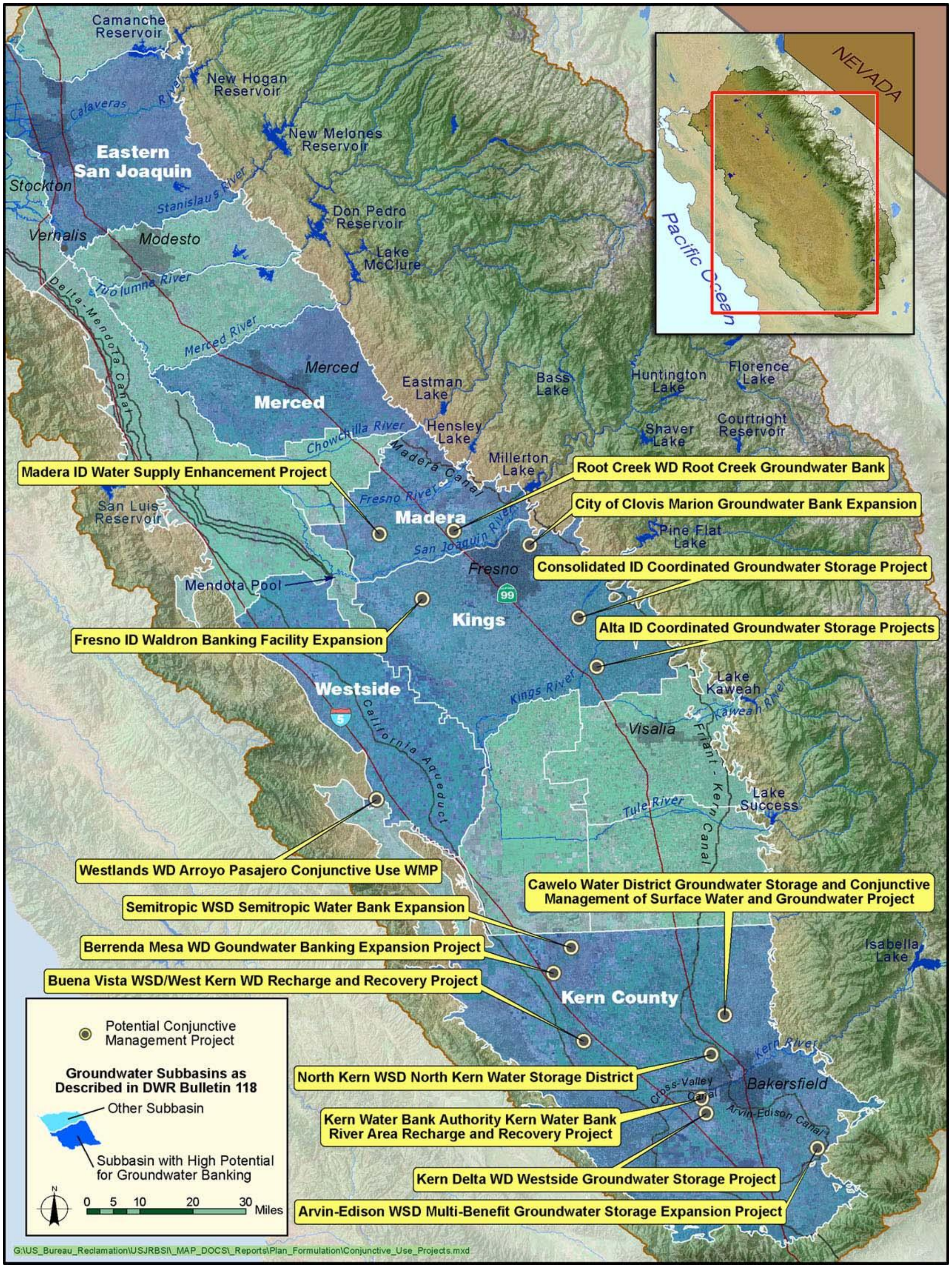

Figure 4-3. Potential Groundwater Storage Measures

Increase Conjunctive Management of Water in the Friant Division As noted above, the Friant Division is a regional conjunctive management project. Water deliveries under long-term Class 2 contracts are specifically intended for delivery to areas with access to groundwater. In wet years, Class 2 water and water delivered under Section 215 contracts are recharged to groundwater or delivered directly in lieu of groundwater pumping. Measures that increase the total delivery of Class 2 water and Section 215 supplies to Friant Division contractors, such as surface water storage measures, would increase conjunctive management and help reduce groundwater overdraft in the region.

Development of local surface water supplies for groundwater recharge, or direct delivery in lieu of groundwater pumping, would increase groundwater storage and help reduce regional overdraft. Increasing groundwater recharge through additional Class 2 deliveries or developing local surface water supplies could help facilitate exchange agreements between Friant Division water users and others. Potential measures identified in the San Joaquin Valley Conjunctive Water Management Opportunities analysis (DWR, 2006c) have not been reviewed to assess their ability to support planning objectives of the Investigation. As mentioned, because specific groundwater recharge facilities have not been defined, this measure is retained in concept only.

Construct and Operate Groundwater Banks in the Friant Division Groundwater banks in the southern San Joaquin Valley have successfully helped manage water supplies for water users in California during the past few decades. A groundwater bank is characterized as an area in an aquifer where the volume of stored water is held under contract for future delivery to other areas. Banked groundwater may be stored through active recharge techniques, such as percolation or injection, or by delivering surface water in lieu of pumping. Generally, water is banked during wet periods and extracted during dry years. Extracted water is generally delivered to the contract holder directly or through exchange.

This measure would involve development of groundwater banks that could support one or more planning objectives. Through the San Joaquin Valley Conjunctive Management Opportunities Study (DWR, 2006c), DWR has begun to identify potential participants who may be interested in groundwater banks that could support Friant contractors. However, as mentioned, because specific potential projects have not been identified, this measure is retained in concept only.

A generalized simulation of groundwater banking potential was completed to assess the potential magnitude of new supply that could be developed with groundwater banking and no additional surface water storage, as well as how the development of additional surface water storage would affect opportunities for groundwater banking. Surface water storage volumes were selected to correspond generally with retained surface water storage measures. The groundwater banking evaluations assumed varying put capacities up to 1,500 cfs and included releases from Friant Dam for Settlement Restoration Flows in the without-project condition. It was also assumed that water stored in groundwater banks would be available supplies for annual allocation, after deducting dissipation losses in the aquifer and use of 50 percent of new supply for local purposes.

Results indicated that an average annual new water supply of up to 17 TAF could be developed through groundwater banking at a put capacity of up to 1,500 cfs without additional surface water storage. Groundwater banking opportunities to support Investigation objectives would diminish as surface water storage capacity increases, and the additional water supply developed with conjunctive management above the supply developed with surface storage is quite small. The evaluation indicated that with new surface water storage of 690 TAF and 1,260 TAF, the incremental amount of additional water supply developed with groundwater banking at a put capacity of up to 1,500 cfs would be up to 8 TAF and 3 TAF, respectively. Typically, reservoir storage capacity would be used before water would be recharged to avoid losses and the additional costs of extraction. To date, specific projects have not been defined sufficiently to allow their evaluation for inclusion in alternatives. Therefore, as mentioned, this measure is retained in concept only at this time.

Increase Transvalley Conveyance Capacity Developing new facilities to convey water across the southern San Joaquin Valley east to west, or west to east, between the Friant-Kern Canal and California Aqueduct, could increase water supply reliability. The measure retained to increase transvalley conveyance capacity is described below.

Construct Trans Valley Canal Increasing transvalley conveyance capacity through construction of a new major transvalley canal would enable potential integration between the Friant Division with the SWP and/or CVP system outside the Friant Division through water exchanges. The Trans Valley Canal would have a conveyance capacity of 1,000 cfs. A conceptual alignment for the canal is more than 50 miles long, and includes a connection to the Friant-Kern Canal near Porterville and a connection to the California Aqueduct south of the Tulare Lake bed. This measure is also being studied at a preliminary level of detail by the FWUA-MWDSC Partnership and the SJRRP.

Measures Retained Addressing Opportunities

Measures retained to address opportunities are described below. These measures include one measure to improve management of flood flows at Friant Dam, three measures to increase energy generation management, one measure to preserve and increase recreation opportunities in the area, and one measure to improve quality of water supplies delivered to urban areas. The measures retained in concept only are not included in this discussion because they have undefined operations, as mentioned in Table 4-3.

Improve Management of Flood Flows at Friant Dam A potential measure that could contribute to increasing the management of flood flows at Friant Dam through increasing flood storage space, as described below.

Increase Flood Storage Space in or Upstream from Millerton Lake
Development of additional storage for water supply provides opportunities for additional dedicated or incidental flood storage space. Evaluations completed during the Initial Alternatives Phase considered the benefits associated with additional dedicated flood space in or upstream from Friant Dam (Reclamation, 2005).

Preserve and Increase Energy Generation and Improve Energy Generation Management Potential measures that could contribute to development of hydropower generation capacity include the three measures described below.

Modify Existing or Construct New Generation Facilities at Friant Dam Canal Outlets This measure would only be combined with the Enlarge Millerton Lake by raising Friant Dam measure, and would provide a potential increase in hydropower output.

Construct New Hydropower Generation Facilities on Retained New Surface Water Storage Measures The construction of new surface water storage facilities presents an opportunity to add hydropower generation facilities and improve energy generation management in the study area.

Extend Kerckhoff No. 2 Tunnel Around New Surface Water Storage Measures
The Temperance Flat RM 274 or RM 279 reservoirs would inundate the Kerckhoff and Kerckhoff No. 2 powerhouses. Evaluations conducted during plan formulation suggest that the Kerckhoff No. 2 tunnel could be extended to a location downstream from either the RM 274 or RM 279 dam site, where a new powerhouse could be constructed. This measure would allow the continued operation of diversions for power generation through the Kerckhoff No. 2 tunnel. Similar hydropower modifications considered for the Kerckhoff tunnel with the RM 274 or RM 279 reservoirs were not retained because the flow capacity and energy generation potential were considered too low to justify the expense.

Preserve and Increase Recreation Opportunities in the Study Area
Potential measures retained for the Investigation that could preserve and increase recreation opportunities in the study area include replacing or upgrading recreation facilities, as described below. A management measure to balance water storage in Millerton Lake and new upstream reservoirs for recreation was discussed above.

Replace or Upgrade Recreation Facilities Implementation of surface water storage and reservoir operations measures would affect existing recreation facilities at Millerton Lake. This measure includes developing suitable replacement facilities, with necessary upgrades to meet current standards and codes, to provide similar or greater recreational opportunities. It is recognized that some recreational experiences, such as whitewater rafting and caving, may not be replaceable for some alternatives.

Improve Quality of Water Supplies Delivered to Urban Areas One measure for improving urban water quality was retained for plan formulation, as described below.

Integrate Friant Dam Operations with State Water Project and/or Central Valley Project Outside of the Friant Division Integrating operations of Friant Dam with operations of SWP and CVP systems would allow for increased Delta exports during wet conditions, and the potential to reduce exports during dry periods, through exchange of water supplies. Water exported during wet periods would be of higher quality. Improvements in raw water quality can benefit urban water areas through a reduction in the treatment costs required to attain a given level of finished water quality.

Refinement of Initial Alternatives

Eighty-four management measures have been identified during the Investigation, as described in previous sections of this chapter. Combinations of retained measures formed various initial alternatives that were developed to address the planning objectives. Many measures that either are not well defined at this time or are under study by others were retained in concept only and, therefore, will not be explicitly defined for inclusion in alternative plans.

Because of these limitations, initial alternatives developed to date fundamentally consist of constructing new surface water storage facilities and operating them primarily to enhance temperature and flow conditions in the San Joaquin River, and increase water supply reliability. Additional retained measures include constructing water temperature management devices, and increasing transvalley conveyance capacity.

Further evaluation and comparison of initial alternatives was performed early during the plan formulation phase. Initial plan formulation efforts concluded that combining an enlargement of Millerton Lake with one of the other storage sites (Temperance Flat RM 274, Temperance Flat RM 279, or Fine Gold reservoirs) would not be effective because very limited additional water supply would be provided and because of the impacts to private property and recreation facilities. Thus, the Enlarge Millerton Lake management measure will not be considered further in this PFR or the Investigation. Other measures addressing opportunities associated with the Enlarge Millerton Lake measure, such as modified or new generation facilities at Friant Dam canal outlets, are also not being considered for further evaluation in the Investigation.

As discussed in Chapter 2, planning considerations were specifically identified to help formulate, evaluate, and compare alternative plans. One important consideration is that alternative plans would include project features for mitigating impacted power generation through developing additional power generation facilities in preference to purchasing replacement energy. This consideration leads to the inclusion of the following measures in initial alternatives considered during plan formulation to replace impacted generation: construct new hydropower generation facilities on retained new surface water storage measures, and extend Kerckhoff No. 2 tunnel around new surface water storage measures.

On the basis of these evaluations, the refined initial alternatives listed below were retained for further evaluation during plan formulation. For each initial alternative, several configurations were formulated to assess the incremental costs and benefits that would result from additional storage, reservoir operations, multiple reservoir elevations, and water temperature management, where relevant.

- Fine Gold Reservoir up to 380 TAF of new storage capacity (380 TAF) with pump-generating facility
- Fine Gold Reservoir up to 780 TAF of new storage capacity (780 TAF) with pump-generating facility
- Temperance Flat RM 279 Reservoir up to 430 TAF of new storage capacity (430 TAF) with extended Kerckhoff No. 2 tunnel
- Temperance Flat RM 279 Reservoir up to 690 TAF of new storage capacity (690 TAF) with extended Kerckhoff No. 2 tunnel
- Temperance Flat RM 274 Reservoir up to 1,260 TAF of new storage capacity (1,260 TAF) with extended Kerckhoff No. 2 tunnel

Evaluation of Surface Water Storage Measures in Refined Initial Alternatives

The surface water storage measures of refined initial alternatives discussed above are listed in Table 4-4. These surface water storage measures are evaluated in a two-step process. Ranges of potential sizes at each site are evaluated to identify incremental cost effectiveness (Step 1). Surface water storage measures retained through Step 1 are comparatively evaluated across sites in Step 2 consistent with four criteria based on the P&G: (1) effectiveness, (2) efficiency, (3) acceptability, and (4) completeness (WRC, 1983). Surface water storage measures retained in plan formulation comparisons through Step 2 are carried forward for development of alternative plans described in Chapter 5.

Table 4-4. Surface Water Storage Measures in Refined Initial Alternatives Subjected to Two-Step Comparison

Step 1 – Incremental Cost Effectiveness		
Fine Gold Reservoir (380 TAF)	Compared to:	Fine Gold Reservoir (780 TAF)
Temperance Flat RM 279 Reservoir (430 TAF)	Compared to:	Temperance Flat RM 279 Reservoir (690 TAF)
Step 2 – Surface Water Storage Measures Site Comparison		
Temperance Flat RM 279 Reservoir (690 TAF)		
Fine Gold Reservoir (780 TAF)		
Temperance Flat RM 274 Reservoir (1,260 TAF)		

Key:
RM = river mile
TAF = thousand acre-feet

Step 1 Incremental Cost Effectiveness of Surface Water Storage Measures in Refined Initial Alternatives

The following sections briefly summarize findings of technical evaluations performed during initial plan formulation for incremental cost effectiveness at a range of potential sizes across surface water storage sites, and conclusions regarding comparison and selection for the Temperance Flat RM 279 Reservoir (430 TAF) and Fine Gold Reservoir (380 TAF) measures.

Temperance Flat RM 279 Reservoir

The Temperance Flat RM 279 Reservoir (430 TAF) storage measure is less cost effective for water supply than larger size measures at this site. The Temperance Flat RM 279 Reservoir (690 TAF) storage measure provides about 30 percent (almost 25 TAF) more new water supply than the 430 TAF size, with an increase in annual cost of about 20 percent. The larger size measure also results in greater power generation and has similar environmental impacts compared with the smaller size measure. Results of analyses performed during plan formulation suggest that storage measures with smaller storage capacities provide less operational flexibility, fewer improvements to water supply reliability, and less ability to manage cold water supplies for release to the San Joaquin River. Therefore, the Temperance Flat RM 279 Reservoir (430 TAF) storage measure is not retained for further evaluation in the Investigation.

Fine Gold Reservoir

Compared to the Fine Gold Reservoir (780 TAF) storage measure, the Fine Gold Reservoir (380 TAF) measure is less cost effective for water supply. The larger size of Fine Gold Reservoir provides almost 40 percent (over 30 TAF) more new water supply than the smaller size, with an increase in annual cost of about 20 percent. The Fine Gold Reservoir (780 TAF) measure also results in a smaller difference between power generation and pumping energy requirements. Based on results of analyses conducted during initial plan formulation, the smaller size Fine Gold Reservoir (380 TAF) measure would likely provide less operational flexibility, fewer improvements to water supply reliability, and less ability to manage cold water supplies for release to the San Joaquin River compared to the Fine Gold Reservoir (780 TAF) measure. For these reasons, the Fine Gold Reservoir (380 TAF) measure is not retained for further evaluation in the Investigation.

Step 2 Site Comparison of Surface Water Storage Measures in Refined Initial Alternatives

Surface water storage measures of refined initial alternatives retained through Step 1 were comparatively evaluated in Step 2 on their relative ability to meet the four P&G criteria. Each criterion is described in the following sections with examples of the types of metrics considered for comparison and selection. The comparative ranking of each storage measure within the four criteria and overall ranking was used as a basis to delete surface water storage measures from further evaluation in the PFR that ranked lower than the other measures.

Effectiveness

Effectiveness is the extent to which a surface water storage measure in refined initial alternatives alleviates specified problems and achieves specified opportunities. Planning objectives for the Investigation were developed to address the identified problems and opportunities, and the extent to which a measure can meet the planning objectives represents its effectiveness. Temperance Flat RM 274 (1,260 TAF) was ranked high for effectiveness, while Temperance Flat RM 279 (690 TAF) ranks medium to high, and Fine Gold Reservoir (780 TAF) ranks low to medium. The effectiveness of each storage measure related to the planning objectives and opportunities is described below.

Planning Objective – Enhance Water Temperature and Flow Conditions in the San Joaquin River Increasing reservoir storage capacity and managing cold-water releases with the use of TCDs would help preserve cold water during winter and spring months for release to the San Joaquin River later in the summer and early fall. Based on water temperature modeling performed during initial plan formulation, Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF) generally provide greater total cold-water volume than Fine Gold Reservoir and are ranked high and medium to high, respectively. Total cold-water volume with Temperance Flat RM 274 Reservoir (1,260 TAF) would be greater than with Temperance Flat RM 279 Reservoir (690 TAF), primarily due to its larger storage capacity.

Fine Gold Reservoir (780 TAF), ranked low, would provide the least amount of cold water, and have the greatest number of months when the volume of cold water would be less than the without-project condition. It is not known if the reduction in cold water would adversely affect river conditions for fish restoration and maintenance, but results suggest a reduction in flexibility in the management of cold-water reserves. This measure would also be the most sensitive to changes in assumed downstream water temperature requirements for anadromous fisheries.

The Settlement does not include Restoration Flow releases to the San Joaquin River during critical-low years, but additional flow in those years could be provided by additional storage. All storage measures in refined initial alternatives are comparable in their ability to provide flows to the San Joaquin River below Friant Dam during critically low years, therefore, were ranked the same for this criterion.

Planning Objective – Increase Water Supply Reliability and System Operational Flexibility Temperance Flat RM 279 Reservoir (690 TAF) and Fine Gold Reservoir (780 TAF) both rank medium and would provide a similar average annual new water supply. Temperance Flat RM 274 Reservoir (1,260 TAF) is ranked medium to high and would yield the greatest average annual new water supply and provide the most system operational flexibility.

Opportunity – Improve Management of Flood Flows at Friant Dam Temperance Flat RM 274 Reservoir (1,260 TAF), ranked high, would provide the greatest end-of-month flood storage and highest flood damage reduction values; Fine Gold Reservoir (780 TAF), ranked low, would provide the least end-of-month flood storage and lowest flood damage reduction values.

All storage measures would provide incidental flood damage reduction benefits; however, the extent of flood damage reduction benefits is closely related to incidental flood space and additional storage capacity. Temperance Flat RM 274 Reservoir (1,260 TAF) would provide the largest volume of available flood storage space and Fine Gold Reservoir (780 TAF) would provide the least flood storage space among the storage measures.

Opportunity – Preserve and Increase Energy Generation and Improve Energy Management in the Study Area Temperance Flat RM 274 Reservoir (1,260 TAF) and RM 279 Reservoir (690 TAF), which include an extension of the Kerckhoff No. 2 tunnel around new surface water storage, would mitigate for power generation losses and are both ranked high. Fine Gold Reservoir (780 TAF), ranked low, would require ongoing power purchases for energy required for pumping to fill the reservoir. Subsequent generation at the Fine Gold Reservoir site would be inadequate to recover the energy used for pumping. All storage measures appear to have similar capacity to add pumped storage operations.

Opportunity – Preserve and Increase Recreation Opportunities in the Study Area All storage measures have the potential for affecting recreation at existing reservoirs, including Millerton Lake, or creating recreation opportunities at or near new reservoirs. Changes to recreation can generate benefits if new recreation sources are created, or if existing recreation is enhanced or improved. Recreation opportunities would generally not be many for the storage measures under consideration. Limited access, steep slopes, and reservoir water levels subject to large fluctuations create constraints that would limit recreation development. Across the measures, Fine Gold Reservoir (780 TAF) would have the lowest potential for recreation opportunity development. Opportunities could be moderately better with Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF), but would strongly depend on operating scenarios.

Opportunity – Improve San Joaquin River Water Quality Improvement to San Joaquin River water quality with the Settlement has not been evaluated for the surface water storage measures in refined initial alternatives, and is not being considered as a criterion for evaluations. It is not anticipated that storage measures would demonstrate differing potential improvements to San Joaquin River water quality.

Opportunity – Improve the Quality of Water Supplies Delivered to Urban Areas Urban water quality improvements have not yet been evaluated for surface water storage measures in refined initial alternatives, and are not being considered as a criterion for evaluations. It is not anticipated that storage measures would demonstrate differing potential improvements to water quality delivered to urban areas.

Efficiency

Efficiency is the extent to which a surface water storage measure in refined initial alternatives is the most cost-effective means of alleviating specified problems and realizing specified opportunities, consistent with protecting the Nation’s environment. The most efficient measures would best address the objectives with the least cost and adverse environmental effects. Subfactors pertinent to this criterion include (1) cost effectiveness, (2) preliminary monetary and environmental benefits, and potential environmental impacts to

(3) biological resources and (4) cultural resources. Potential impacts to biological resources are based on inundated acreage for the surface water storage measure in refined initial alternatives and ecological diversity of habitat types within inundated areas. Rankings related to cultural resources impacts are based on known and simulated occurrences of archaeological sites within the inundated areas.

Based on preliminary benefits and cost estimates, Temperance Flat RM 279 (690 TAF), Fine Gold Reservoir (780 TAF), and Temperance Flat RM 274 (1,260 TAF) all ranked medium for cost effectiveness. Fine Gold Reservoir (780 TAF) was ranked medium for preliminary monetary and environmental benefits. Temperance Flat RM 274 Reservoir (1,260 TAF) was ranked high for preliminary monetary and environmental benefits, and Temperance Flat RM 279 (690 TAF) was ranked medium to high. Although detailed field investigations have not been conducted within the Fine Gold Reservoir area, biological resources impacts are anticipated to be greater for Fine Gold Reservoir than for the other measures because of a greater inundated land area and likely more diverse habitats. Cultural resources impacts, based on modeled information for potential archaeological sites, were higher for Fine Gold Reservoir (780 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF).

Overall, Fine Gold Reservoir (780 TAF) ranks low to medium for efficiency, while Temperance Flat RM 279 Reservoir (690 TAF) was ranked medium to high, and Temperance Flat RM 274 Reservoir (1,260 TAF) was ranked medium.

Acceptability

Acceptability is the workability and viability of the surface water storage measure in refined initial alternatives with respect to acceptance by Federal, State, and local entities and the public, and compatibility with existing laws, regulations, and public policies. A measure with less support is not infeasible or unacceptable; rather, it is simply less preferred. All surface water storage measures in refined initial alternatives are compatible with existing laws, regulations, and public policies. Subfactors pertinent to acceptability evaluations include (1) relative stakeholder concerns regarding biological resources, (2) potential to develop adequate mitigation in the vicinity of potential impacts, and (3) relative stakeholder concerns regarding cultural resources. In general, impacts to biological and cultural resources would be as described under the section on efficiency.

For Subfactor 1, concerns over habitat within the Fine Gold Reservoir area were raised by USFWS during plan formulation. As described above, biological resources impacts are anticipated to be greater for Fine Gold Reservoir than for the other measures. Fine Gold Reservoir (780 TAF) ranks high for Subfactor 1. Relating to Subfactor 2, the Fine Gold Reservoir area would likely provide suitable mitigation for environmental impacts associated with implementation of either the Temperance Flat RM 279 or RM 274 measures, but it would be more difficult to find suitable mitigation for environmental impacts from implementation of the Fine Gold Reservoir measures. Therefore, Fine Gold Reservoir (780 TAF) ranks low for Subfactor 2, while Temperance Flat RM 279 Reservoir (690 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) rank medium. For Subfactor 3, Native Americans have expressed that inundation-related impacts to cultural resources would be less acceptable in either of the Temperance Flat RM 279 Reservoir (690 TAF) or Temperance Flat RM 274 Reservoir (1,260 TAF) areas compared to the Fine Gold Reservoir area.

Considering all subfactors for acceptability, Temperance Flat RM 279 (690 TAF) was ranked medium, while Fine Gold Reservoir (780 TAF) and Temperance Flat RM 274 (1,260 TAF) were ranked low to medium.

Completeness

Completeness is the extent to which a surface water storage measure in refined initial alternatives provides and accounts for all necessary investments and other actions to ensure the realization of the planned effects. Completeness will be identified through a determination that all necessary components of actions are identified, including adequate mitigation of adverse impacts, and the degree of uncertainty (or reliability) of achieving the intended objectives. Pertinent subfactors that are important in measuring this criterion include (1) reliability, and (2) constructibility. This criterion is not expected to differentiate the surface water storage measures because each has been defined at a consistent level, but some subtle differences do exist that distinguish their characteristics. At this phase of the feasibility study, assessing completeness is conceptual, and lacks information such as specific mitigation needs, and detailed designs and cost estimates.

Subfactor 1 is a measure of a surface water storage measure's capability to provide, over the life of a project, the specific and sustained benefits for which the measure was intended. It also includes a determination of whether other projects, programs, or actions are necessary to implement the project and to develop the full level of benefit for which the storage measure was intended. It includes determining whether future actions, other than normal and identified operations and maintenance (O&M), are required for full and successful implementation of the plan. Fine Gold Reservoir (780 TAF) would require a (new) reliable source of electricity for pumping water into the reservoir to meet the objectives, would reduce cold-water volume compared to the baseline conditions, and provide limited ability to capture flood flows. Therefore, Fine Gold Reservoir (780 TAF) ranks low to medium among the storage measures for this subfactor. Temperance Flat RM 274 Reservoir (1,260 TAF) ranks medium to high for the reliability subfactor, while Temperance Flat Reservoir (690 TAF) ranks medium.

Fine Gold Reservoir (780 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) rank medium for Subfactor 2 because of questions/uncertainties relating to construction of very large coffer dams in deep water, while Temperance Flat

RM 279 Reservoir (690 TAF) was ranked medium to high. To date, initial engineering studies indicate that the large coffer dams can be constructed. Constructibility issues will be further addressed as the Investigation progresses.

Considering all subfactors for completeness, Temperance Flat RM 279 Reservoir (690 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) were ranked medium to high, compared to a medium ranking for Fine Gold Reservoir (780 TAF).

Summary of Evaluation of Surface Water Storage Measures of Refined Initial Alternatives

Based on technical evaluations performed during initial plan formulation for incremental cost effectiveness at a range of potential sizes across surface water storage measures of refined initial alternatives, Temperance Flat RM 279 Reservoir (430 TAF) and Fine Gold Reservoir (380 TAF) measures were not retained for further evaluation in the Investigation. At a lesser incremental cost, the larger size storage measures provide more operational flexibility, more improvements to water supply reliability, and greater ability to manage cold water supplies for release to the San Joaquin River.

A summary comparison of the surface water storage measures of refined initial alternatives for each of the four P&G criteria evaluated in Step 2 is presented in Table 4-5. The table includes rankings for how each measure meets the comparison criteria and also shows the relative ranking between all storage measures. Table 4-6 summarizes results of the surface water storage measures comparison, and a combined ranking from the relative ranking against all four P&G criteria. The combined rankings are followed by a recommendation whether or not to retain each surface water storage measure for further evaluation. In developing a combined ranking and recommendation for each storage measure, the effectiveness criterion was given twice the weight compared to each of the efficiency, acceptability, and completeness criteria.

The Fine Gold Reservoir (780 TAF) surface water storage measure was considered inferior to the Temperance Flat RM 274 and RM 279 surface water storage measures based on the evaluation criteria. This surface water storage measure provides fewer water supply and cold water management benefits (the primary purposes), and results in more reservoir area environmental consequences. The retained surface water storage measures of refined initial alternatives, Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF), are shown in Figure 4-5, rank consistently higher than Fine Gold Reservoir (780 TAF), based on initial plan formulation evaluations. Temperance Flat RM 279 Reservoir (690 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) are further evaluated and described in more detail in Chapter 5.

Table 4-5. Comparison of Surface Water Storage Measures of Refined Initial Alternatives

CRITERIA	Temperance Flat RM 279 Reservoir (690 TAF)	Fine Gold Reservoir (780 TAF)	Temperance Flat RM 274 Reservoir (1,260 TAF)
Effectiveness			
Objectives			
Temperature management	Medium to High	Low	High
Critical-low year Restoration Flow	High	High	High
Water supply	Medium	Medium	Medium to High
Opportunities			
Management of flood flows	Medium	Low	High
Energy generation	High	Low	High
Recreation opportunities	Low to Medium	Low	Low to Medium
Efficiency			
Cost effectiveness	Medium	Medium	Medium
Preliminary monetary and environmental benefits	Medium to High	Medium	High
Relative impacts to biological resources	Low to Medium	High	Medium
Relative impacts to cultural resources	Medium	High	High
Acceptability			
Relative stakeholder concerns regarding biological resources	Low to Medium	High	Medium
Potential to develop mitigation in vicinity of potential impacts	Medium	Low	Medium
Relative stakeholder concerns regarding cultural resources	High	Medium	High
Completeness			
Reliability	Medium	Low to Medium	Medium to High
Constructibility	Medium to High	Medium	Medium

Key:
RM = river mile
TAF = thousand acre-feet

Scale (red → orange → yellow → light green → dark green)
Less Desirable — More Desirable

Table 4-6. Surface Water Storage Measures Comparison and Selection Summary

CRITERIA	Temperance Flat RM 279 Reservoir (690 TAF)	Fine Gold Reservoir (780 TAF)	Temperance Flat RM 274 Reservoir (1,260 TAF)
Effectiveness	Medium to High	Low to Medium	High
Efficiency	Medium	Low to Medium	Medium
Acceptability	Medium	Low to Medium	Low to Medium
Completeness	Medium to High	Medium	Medium to High
COMBINED RANKING[1]	Medium	Low to Medium (LOWEST)	Medium to High (HIGHEST)
STATUS	RETAINED FOR FURTHER CONSIDERATION	NOT RETAINED FOR FURTHER CONSIDERATION[2]	RETAINED FOR FURTHER CONSIDERATION

Notes:
[1] In developing a combined ranking, the effectiveness criterion was given twice the weight compared to each of the efficiency, acceptability, and completeness criteria.
[2] The Fine Gold Reservoir (780 TAF) surface water storage measure was not retained for further consideration because it is considered inferior to the Temperance Flat RM 279 and RM 274 surface water storage measures. This surface water storage measure would provide less water supply and cold water management benefits, and result in more reservoir area environmental consequences.

Key:
RM = river mile
TAF = thousand acre-feet

Scale (red, orange, yellow, light green, dark green)
Less Desirable — More Desirable

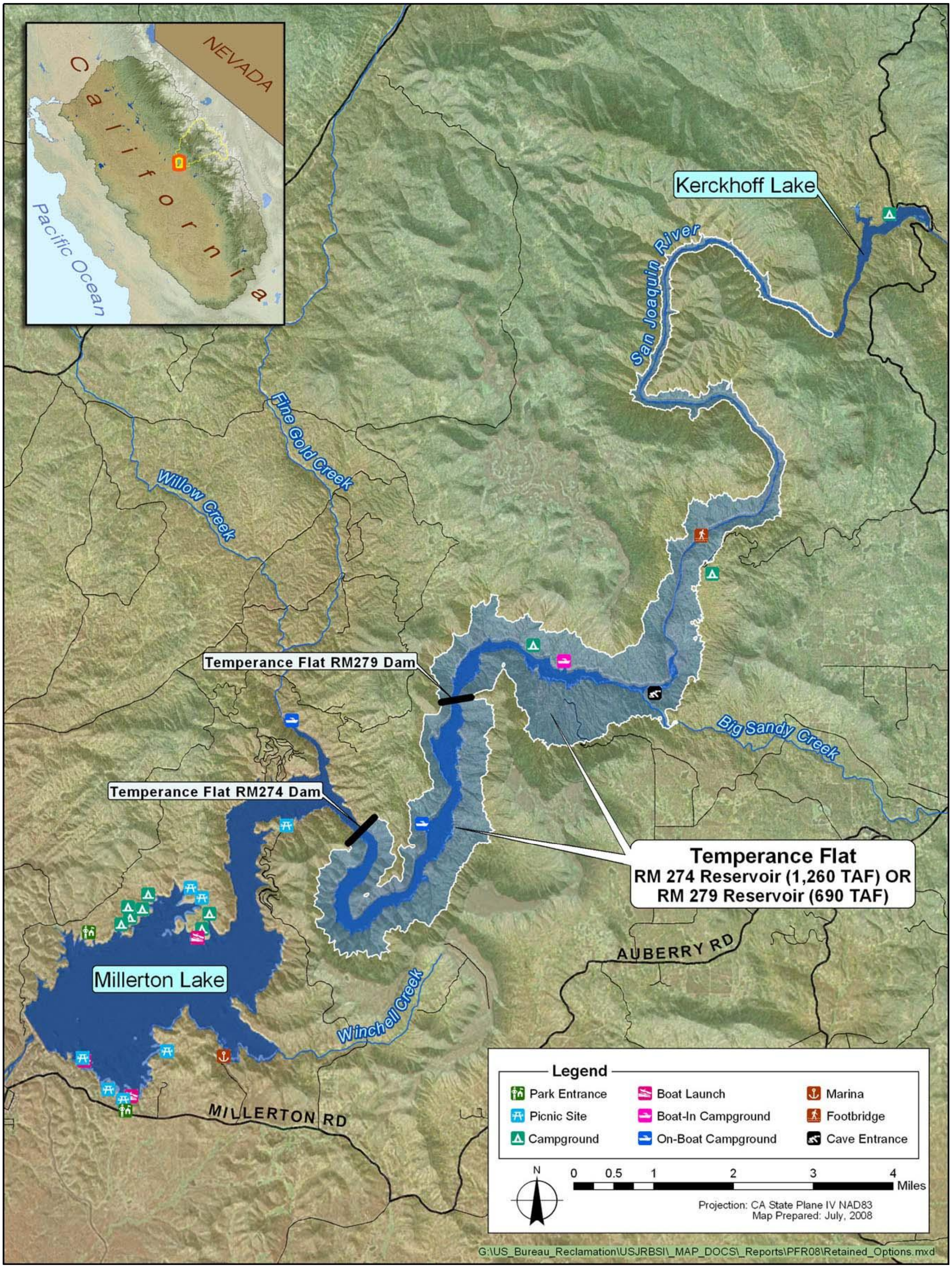

Figure 4-4. Retained Surface Water Storage Measures for Alternative Plans Formulation

Chapter 5
Features and Potential Effects of Alternative Plans

This chapter provides an overview of the features and potential effects of the No-Action/No-Project Alternative and four groupings of alternative plans formulated for the Investigation. Major alternative components, accomplishments, primary effects, and economics of each of the four groupings of alternative plans are described.

Development of Alternative Plans

In addition to the No-Action/No-Project Alternative, the four groupings of alternative plans addressed in this chapter include the following:

- Temperance Flat RM 274 Reservoir
- Temperance Flat RM 274 Reservoir and Trans Valley Canal
- Temperance Flat RM 279 Reservoir
- Temperance Flat RM 279 Reservoir and Trans Valley Canal

The effects of the four groupings of action alternative plans are determined in comparison to the No-Action/No-Project Alternative. For each alternative plan grouping, several operational scenarios were formulated and evaluated to assess the sensitivity of accomplishments for the alternatives to varying operational strategies and assumptions reflecting various management measures.

As described in Chapter 4, alternative plans fundamentally consist of constructing new surface water storage facilities and operating them primarily to address the planning objectives of enhancing temperature and flow conditions in the San Joaquin River, and increasing water supply reliability. In addition to surface water storage measures (Temperance Flat RM 274 and RM 279 reservoirs), alternative plans consist of management measures retained in Chapter 4, as shown in Table 5-1. Many of these measures are included in all action alternative plans described in this chapter. Measures to increase transvalley conveyance capacity are included in two of the four groupings of alternative plans. Measures that were retained in concept only in Chapter 4 because of a lack of specific information (such as increasing groundwater storage) or because they are under study by others (such as enlarging Mammoth Pool Reservoir), are not explicitly defined for inclusion in alternative plans.

Table 5-1. Management Measures Retained for Alternative Plans

Management Measures Addressing Planning Objectives
Perform Reservoir Operations and Water Management
Balance water storage in Millerton Lake and new upstream reservoirs
Modify storage and release operations at Friant Dam
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division
Increase Surface Water Storage in the Upper San Joaquin River Basin
Construct Temperance Flat RM 274 Reservoir
Construct Temperance Flat RM 279 Reservoir
Construct Water Temperature Management Devices
Construct temperature control devices on Friant Dam canal outlets
Construct temperature control device on Friant Dam river outlet
Construct selective level intake structures on new upstream dams
Management Measures Addressing Opportunities
Improve Management of Flood Flows at Friant Dam
Increase flood storage space in or upstream from Millerton Lake
Preserve and Increase Energy Generation and Improve Energy Generation Management
Construct new hydropower generation facilities on retained new surface water storage measures
Extend Kerckhoff No. 2 Powerhouse tunnel around new surface water storage measures
Preserve and Increase Recreation Opportunities in the Study Area
Replace or upgrade recreation facilities
Improve Quality of Water Supplies Delivered to Urban Areas
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division

Key:
CALFED = CALFED Bay-Delta Program
CVP = Central Valley Project
RM = river mile
SWP = State Water Project

Evaluation Methods

This section describes evaluation methods used to assess the features and effects of alternative plans. Evaluation methods are described for engineering and cost estimates, reservoir water supply operations modeling, reservoir water temperature modeling, hydropower generation modeling, flood damage reduction modeling, recreation opportunities assessment, biological resources evaluations, recreation resources evaluations, cultural resources review, and economic assessments.

Engineering and Cost Estimates

Appraisal-level designs and cost estimates were prepared for features in each of the alternative plans, including dams and appurtenant features, pumping plants and/or powerhouses, TCDs, and affected facilities. The cost estimates were prepared at September 2006 price levels and are consistent with Reclamation cost-estimating guidance for appraisal-level cost estimates. Appraisal-level estimates are intended to be used to compare alternative plan features such as dam types, dam sites, and powerhouses or pumping plant capacities. Appraisal-level designs are based on standard practice with limited specific analysis, design optimization or estimated cost minimization.

Allowances for unlisted items and contingencies are included in the estimates of field costs to account for minor components not included in the estimates and for uncertainties, respectively. The allowance for unlisted items or design contingencies involved in constructing project components is estimated to be about 15 percent of the subtotal of feature line items and mobilization. The allowance for construction contingencies is estimated to be about 25 percent of the estimated contract cost (subtotal of feature line items with mobilization and unlisted items).

Estimated construction costs represent the sum of field costs and non-contract costs. Estimated non-contract costs include work or services provided by agency personnel, or acquisitions to facilitate project development, such as land acquisition, recreation facility replacement, environmental mitigation, and distributive costs for planning, engineering, design, and construction management. The allowance for planning, engineering, design, and construction management is estimated to be about 10 percent of the estimated field cost.

The total estimated capital cost (estimated construction cost and interest during construction) was annualized, and estimated annual costs were also included for O&M and power replacement, where applicable, to obtain the estimated annual cost for each alternative configuration. Cost estimates are presented in the economics section of this chapter for each alternative.

Reservoir Water Supply Operations Modeling

The effects of the alternative plans were simulated with CALSIM II (CALSIM), which is the joint DWR/Reclamation planning simulation model used to evaluate statewide water operations on a monthly time step. CALSIM includes an 82-year simulation period based on 1922 through 2003 hydrology. CALSIM encompasses the operations of major Sacramento River basin reservoirs, including Trinity, Shasta, Oroville, and Folsom; operations of major San Joaquin Basin reservoirs, including New Melones, Don Pedro, McClure, and Millerton; and operations of numerous smaller reservoirs. Current flow and regulatory standards throughout the water system are included as constraints in the model, including Delta salinity standards.

CALSIM's representation of the Friant Division was revised to incorporate operations that include Settlement Restoration Flow releases from Friant Dam. Canal diversions vary from year to year based on an annually varying water supply. The baseline CALSIM representation used in the analysis of system effects is the Future (2030) No-Action condition assumption in the Common Model Package.

CALSIM simulations were used to characterize the system effects of new storage, and provide a perspective on the level of magnitude of those effects. Complex water operations models such as CALSIM use operating rules and criteria to simulate water systems. The existing CALSIM operating rules were developed and tuned to simulate the existing system. Inherently, these rules may not properly simulate how the system would operate with additional storage on the San Joaquin River. Many unknowns exist concerning the changes in institutional and regulatory commitments and requirements that may result from the effects of additional storage. To avoid speculation within the PFR analyses, the existing CALSIM rules and operational protocols were not adjusted. Therefore, the CALSIM model results should not be considered absolute, but instead used to provide general trends for comparing alternative plans.

Results from the CALSIM model are used as input to several other technical studies, including reservoir water temperature, hydropower generation, flood management, reservoir fisheries, and recreation evaluations. Because some of these assessments required operations data on a shorter time step, a procedure was developed to disaggregate monthly simulation results into daily output. Daily inflow, outflow, and reservoir storage were used for water temperature and reservoir fisheries analyses to provide insight on relative potential benefits and effects of alternatives. Refinements were made to CALSIM to represent operations of Friant Dam and upstream surface water storage measures integrated with operations of the CVP and SWP systems.

Reservoir Water Temperature Modeling

The CE-QUAL-W2 (W2) model was used to evaluate water temperature in simulated reservoirs. W2 is a two-dimensional (longitudinal and vertical) water quality and hydrodynamic model for rivers, estuaries, lakes, reservoirs, and river basin systems. W2 consists of directly coupled hydrodynamic and water quality transport models to represent basic eutrophication processes, such as temperature-nutrient-algae-dissolved oxygen (DO)-organic matter and sediment relationships. Inputs to the W2 model included inflow rates, inflow water temperature, meteorological data, bathymetry, and topography.

The W2 model for the Investigation was calibrated for 2004, 2005, and 2006 conditions in Millerton Lake. After calibration, river outlet releases at Friant Dam matched actual data with an error of less than 1 degree Celsius (ºC). Temperature profiles simulated with the Investigation model also agreed with measurements with an error of less than 1ºC. Inflow and outflow for the reservoirs in the W2 model are based on daily (disaggregated) output from the water supply operations model for a 20-year period of record, water years 1984 to 2003. This period is considered long enough to represent multiple water year-types, and short enough to allow the model to run in a reasonable time frame. The W2 model was applied to a variety of operational scenarios included in the alternative plans.

Because temperature dynamics for the San Joaquin River are not being simulated as part of the PFR, water temperature performance for alternative plans was evaluated based on cold water management flexibility as represented by the monthly multipliers (alternative divided by without-project condition) of volume of cold water at specific target temperatures. All alternatives were simulated with SLISs for the Temperance Flat Reservoir alternatives and TCDs on Friant Dam river outlet and canal outlets.

Hydropower Generation Modeling

Preliminary energy estimates for generation at Friant Dam and Temperance Flat RM 274 and RM 279 dams were made using a spreadsheet approach based on output from the water operations models developed for the Investigation. Key features of the hydropower generation analyses include the following:

- Monthly time step calculations based on head and flow
- Generation unit capacity consistent with engineering assumptions
- Assumed peak and off-peak energy prices, as described in the economics section below
- Calculated peak and off-peak power use, generation, and values

The hydropower model also has a pumped-storage module which can simulate management of weekly water volume in a manner to maximize peak generation with off-peak pump back to upper reservoirs. Effects of the alternative plans on system-wide energy generation and usage for CVP and SWP facilities were evaluated using the LongTermGen and SWP Power California models.

Flood Damage Reduction Modeling

Flood damage reduction evaluations were completed using analytical tools and data developed by USACE and the Reclamation Board of the State of California (The Reclamation Board) for the Comprehensive Study (2002). Analytical tools developed for the Comprehensive Study were designed to support evaluations of flood management actions for the entire San Joaquin River basin. Hydrologic data include inflows to all major reservoirs operated for flood management, from Pine Flat Reservoir on the Kings River to New Hogan Reservoir on the Calaveras River. The USACE UNET hydraulic model used for evaluations represents all floodways, including river channels (leveed and nonleveed reaches) and bypasses. The Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) flood benefits model used to evaluate economics represents damageable property in all areas subject to flooding from major flood management and conveyance systems in the entire San Joaquin River basin.

A series of evaluations was completed to estimate potential flood damage reduction benefits that would result from dedicating a range of additional flood storage space at or upstream from Millerton Lake. Evaluations also were performed to estimate potential incidental flood benefits that would accrue from alternative plans that do not include additional dedicated flood storage space. For the incidental flood benefit analysis, the monthly storage capacity that would be available at a 90 percent exceedence was identified for the without-project condition and for all alternative plans. The minimum increase in available storage space between the without-project conditions and the alternative plans was identified, and the corresponding flood damage reduction benefit that would result from that amount of additional dedicated available space was identified as the potential incidental flood damage reduction benefit.

Biological Resources Evaluations

Biological resources evaluations during plan formulation were conducted for aquatic, plant, and wildlife species, including threatened, endangered, and sensitive species. Evaluations focused on effects of alternative plans on habitat and species in the primary study area.

Aquatic Biological Resources

The following sections describe evaluation methods for aquatic biological resources.

Habitat Evaluation Shallow water habitat analyses were conducted for centrarchid game species (black basses and sunfishes), which reside predominately in the shallow water margins of reservoirs. Mean surface areas between the reservoir surface and the 15-foot depth contour, the approximate lower depth of the principal spawning and rearing habitat of all the centrarchid species, were computed for each of several representative reservoir operations scenarios. Means were computed only for the months of April through September, because most spawning for these species occurs from April through June, and April through September are the most critical months for successful rearing. A 24-year period of record was used to calculate the mean values.

Effects of the alternatives on lotic (i.e., riverine or stream) habitat were evaluated by calculating how much stream habitat exists under current conditions with Millerton Lake at the top of active storage and how much would be inundated with each alternative at the top of active storage. These physical effects were expressed as lengths of stream habitat affected. Streambed gradient (i.e., stream slopes) of all lotic reaches was estimated from contour maps and digital elevation models. Certain species are less likely to use lotic habitat with slopes greater than 3 percent; therefore, length of stream habitat with slopes less than and greater than 3 percent was estimated. The numbers generated for the length of stream under each gradient category are approximations and are meant to be used for comparing the alternative plans only.

Species Evaluation Methods for evaluating effects of alternative plans on aquatic and fish species are described below.

Reservoir Species Results of the reservoir habitat analyses were combined with the known habitat requirements of the target reservoir species to assess species-specific effects of the alternative plans. For striped bass and American shad, analyses of effects were based on general information about projected reservoir volumes and inundation zones of the alternative plans, including inundation of spawning habitat. For the two principal black bass game species, largemouth and spotted bass, life history-habitat spreadsheet models were developed using quantitative data on shallow water surface areas and reservoir surface elevations for each alternative. The models simulate spawning production of these species under the selected alternatives scenarios. The model outputs an index of total reservoir production rather than a true production estimate. Results of the model for largemouth and spotted bass were also used to determine likely effects of the alternatives on the other target centrarchids species, smallmouth bass, bluegill, and black crappie. Potential differences in the habitat requirements of the different species were considered in applying the model results to assess effects on the two sunfishes and smallmouth bass.

The largemouth and spotted bass spawning models were developed to simulate effects of changes in water level, shallow water surface area, and water temperature on production of these species. Only 21 years of production are simulated in the model because an initial 3 years of operations data are required to simulate effects of changes in reservoir elevations on habitat quality. The model was used to simulate production for several representative operations scenarios.

Lotic Species Species evaluations for the alternatives relative to lotic habitat were considered with regard to their effects on critical habitat elements of fish species and their life stage requirements. The length of useable habitat affected for each of the lotic species was calculated as the total length of lotic habitat affected by the alternative, multiplied by the percent of that habitat suitable for the species. For example, hardhead are less likely to use lotic habitat with slopes of greater than 3 percent; therefore, the total length of stream with slope of less than 3 percent was considered useable hardhead habitat. Streams considered for the lotic habitat analyses include the San Joaquin River and Big Sandy Creek.

The lotic habitat evaluation for rainbow trout was based on the assumption that this species occupies stream habitat with a gradient both greater and less than 3 percent, and potentially occurs in Big Sandy Creek and the San Joaquin River. Hardhead and Kern brook lamprey habitat analyses assumed these species mostly use habitat with a gradient of less than 3 percent. Although a 3-percent gradient is not a barrier to hardhead or to the Kern brook lamprey, these fishes are not likely present on a regular basis in higher gradient habitats. Therefore, the higher reach gradients were not included as useable habitat. Hardhead are known to occur in the San Joaquin River, but for purposes of the evaluation, it was assumed that they are also present where stream gradient is less than 3 percent in Big Sandy Creek. Within the primary study area, Kern brook lamprey were assumed to occur only in the San Joaquin River, and not in Big Sandy Creek. Hitch were captured within the primary study area, but outside the stream considered for lotic habitat analyses, in Fine Gold and Little Fine Gold creeks (Moyle et al., 1996). Hitch are not likely to be present within the primary study area because green sunfish, a predator of hitch and other fish species, were captured in the lower reaches of Fine Gold Creek (Blumenshine, 2006). However, because no data exist proving or disproving their presence, hitch were included as a species present throughout the Fine Gold Creek watershed.

Terrestrial Biological Resources

Alternatives evaluations provided in this section for terrestrial biological resources are based on vegetation and wildlife studies conducted from February through July 2007 for the Investigation within the area inundated by the Temperance Flat RM 274 and RM 279 reservoir alternatives. Studies were conducted to describe baseline vegetation, habitat conditions, and plant and wildlife species occurrence, with an emphasis on special-status species. The comparative analysis presented in this chapter is limited to special-status species actually observed by biologists, and for which adequate data are available during plan formulation. For purposes of this analysis, special-status species refer to those that are legally protected or are otherwise considered sensitive by Federal, State, or local resource conservation agencies and organizations. Special-status taxa are species, subspecies, or varieties that fall into one or more of the following categories, regardless of their legal or protection status:

- Officially listed or proposed for listing by California or the Federal Government as endangered, threatened, or rare
- Candidate for Federal or State listing as endangered, threatened, or rare
- Taxa that meet the criteria for listing, even if not currently included on any list, as described in Section 15380 of the CEQA Guidelines
- Taxa designated as a special-status, sensitive, or declining species by other Federal or State agencies or nongovernmental organizations (including species classified as sensitive by BLM)
- Taxa considered by the California Native Plant Society (CNPS) to be "rare, threatened, or endangered in California" (Lists 1B and 2)
- Species identified by DFG as California species of special concern
- Animals fully protected under the California Fish and Game Code

Biologists mapped habitat in the field onto 1:2,400-scale (1 inch = 200 feet) rectified aerial photograph base maps. In addition, plant species composition data were collected in representative stands of each plant community type within the study area. Botanical surveys were conducted during April and May 2007 by walking meandering transects on public lands throughout the study area; the locations of rare plant species individuals and populations were recorded and mapped. Habitats were mapped using the Holland classification, and the area of each habitat was calculated for each alternative plan. The resulting "ground-verified" geographic information system (GIS) layer is suitable for use in determining the extent of inundation-related effects of Investigation alternative plans on plant communities and potential habitat for plant and wildlife species, including special-status species.

Biologists also performed general wildlife surveys between February and July 2007, recording and mapping any special-status species observed. Habitat suitability was modeled for several species, including foothill yellow-legged frog, California tiger salamander, and western pond turtle. Modeled habitats were applied toward focused surveys for foothill yellow-legged frog and western pond turtle.

Special-status plant and wildlife species, identified through existing biological reports, literature, the California Natural Diversity Database (CNDDB), and discussions with local authorities and other biologists knowledgeable on the area's terrestrial resources, are summarized in tables that list species' habitat preferences and the likelihood of species occurring in the primary study area. Potential wildlife species distribution and potential occurrence of unmapped plant species are generally indistinguishable between the alternatives, and are not addressed in this PFR. Evaluations in this chapter summarize identifiable differences between the Temperance Flat RM 274 Reservoir and Temperance Flat RM 279 Reservoir alternative plans, based on data collected during plan formulation. General results for botanical and wildlife resources in both alternative plan areas are also summarized.

Habitat effects for alternative plans were compared using GIS. GIS was also used to summarize special-status botanical and wildlife species information for each alternative where geographical locations were recorded during data collection. Species-specific comparisons were reviewed where a species and its requisite habitat can be discerned between the Temperance Flat RM 274 Reservoir and Temperance Flat RM 279 Reservoir measures of alternative plans.

Recreation Opportunities Assessment

During plan formulation, analysis of the effects of fluctuating reservoir levels focused on the pool elevation of Millerton Lake, or a smaller Millerton Lake resulting from a dam located upstream at either of the Temperance Flat dam sites. This was because the majority of existing recreation opportunities that could be impacted by reservoir operations are on Millerton Lake, particularly in association with the facilities on the north and south shore at the lower end of the lake. More specifically, pool elevations for Millerton Lake during the key May-through-September peak water-based recreation season, under baseline conditions, were compared with the range most desirable for current use and the range that would occur under the alternatives. Reservoir operations would also influence the recreation opportunities available at the new Temperance Flat reservoirs created under the alternatives. Recreation opportunities and facilities that could be developed at the new reservoirs would be influenced by operations, particularly by the pool elevations that are most likely to exist during the summer water-based recreation season, and seasonal fluctuation in pool elevation.

Recreation opportunities for the alternative plans were assessed using these reservoir pool elevations, and suitable characteristics for recreation site development and recreation development constraints. Suitable characteristics included favorable slope for development, road access, existing recreation sites for potential infill or expansion, and proximity to proposed shorelines. Recreation development constraints analyses included slopes unfavorable for development, inundated areas, sensitive species buffers, and several sensitive fish and plant habitat areas.

Recreation Resources Evaluations

Methods used during plan formulation for evaluating effects of Investigation alternatives on recreation resources are described below. Categories of effects to recreation resources include direct effects, indirect effects, and effects of reservoir balancing scenarios for alternatives on recreation resources.

Direct Effects

The direct effects of the alternative plans on recreation are those effects that result from inundation of recreation facilities, access roads, and undeveloped shoreline use areas due to increased maximum pool levels and new reservoirs. Direct effects to recreation facilities resulting from Investigation alternatives were estimated through mapping the maximum reservoir pool and identifying facilities affected by the alternative plans.

Indirect Effects

The indirect effects of the alternatives on recreation opportunities are those effects that result from the direct effects listed above, such as potential reductions in recreation use of various types due to loss of the facilities and shoreline land areas that support use. Other indirect effects that may occur relate to changes in the types and quality of recreation opportunities under the alternative plans. Estimates of indirect effects of the Investigation alternative plans are based on information such as the number and types of recreation visitors (e.g., shore-based day users, boaters, campers) who use individual facilities. Assessment of indirect effects is also based on existing descriptions and field observations of the types of recreation opportunities and settings currently existing in the study area, and similar qualitative information.

Cultural Resources Review

Evaluation methods during plan formulation for archaeological and historical structural resources, and historic and modern Native American resources, are described in this section.

Archaeological and Historical Structural Resources

The extent of archaeological surveys previously conducted varies widely across the primary study area for the alternatives sites. Also, survey methods and recording procedures have changed over time and between resources categories. For example, few low-density prehistoric artifact scatters and no buried sites (sites that lack obvious surface indicators) have been recorded, and historic-era sites often were not recorded; it appears that only prehistoric residential settlements and bedrock milling localities have been systematically discovered and recorded. Therefore, the archaeological inventory of the primary study area is not fully representative of all resources categories; the number of known resources varies widely between project alternatives largely because of the scale and nature of archaeological investigations; and the existing inventory is not fully comparable across the alternatives.

Sensitivity Analyses for Unsurveyed Areas To predict the total number of sites present within each alternative plan area, it was not practical to create simple site-density values based on known site quantities, for the reasons outlined above. Sensitivity analyses were conducted for prehistoric and historic-era sites to address data gaps using methods tailored to each data set. Results of the prehistoric and historic-era sensitivity analyses were integrated to provide quantitative, comprehensive sensitivity and effects assessments that take into account both documented and undocumented cultural resources (both archaeological sites and historic-era structures).

Prehistoric Sensitivity Analysis The prehistoric sensitivity analysis used existing data on survey coverage and sites from a larger area, along with selected environmental variables, to construct a statistical model to predict total site numbers for each alternative plan. A weights-of-evidence quantitative analysis predicted the overall density and distribution of sites. The analysis comprised several major components:

- Development of evidential themes, including slope, hydrology, distance to water, and soil type
- Compilation of a training-point theme (site locations)
- Weights calculations and model building

A larger regional database of archaeological sites and survey coverage was compiled. This analysis was extrapolated to the primary study area and, using the evidential themes, a single response theme was calculated to predict the overall probability for sites. This provided a quantitative basis for estimating the total number of prehistoric sites within the areas for surface water storage measures of alternative plans.

Historic-Era Sensitivity Analysis In contrast, the historic-era sensitivity study gathered archival data within the primary study area to make predictions regarding the range and number of potential historic-era resources (both structures and sites) by alternative plan, given that prior archaeological surveys did not appear to have systematically recorded historic-era sites and structures. The historic-era study relied more heavily on qualitative and categorical analysis to assess sensitivity for each alternative plan.

Archival information was derived primarily from Federal land records. Information was found for localities identified by Federal land surveyors who subdivided townships adjacent to the San Joaquin River in the late nineteenth century, and records of Federal disposition of the public domain to private individuals for homesteading, stock raising, mining, and other purposes.

Potential historic-era sites or properties were counted whose locations had been identified in historical documentation, but their existence had not been verified by field investigation. Historic-era buildings, structures, mines, towns, roads, and other features were identified and plotted as they appeared on historical maps. Historic-era mining claims and patents on the public domain, locations of mines reported in State Mineralogist and State Mining Bureau reports, and homestead patents were also tabulated. These sites, claims, and patents provide a basis for identifying more sensitive areas of potential historic-era resources in the future. Information on patterns of land use within the study area in the more recent past was derived from historical literature and the cultural information depicted on historical USGS topographic maps from 1912 to 1945.

Historic-Era and Modern Native American Resources

During the plan formulation phase of the Investigation, identification of Native American issues and resource locations was limited. The California NAHC was contacted to identify whether any recorded sacred sites were situated within the primary study area, and to obtain a recommended list of Native Americans to contact regarding the Investigation. Federally recognized Native American tribes were invited to begin the consultation process at an information meeting, followed by additional telephone contact to learn of their concerns regarding the Investigation, and to gain an initial sense of where sensitive resource localities are situated within the primary study area. Unrecognized tribes and individuals were contacted who provided valuable information for the Investigation. Also, in-person visits were made to tribal members to collect information.

Economics Assessments

The P&G (WRC, 1983) established four accounts to facilitate evaluation and display of alternative water resource plans:

- NED – Effects on the national economy, expressed in monetary units. NED benefits are the increase in value of national output of goods and services expressed in dollars. NED figures measure benefits to the Nation, rather than to a particular region.
- Regional Economic Development (RED) – Regional incidence of economic effects, income transfers, and employment.
- Environmental Quality (EQ) – Effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that cannot be measured in monetary terms.
- Other Social Effects (OSE) – Urban and community impacts and effects on life, health, and safety.

The categories identified in the Investigation for potential NED benefits include agricultural and M&I water supply reliability, ecosystem enhancement, M&I water quality, emergency water supply, hydropower, recreation, and flood damage reduction. Evaluation methods were developed for those categories in which direct quantitative information would be available from the technical studies completed during plan formulation. Regional economic analyses were performed for the RED account, and the EQ and OSE accounts were addressed more generally in this phase of the Investigation. All economics assessments are considered preliminary and will be refined as the feasibility study progresses.

National Economic Development Account

Potential NED benefit categories and the associated evaluation methods used are summarized in this section.

M&I Water Supply Reliability Benefits Potential M&I water supply reliability benefits were estimated based on changes in M&I deliveries to SOD SWP M&I contractors. Changes in M&I deliveries to Friant Division contractors and other CVP M&I contractors resulting from the alternative plans were very small, and were not considered in the economics analysis at this stage. Friant Division M&I contracts account for about 8 percent of total Class 1 contracts and CVP M&I contracts are less than 7 percent of total SOD CVP water service contracts. The potential benefits to M&I water users are measured according to the estimated cost of the most likely alternative water supply that would be pursued in the absence of development of the alternative plans. For potential water supply reliability benefits, the estimated cost of the most likely alternative plan represents the next unit of water supply the water user would purchase or develop if the additional storage were not in place. The estimated cost of the most likely alternative plan assumes that if the preferred alternative plan is not implemented, the alternative action most likely to take place provides a relevant comparison. If the preferred alternative plan provides the same output as the most likely alternative plan at a lower estimated cost, the net potential benefit of the preferred alternative plan is equal to the difference in the estimated project costs.

The analysis performed relies in part on market prices paid to purchase water on an annual basis from willing sellers. The market prices are reported according to the payments made directly to the sellers. The buyers incur additional costs to convey the water to their M&I service areas. These estimated costs include both conveyance losses that diminish the volume of water delivered to end users as well as wheeling and power charges. The conveyance costs are estimated for M&I water users benefiting from the alternative plans and added to the estimated market prices to acquire the water to develop an estimate of the willingness to pay for additional water supply. Two equations were applied to estimate the potential economic benefits of increased M&I water supplies. The first equation was used to forecast prices when volume of water traded is an explanatory variable. The second equation was used to estimate the volume of water traded in the market. Quantity traded can be estimated to project the volume of water traded over a 100-year period. The model was estimated using data from 1990 to 2007.

Agricultural Water Supply Reliability Benefits Direct potential agricultural water supply reliability benefits associated with the alternative plans were estimated according to changes in net revenue to agricultural producers within the Central Valley resulting from changes in agricultural deliveries to Friant Division and other CVP and SWP contractors. Improvements in surface water supply reliability to agricultural producers would result in less temporary crop idling and avoidance of obtaining more costly alternative water supplies, among other effects. The additional farm income generated through increased production opportunities and avoided production costs would result in direct potential economic benefits to the region. In addition, improvements in surface water deliveries would reduce reliance on groundwater, thereby reducing aquifer drawdown over time.

Regional agricultural water deliveries from CALSIM are used as inputs to the agricultural production model (CVPM). In this analysis, changes in 2030 groundwater pumping lifts among project alternatives are estimated for the Friant Division as well as adjacent agricultural production regions, and incorporated into the CVPM. Key output from the CVPM includes irrigated acres, net revenue, and gross revenue.

Hydropower Benefits As explained previously, all alternative plans evaluated would affect energy generation and use in the upper San Joaquin River watershed and, to a limited extent, at CVP and SWP facilities. The value of the energy used or generated was calculated using 5-year average monthly Dow Jones South of Path 15 (SP15) wholesale energy prices.

For alternative plans that adversely affect hydropower generation, it is assumed that impacted energy would be recovered to the extent possible using hydropower measures included in the plans. Potential hydropower benefits are presented as net benefits. If the estimated value of energy generated by an alternative plan exceeds the value of lost energy generation from the without-project condition, the difference in value is recorded as a positive benefit. If the estimated value of energy generated by an alternative plan is less than the value of lost energy generation compared to the without-project condition, the difference in value is recorded as a negative benefit.

Flood Damage Reduction Benefits Increased dedicated flood storage space is not included in alternative plans. Evaluations completed in previous phases of the Investigation demonstrated that potential flood damage reduction benefits resulting from incidental availability of flood storage space would be similar to those that would result from the dedication of additional flood storage space.

Recreation Benefits Potential recreation benefits are estimated based on changes in consumer surplus for various activities, such as boating, picnicking, camping, swimming, and fishing. The valuation of potential benefits for recreation would abide by a willingness to pay framework, as required by the P&G. Recreation is primarily a nonmarket good, and nonmarket potential benefits quantification is often difficult and time consuming. The "benefits transfer" approach was used to derive an estimate of consumer surplus, by applying estimates of willingness to pay values for the same nonmarketed commodity to the Investigation alternatives.

To develop an estimate of recreation enhancement, a model was developed to incorporate available information on visitation and economic values, and an assessment of the relationship of lake level to activities. The results of the qualitative recreation assessment were incorporated into the visitation model according to the degree of change anticipated. The model then estimated the change in recreation by activity type on an annual basis. By applying recreation visitor-day values, the results of the analysis predict the potential net economic benefits of recreation. The economic user-day estimates of consumer surplus require refinement in the future to ensure that they properly reflect conditions at Millerton Lake. It is expected that there would be a large proportion of new visitors with potentially different expenditure patterns. These factors would lend uncertainty to the estimate such that the true economic value could be as much as 25 percent higher. The recreation benefits reported in the PFR are based on the recreation model estimates increased by 25 percent.

M&I Water Quality Benefits In general, potential economic benefits of water quality improvements are measured by changes in consumer and producer surplus, and defined as the willingness to pay for an environmental improvement. In this context, it is often measured in terms of damages (increased costs of production and decreased output).

Water quality improvements resulting from the alternative plans are valued in the Investigation using a combination of methods addressing both demand and supply of treated water. A least-cost alternative approach involves valuation of the reduction in treatment costs attributable to improvements in raw water quality facilitated by the exchange. An important assumption in the valuation of water quality benefits using this approach is that the urban water providers would attain the same level of finished water quality with or without an exchange. The approach also assumes that any reduction in finished water price resulting from the exchange would not measurably affect urban water demand.

A literature review of potential water quality benefits estimation methods was performed. In addition, an operations model developed previously by MWDSC and Reclamation was used with some simplifying adjustments. The model provides a means to estimate cost savings to consumers of water provided by MWDSC, identified in categories of residential, commercial, industrial, agricultural, and utilities. Cost savings are also measured to users of groundwater within the service area, and to purchasers of recycled water. The model was used to develop preliminary quantitative estimates on the net economic benefits associated with M&I water quality improvement, assuming that treatment cost savings to MWDSC are passed along to consumers.

While cost savings can provide a reliable measure of economic benefits to consumers, it may represent an underestimate of the total benefit. Economic theory indicates that if the willingness to pay by consumers exceeds the cost savings they would realize, the benefits may be higher than cost savings alone. In the case of water quality for customers of MWDSC, there is strong indication that this may be true: MWDSC and CALFED have developed focused efforts to resolve salinity problems in MWDSC's source water, and the salinity of Colorado River water is forecasted to continue to increase in concentration. For water quality benefits reported in the PFR, the cost savings modeling results were increased by 50 percent to capture possible willingness to pay. These estimates were reasonable compared to other findings in the literature.

Emergency Water Supply Benefits The alternative plans could provide one source of short-term emergency supplies to SOD water users in the event of a disruption in Delta water supplies from a levee failure from a seismic event in the Delta that would disrupt the ability to pump water south out of the Delta. In addition to natural events, future environmental constraints may periodically limit the amount of imported water that can be delivered through Delta pumping facilities. This analysis considers the emergency water supplies available to urban water users. A variety of factors may influence potential water supply disruptions to SOD urban water users, including the vulnerability and availability of non-Delta water supplies and the timing and duration of the supply disruption. Water from the alternative plans could be immediately available to SOD water users (either directly or through exchange), since the water would already be stored south of the Delta.

Key considerations in estimating the economic cost of water supply disruptions include the probability that a supply disruption would occur; duration and timing of the supply disruption; and level of water supply shortage to urban water agencies. Supply disruptions could arise from a variety of human and natural conditions. Various estimates exist of the probability of levee failures from seismic and flood events. This analysis relies on estimates of levee failures due to seismic events only. Similarly, this analysis assumes that seismic events that result in a small number of levee breaches do not result in significant water shortages to urban water suppliers. This analysis is limited to longer disruptions, as characterized by a 20-Delta island levee breach scenario. Annual probability was used to estimate risk-adjusted annual emergency water supply benefits for the 20-Delta island levee breach scenario. Information regarding the probabilities of Delta levee failures, potential levee failure scenarios, and associated projected shortages south of the Delta, were based on information developed for the Delta Risk Management Strategy (DRMS) (DWR, USACE, and DFG, 2007). The estimated water supply deficit from SWP and CVP operations subsequent to the Delta island levee breach scenario was simulated with the Water Analysis Module (WAM).

This analysis does not consider water transfers and does not account for the availability of local supplies to alleviate urban water shortages. As a result, the economic benefits of emergency water supplies may be overstated. Additional research would be required to fully consider these factors. As a first approximation, 40 percent of the water supply deficit estimated in WAM is assumed to accrue to urban water agencies. Urban water shortages were then estimated by comparing the average monthly deficit to the average monthly urban water demand. The amount of water available for emergency purposes from the alternative plans was estimated as the amount of water in storage in Millerton Lake and Temperance Flat Reservoir (RM 274 or RM 279) above the Millerton Lake storage in the without-project conditions. In most cases, the water available from the alternative plans would be less than the urban water supply shortage.

Economic benefits from emergency water supplies are measured according to water users' willingness to pay to avoid interruptions in water deliveries. Estimated benefits were weighted according to the probability of a Delta water supply disruption. The emergency water supply benefits will be refined in the feasibility phase of the Investigation.

Ecosystem Benefits The alternative plans provide opportunities for enhancement of water temperature in the San Joaquin River as a means of improving habitat conditions for Chinook salmon restoration efforts. The economic benefits from temperature improvement are estimated based on the application of benefit transfer methods from applicable studies that addressed habitat improvements, combined with efforts to isolate the contribution from improvement to the temperature attributes. The ecosystem benefits are considered preliminary and will be refined in the feasibility phase of the Investigation.

One of the goals of the SJRRP is to restore and maintain populations of Chinook salmon and other fish in the San Joaquin River from Friant Dam to the Merced River. Although the SJRRP has not finalized an assessment of specific requirements for the fish species, a number of experts have identified features and physical and biological conditions that would be necessary for a naturally reproducing Chinook salmon population in the upper San Joaquin River, and the SJRRP Team developed some initial Chinook salmon temporal occurrence and environmental requirements (SJRRP, 2007b). These initial requirements focus on identifying primary habitat conditions and limiting factors related to the spawning and rearing life stages of both spring- and fall-run Chinook salmon. They include, for example, monthly minimum flow levels, optimal depths, presence and characteristics of gravels, and maximum water temperatures.

The preliminary temperature requirement tables developed for the SJRRP were considered in combination with simulated Friant Dam release temperature exceedence probability curves for the alternative plans to assess the extent to which additional storage and the use of temperature control devices could further enhance water temperature conditions in the San Joaquin River at Friant Dam compared to the assumed without-project conditions (restoration releases and no additional storage). River temperature modeling has not been performed during the plan formulation phase of the Investigation, but will be performed during the feasibility phase to determine the downstream extent of potential water temperature improvements compared to the without project conditions.

The economic benefit associated with temperature modification for salmon habitat is difficult to measure, and there are no known directly comparable studies that focus on the benefits of temperature improvements alone on which to draw for guidance. Nevertheless, if temperature modification can be shown to improve biological conditions and lead to increased survival of salmon populations, an economic benefit, at least in theory, can be attributed to the improved temperature conditions resulting from the TCDs, operations, and additional cold water volume. For the purposes of this PFR Investigation, a preliminary estimate was developed in order to assess a reasonable approximation of the quantity of this benefit. Extensive literature exists with efforts at valuing fisheries, including salmon. A benefits transfer estimate from the literature was developed using parameters of the region's population and number of households, both present and forecasted, in combination with assumptions about the limiting factors for survival of salmon. Particular emphasis was placed on the spawning and incubation period occurring in the fall months of the year. Other ecosystem benefits that were not quantified are encompassed in the EQ account.

Regional Economic Development Account

A regional economic analysis of the direct effects of the alternative plans was performed to satisfy the requirements of the RED account. The analyses incorporate changes in agricultural output and recreation for the alternatives. The changes in hydroelectric power generation would affect statewide residents in terms of electricity rates; however, preliminary results indicate the changes would be very small at the statewide level, and were not included in the analysis. A regional analysis has not been conducted for other potential direct impacts, including changes in M&I water quality, flood damage reduction, or other areas potentially affected by the storage alternatives.

Two input-output (I-O) regional economics models, based on IMPLAN software, were developed for regional economic analyses specific to the Investigation. The models are used to measure the indirect impacts that changes in crop production and recreation-related expenditures (or other direct impacts) may have on the regional economy, in terms of changes in industry output, employment, and income. The first model incorporated economic activity in the six-county region surrounding the Friant Division; the six counties are Fresno, Kern, Kings, Madera, Merced, and Tulare.

A second regional economic impacts model was developed to address impacts at the California statewide level. This model is intended to capture effects of the alternative plans that transcend the Friant Division, affecting residents and businesses throughout the State. In general, even when a project is concentrated in a particular region and sector, economic activity (sales and purchases) typically extend beyond that area, both directly and indirectly. For example, agricultural inputs such as seed, fertilizer, insurance services, and fuel and transportation often originate outside the region of emphasis. After accounting for direct sales and purchases, the indirect and induced transactions that result from income changes and secondary impacts broaden the boundaries of the originally affected area. The multidisciplinary nature of the proposed alternative plans would result in categories of effects that are more likely to accrue outside the six-county Friant Division. These include M&I water quality benefits, M&I water supply, emergency water supply reliability, and ecosystem benefits. For this reason, a statewide model is best able to capture the economic effects on the larger scale.

Environmental Quality and Other Social Effects Accounts

Detailed information regarding the EQ and OSE accounts has not been developed at this stage of the feasibility study. Preliminary summary alternative comparison information for the EQ and OSE accounts is included in Chapter 6.

Unquantified Benefits The alternative plans would provide benefits that would accrue to the general public but could be difficult to quantify on a monetary scale. For the alternative plans, these “unquantified benefits” could include the following:

- Habitat function and services
- Biodiversity, including endangered species recovery
- Water management system operational flexibility
- Climate change adaptation

These benefits would not be included in the NED account under the P&G, but the State emphasizes the importance of these benefits in evaluating alternative plans. These public benefits could be considered relevant to the EQ and/or OSE accounts. While not explicitly quantified, they are discussed and recognized by economists as positive in value and essentially additive to the monetized annual benefits for the alternative plans.

Ecological functions provided by riverine ecosystems generate value either because they induce specific economic uses or because they themselves are valued. Not all values can be measured in the market, and not all values can or should reasonably be measured in quantitative terms. A commonly accepted framework that provides an organization to goods and services includes market and nonmarket values, with subcategories of use and non-use values. “Nonmarket use values” include recreation, flood damage reduction, and water quality improvement. These categories are difficult to measure and are being continually refined. “Non-use values” are more difficult to quantify, and the methods for doing so not as generally accepted. This category of benefits includes the following:

- Option value – Willingness to pay to retain the opportunity for future use of the resource
- Existence value – Willingness to pay to know that a resource continues to exist, whether the payer enjoys or uses the resources directly
- Bequest value – Willingness to pay to ensure that a resource is available for both current and future generations
- Philanthropic value – Willingness to pay to ensure that a resource may be enjoyed by others

Examples of additional benefits not directly related to ecosystem improvements that are difficult to quantify include water management flexibility and climate change adaptation. Additional surface storage provided by the alternative plans could provide flexibility to the State's constrained water management system that cannot be provided by other management actions. Flexibility created within the water management system would likely prove to be essential in developing solutions to Delta ecosystem challenges. Surface water storage could also be useful in mitigating lost snowpack storage due to climate change, and in responding to other unforeseen circumstances. While approaches may exist for quantifying these benefits categories, the P&G require reliance on generally accepted practices that may not be available.

No-Action/No-Project Alternative

This alternative represents future conditions that would occur if none of the action alternatives are implemented. The No-Action Alternative provides the basis for comparison with potential action alternatives, consistent with the P&G (WRC, 1983) and NEPA guidelines. The No-Project Alternative provides a basis for comparison with potential action alternatives, consistent with CEQA guidelines. CEQA also requires that the No-Project Alternative be compared to the existing conditions. For the Investigation, the No-Action Alternative and the No-Project Alternative are based on the same assumptions, and are defined by the same conditions. Under the No-Action/No-Project Alternative, the Federal Government and the State would take no additional action toward implementing a specific plan to enhance water temperature and flow conditions in the San Joaquin River, or to help address the growing water supply reliability issues in California.

The following section highlights the consequences of implementing the No-Action/No-Project Alternative as they relate to the planning objectives and opportunities of the Investigation. For feasibility studies of potential water resources projects, the No-Action/No-Project Alternative is intended to account for various resources conditions today and to show how those conditions are expected to change over the foreseeable future.

Water Temperature and Flow Conditions in the San Joaquin River

As described in Chapter 2, the ability to manage cold water, release water from Friant Dam at suitable temperatures, and to provide for Restoration Flows during critical-low years, may be challenges to fully meeting the Restoration Goal of the Settlement.

Water Supply Reliability

Under the No-Action/No-Project Alternative, more reliance would be placed on shifting water uses from such areas as agricultural production to urban uses. With continued and deepening shortages in available water supplies, it is likely that increasing adverse economic effects would occur over time in the Central Valley and elsewhere in California, including higher water costs resulting in a further shift in agricultural production to areas outside California and/or outside the United States. Groundwater basins in the eastern San Joaquin Valley would remain in a state of overdraft in most years, and substantial water supply reliability problems would remain in the Friant Division of the CVP. The continued downward trend in groundwater levels may also result in localized areas of impaired groundwater quality.

Flood Damage Reduction, Hydropower Generation and Management, Recreation, San Joaquin River Water Quality, and Urban Water Quality

Residual risks to human life, health, and safety along the upper San Joaquin River remain. Development in flood-prone areas has exposed the public to the risk of flooding. Storms producing peak flows, and volumes greater than the existing system was designed for, can occur, and result in extensive flooding along the upper San Joaquin River. Under the No-Action/No-Project Alternative, the threat of flooding would continue.

California's demand for electricity is expected to substantially increase in the future. Under the No-Action/No-Project Alternative, no new hydropower facilities would be constructed to help meet this growing demand. As the population of the State continues to grow, demand would grow considerably for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. This increase in demand would be especially pronounced at reservoirs near urban areas, such as Millerton Lake near Fresno. Water quality conditions in the San Joaquin River would likely improve through implementation of various projects and programs in the study area. The extent of San Joaquin River water quality improvements resulting from these activities is unknown.

Local water agencies would likely have more difficulty achieving their overall water quality objectives under the No-Action/No-Project Alternative compared to existing conditions. As local substitute supplies to Delta exports are relied on more heavily, and rising demands for water in the Central Valley continue to exert pressure on the Delta, it would become more difficult and costly for water agencies to provide high quality water in the future without actions to improve the quality of water supplies delivered to urban areas.

Temperance Flat RM 274 Reservoir Alternative Plans

This section describes the components, accomplishments, potential effects, and economics of the Temperance Flat RM 274 alternative plans.

Plan Components

Temperance Flat RM 274 Reservoir would be created through constructing a dam in the upstream portion of Millerton Lake at RM 274.

Surface Water Storage Measures

The Temperance Flat RM 274 Dam site is located approximately 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. Permanent features would include a main dam with an uncontrolled spillway to pass flood flows, a powerhouse to generate electricity, and outlet works for other controlled releases. Upstream and downstream cofferdams would be required for river diversion, and to keep Millerton Lake out of the construction zone. Diversion tunnels to route river flows around the construction zone would be required during construction. Figure 5-1 shows the extent of Temperance Flat RM 274 Reservoir and power features, and affected features in the reservoir area.

At the top of active storage capacity (elevation 985), Temperance Flat RM 274 Reservoir would provide about 1,260 TAF of additional storage (1,331 TAF of total storage, 75 TAF of which overlap with Millerton Lake), and would have a surface area of about 5,700 acres. The reservoir would extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. At top of active storage capacity, the reservoir would reach about 12 feet below the crest of Kerckhoff Dam. Temperance Flat RM 274 Reservoir would reduce Millerton Lake storage volume and acreage at top of active storage capacity to 449 TAF and 3,890 acres, respectively.

RCC and embankment dam types have been recently considered for the RM 274 dam site, and a formal decision has not yet been made regarding which dam type would be selected. Embankment dam types were assumed for the designs and cost estimates in the PFR. The dam would be about 640 feet high, from about elevation 365 in the bottom of Millerton Lake (San Joaquin River channel) at the upstream face to the dam crest at elevation 1,005. No saddle dams would be required.

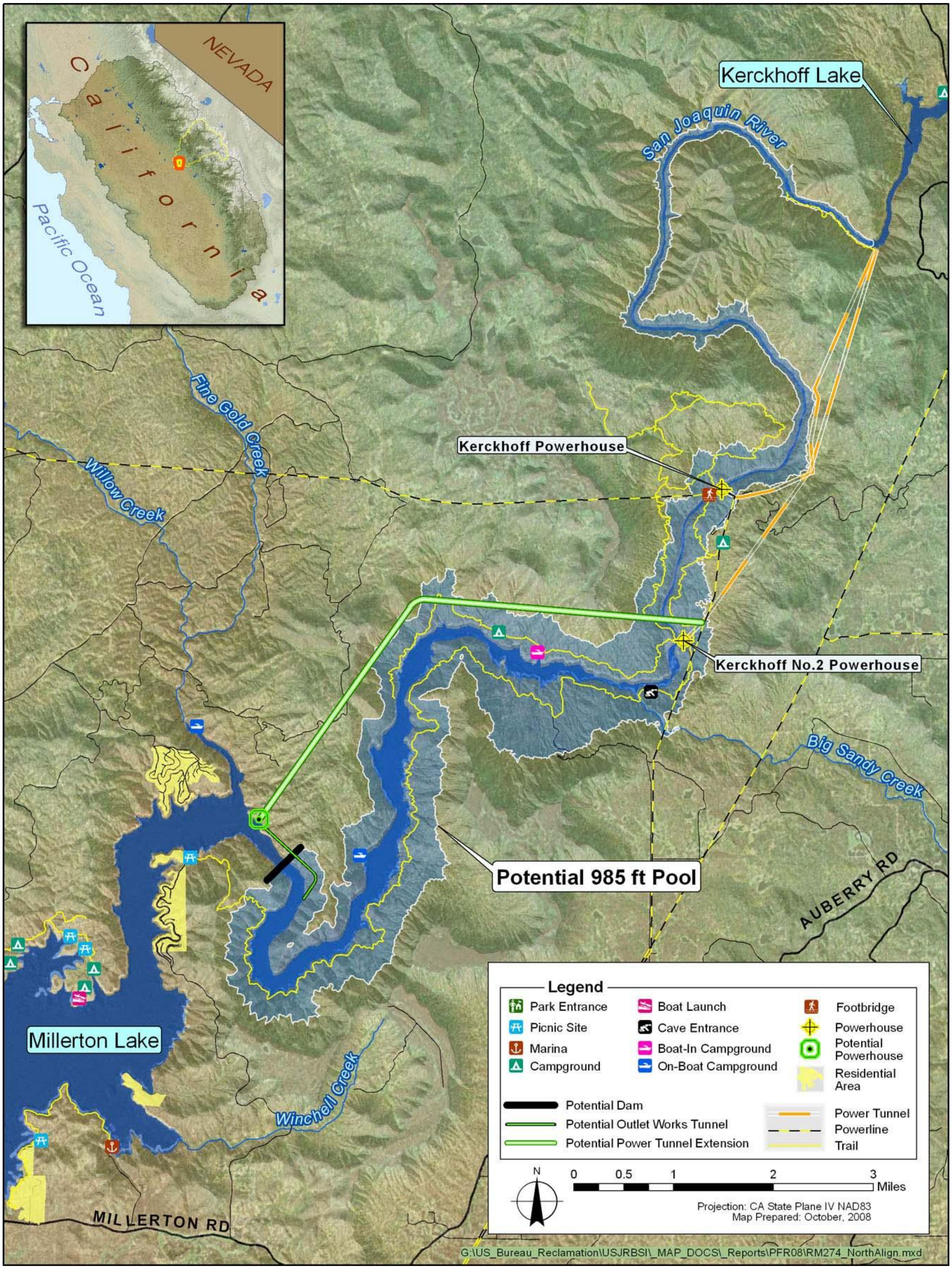

Figure 5-1. Potential Temperance Flat RM 274 Reservoir

Water Temperature Management Measures

Potential water temperature management measures include a SLIS on the main dam and TCDs on Friant Dam. A multiple-port SLIS could be constructed for Temperance Flat RM 274 Dam to improve management of the cold water pool in the reservoir for releases to Millerton Lake. The SLIS would be designed and operated to withdraw water from the highest level in the reservoir that would meet temperature targets, thereby preserving colder water at lower elevations in the reservoir. Without a SLIS, water would be drawn from the reservoir at the same elevation as the outlet works.

A steel TCD would be constructed for the Friant Dam river outlet and would be operated in a manner similar to above. TCDs also could be constructed on the canal outlets at Friant Dam to divert warmer water from the upper portion of the reservoir and preserve colder water for release to the river.

Energy Generation Measures

Temperance Flat RM 274 Reservoir would inundate the PG&E Kerckhoff and Kerckhoff No. 2 powerhouses. These facilities would be decommissioned and abandoned. Temperance Flat RM 274 Reservoir alternative plans include features to mitigate the loss of generation from the Kerckhoff Project powerhouses. These would involve modifying and extending the Kerckhoff No. 2 powerhouse tunnel to route water from Kerckhoff Lake to a new powerhouse and release valves downstream from Temperance Flat RM 274 Dam that would discharge into Millerton Lake, as shown in Figure 5-1. Tunnel extension alignments both north and south of the San Joaquin River have been considered; the northern alignment was assumed for the appraisal-level designs and cost estimates in the PFR. Water not routed through the extended tunnel would flow into Temperance Flat RM 274 Reservoir. This configuration would make use of the relatively constant head in Kerckhoff Lake to maximize power generation. The powerhouse would have a capacity of 135 MW, with 120 MW from three 40-MW units on the extended Kerckhoff No. 2 tunnel, and one 15-MW unit on the outlet works tunnel from Temperance Flat RM 274 Reservoir. The power features are subject to change as the feasibility study progresses.

During normal releases, all flows would pass through the turbines. During turbine outages, the outlet valves would be operated as necessary to maintain water operations flows. During periods of high inflow, the outlet works release valves could be used to supplement releases, in combination with the spillway, as necessary.

Reservoir Operations and Water Management Measures

Temperance Flat RM 274 Reservoir could be operated under a variety of scenarios that each could provide potential benefits to different purposes. For all operations scenarios, the primary focus would be increasing water supply reliability and enhancing water temperature conditions in the San Joaquin River. To the extent possible without impacting the primary purposes, the reservoir also would be managed to improve opportunities for hydropower generation and recreation. Potential flood damage reduction benefits would be achieved through the incidental effect of additional available storage space.

Alternative plans for Temperance Flat RM 274 Reservoir were evaluated under six distinct operations scenarios associated with the reservoir operations and water management measures. These scenarios vary according to the options applied for the extent of operations integration, available transvalley conveyance, and reservoir balancing. These three options within the six operations scenarios are summarized in Table 5-2 and described in the following sections.

Table 5-2. Six Reservoir Operations Scenarios Simulated for Temperance Flat RM 274 Reservoir Alternative Plans

Alternative Plans	Operations Integration Options	Transvalley Conveyance Options	Reservoir Balancing Options
Temperance Flat RM 274 Reservoir	Friant Only	N/A	Millerton Baseline
	SWP/Friant	AE	Millerton Baseline
	SWP/Friant	SW/CVC/AE	Millerton Baseline
	CVP/Friant	SW/CVC/AE	Millerton Baseline
	SWP/CVP/Friant	SW/CVC/AE	Millerton Baseline
	SWP/CVP/Friant	SW/CVC/AE	Millerton High

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
N/A = not applicable
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project

Operations scenarios vary, in part, on the degree to which Friant Dam would be operated in a coordinated manner with other CVP and SWP facilities (operations integration). The level of operations integration, in combination with additional storage, has the potential to affect the geographic extent, type, and magnitude of potential water supply benefits that could be achieved with alternative plans for each reservoir site.

At the simplest level, operations with additional surface water storage would be integrated with Friant Division demands in the same manner as Friant Dam in the No-Action Alternative (Friant-only integration). Under this operations integration option, potential water supply benefits would be provided to the Friant Division only.

Operations integration with the SWP and/or CVP would include coordinated management of water supplies in Millerton Lake and new storage with project operations of SOD facilities. This would involve delivery of water supplies to the Friant Division in combination with water exchanges between the Friant Division and SWP and/or other CVP service areas. Some SWP or CVP Delta water supplies diverted to San Luis Reservoir would be delivered to water users in the Friant Division while San Joaquin River water would be stored in the new reservoir. This would provide additional available storage space in San Luis

Reservoir during wet periods, which would allow export of additional supplies from the Delta. Accumulated San Joaquin River water supplies would be provided through exchange to SWP and/or CVP SOD water users at a later time, depending on the operations scenario. Operations integration in this manner would result in additional water supply quantities compared to a Friant-only integration, and would expand the geographic extent, type, and magnitude of potential project benefits. Four distinct operations integration options were developed and applied to alternative plans involving Temperance Flat RM 274 Reservoir, as shown in Table 5-2.

The ability to accomplish the transvalley water exchanges that facilitate operations integration of surface water storage with the SWP and/or CVP systems depends on available conveyance capacity. Most of the simulations performed for the alternative plans assume available transvalley conveyance capacity in the Shafter-Wasco Pipeline (SW), Cross Valley Canal (CVC), and Arvin-Edison Canal (AE). Assumed capacity is 200 cfs for the SW, 800/500 cfs minus existing use for forward (west to east)/reverse (east to west) capacity of the CVC, and 200 cfs minus existing use for the AE. The Friant-Kern Canal and California Aqueduct are also necessary conveyance components for water exchanges. Unused capacity in the Friant-Kern Canal and California Aqueduct for operations of the alternative is assumed to be equivalent to current operations. Assumptions regarding transvalley conveyance routes and capacities are preliminary and will continue to be refined as the Investigation progresses.

Two reservoir balancing options were applied to represent a range of operations for balancing water storage levels between Millerton Lake and Temperance Flat RM 274 Reservoir. One balancing option would maintain Millerton Lake storage levels at the average monthly storage level from simulation of without-project conditions with the Settlement (Millerton Baseline). A second balancing option would set a priority for maintaining Millerton Lake levels higher during the recreation season (Millerton High).

Potential Accomplishments

This section summarizes the potential accomplishments of the Temperance Flat RM 274 Reservoir alternative plans, including water supply reliability, water temperature, energy generation, flood damage reduction, M&I water quality, recreation opportunities, emergency water supply, and ecosystem enhancement.

Water Supply Reliability

Table 5-3 summarizes average annual changes in water deliveries for the Temperance Flat RM 274 alternative plans, based on CALSIM simulations. The reservoir balancing options would have minimal effect on deliveries and are not shown. The operations scenario involving the SWP, CVP, and Friant Division would produce the largest increase in delivery, followed by CVP/Friant and SWP/Friant operations integration.

Table 5-3. Average Annual Change in Delivery for Temperance Flat RM 274 Reservoir Alternative Plans

Item	Friant Only	Operations Integration[1]			
		SWP/ CVP/ Friant	SWP/ Friant	CVP/ Friant	SWP/ Friant
		Transvalley Conveyance			
		SW/CVC/AE			AE
Total (TAF)					
Dry & Critical Years[2]	112	168	171	120	116
All Years	112	180	158	167	125
Friant Division (TAF)					
Dry & Critical Years[2]	112	106	106	109	107
All Years	113	107	107	110	109
CVP (TAF)					
Dry & Critical Years[2]	-4	21	-4	46	2
All Years	-4	38	-2	66	0
SWP (TAF)					
Dry & Critical Years[2]	4	41	68	-35	7
All Years	4	35	53	-10	16

Notes:
1 Reservoir balancing option has negligible effect on water deliveries and was not included in this table.
2 All dry & critical values are reported based on Sacramento River Index. Reporting of changes in Friant Division deliveries based on San Joaquin River Index would result in higher dry and critical year values.
Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet

For operations integration beyond the Friant Division, the simulations showed minimal effect on Friant Division deliveries because the Friant Division was given priority over SWP and CVP to conveyance within the Friant-Kern Canal. SWP delivery also decreased when CVP was added to SWP/Friant integration. The decrease in simulated SWP delivery is due to SWP/CVP competition for limited storage and conveyance capacities, and the CVP is given priority over the SWP in the simulations. The last column in the table assumes transvalley conveyance capacity is only available in AE, and illustrates the sensitivity of delivery results to available conveyance for exchanges. For the SWP/Friant integration option, annual average SWP delivery decreased by about 50 TAF when conveyance capacity was assumed to be limited to AE.

On average, the Temperance Flat RM 274 Reservoir alternative plans would provide between 112 to 180 TAF per year of additional agricultural and M&I water deliveries, depending on operations scenario. In general, the CVP/Friant integration option was not carried forward from the water supply reliability assessment into the dependent analyses (temperature, power, water quality, emergency water supply, and economics).

Emergency Water Supply

Table 5-4 presents estimated annual emergency water supply benefits for the Temperance Flat RM 274 Reservoir grouping of alternative plans for the 20-Delta island levee breach scenario.

Table 5-4. Annual Emergency Water Supply Benefits for Temperance Flat RM 274 Reservoir Alternative Plans

Item	Operations Integration[1]			
	Friant Only	SWP/CVP/ Friant	SWP/ Friant	SWP/ Friant
		Transvalley Conveyance		
		SW/CVC/AE		AE
Avg. Emergency Water Supply, 20-Island Breach (TAF)	168	323	320	251
Annual Benefits, 20-Island Breach ($million)	8.0	14.6	14.5	11.2

Note:
1 Reservoir balancing option has negligible effect on water deliveries and was not included in this table.
Key:
AE = Arvin-Edison
Avg. = average
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet

Ecosystem and Water Temperature

The Temperance Flat RM 274 Reservoir alternative plans could improve the capability, reliability, and flexibility to release water at suitable temperatures for anadromous fish downstream from Friant Dam. Several reservoir water temperature simulations were performed for Temperance Flat RM 274 Reservoir alternative plans for the various operations scenarios. All scenarios were effective in preserving the total volume of cold water in Millerton Lake and Temperance Flat RM 274 Reservoir. Scenarios that include Friant Division, CVP, and/or SWP operations integration developed larger total cold water volumes compared to scenarios integrated with the Friant Division only because of exchanges resulting in higher storage levels. Both reservoir balancing options for Temperance Flat RM 274 Reservoir alternative plans were effective in preserving the total volume of cold water in both reservoirs.

Figure 5-2 presents the relative changes in total cold water volume at or below 52ºF in Temperance Flat RM 274 Reservoir and Millerton Lake during dry and normal-dry years (based on Settlement year-types, which are equivalent to dry and below normal year-types in the San Joaquin Valley Index (DWR, 2005)). Changes in total cold water volume are based on cold water volume multipliers equal to the cold water developed by Temperance Flat RM 274 Reservoir alternative plans divided by the volume of cold water available under future without-project conditions. For example, if the total volume of cold water below 52ºF under the alternative is equal to 165.3 TAF, and the volume of cold water below 52ºF for without-project conditions during the same time period is equal to 90.6 TAF, the cold water multiplier would equal 1.8, which corresponds to the light blue category of 1 to 2 cold water multiplier ranges in Figure 5-2. All operations scenarios evaluated for Temperance Flat RM 274 Reservoir alternative plans demonstrate substantial improvements in the volume of cold water that would be available for management and release to the San Joaquin River to support assumed restoration targets throughout the year.

Based on cold water multiplier ranges shown for the alternatives in Figure 5-2, operations integration and reservoir balancing options do not demonstrate substantial cold water volume differences between the Temperance Flat RM 274 Reservoir alternatives.

The simulated changes in Friant Dam release temperature were evaluated for the alternative plans and compared to the without-project conditions. In each case, an exceedence curve was developed that compared water temperature during the month with the probability of occurrence. These exceedence curves were further compared to the without-project conditions and the particular Chinook salmon temperature threshold for the month. The alternative plans would provide opportunity to improve the probability of meeting the temperature thresholds during the critical spawning and incubation periods for Chinook salmon of September through December.

While the results for the alternative plans indicated improvements during each of those months, the differences among alternatives were found to be small. In particular, there is uncertainty relating to both the temperature modeling and the economic estimation for temperature enhancement effects on salmon, such that the minor differences among the alternatives based on the release temperature information is not considered to be definitive at this phase of the Investigation. As such, results are developed as the average of the operation scenarios, and then applied uniformly to each of the alternative plans. The preliminary annual ecosystem benefits for Temperance Flat RM 274 Reservoir alternative plans are $24.5 million.

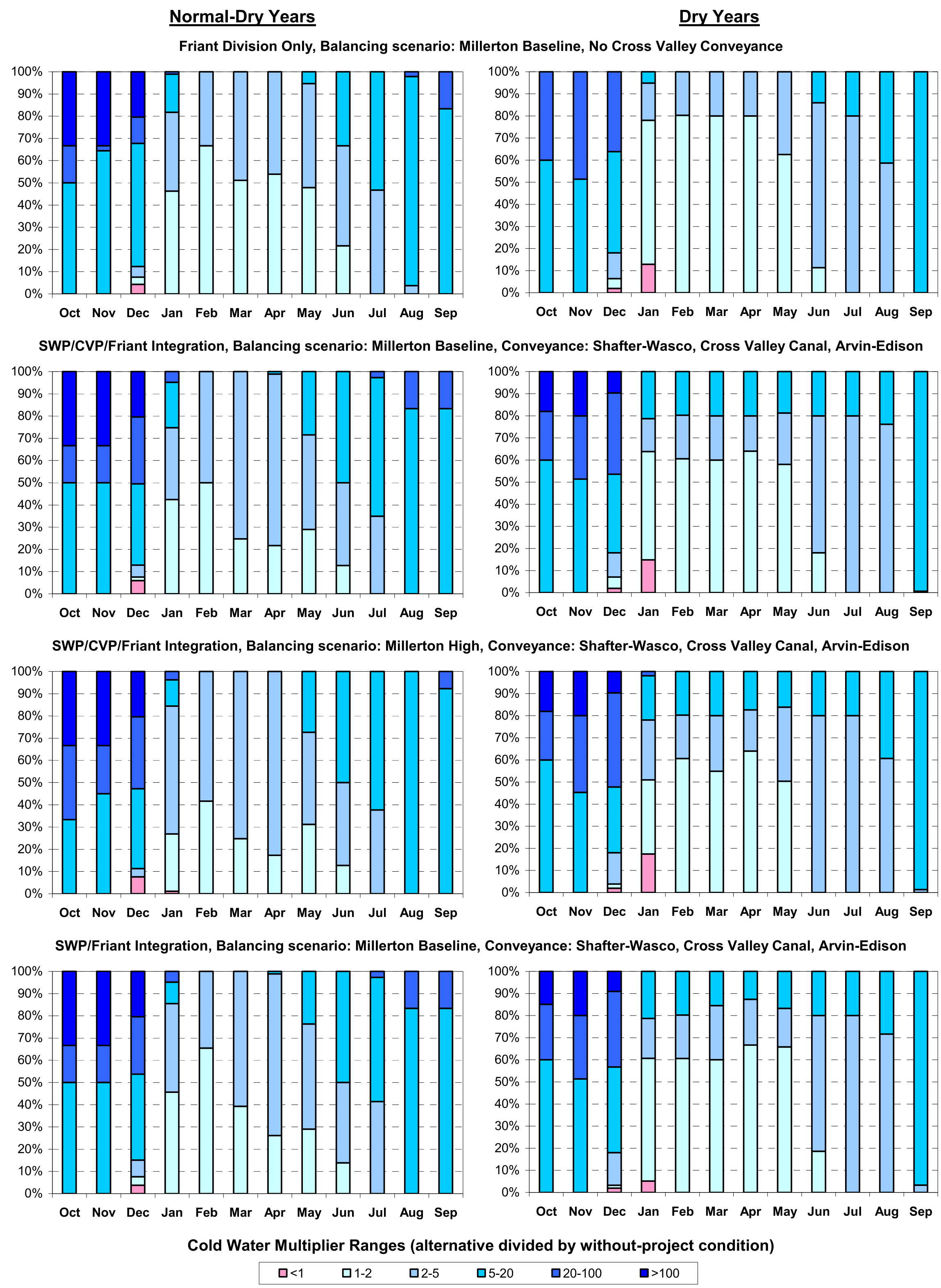

Figure 5-2. Changes in Cold Water Volume Below 52ºF for Temperance Flat RM 274 Reservoir Alternative Plans

Energy Generation

Most of the hydropower for the Temperance Flat RM 274 Reservoir alternative plans would be generated by diverting flow into the Kerckhoff No. 2 Powerhouse tunnel at Kerckhoff Lake and discharging flow through a new powerhouse just downstream from Temperance Flat RM 274 Dam into Millerton Lake. Releases from Temperance Flat RM 274 Reservoir would also be used for power generation. As shown in Table 5-5, power generation for this group of alternative plans would generate enough energy to replace all or most of the energy lost through inundation of the Kerckhoff Project powerhouses, on an average annual basis. Scenarios including Friant Division integration with SWP and/or CVP would result in less power generation because of reduced available head. The lower heads with operations integration options would occur as storage increases in both Millerton Lake and Temperance Flat because Delta supplies are delivered to Friant Division users and water levels increase in Millerton Lake and Temperance Flat RM 274 Reservoir. The Millerton High balancing option would result in less hydropower generation than the Millerton Baseline option, also due to reduced available head. For SWP/CVP operations integration with Millerton Baseline balancing, the power features could replace approximately 97 percent of the impacted Kerckhoff generation; therefore, even with system integration, the impacted generation would generally be replaced.

Table 5-5. Estimated Net Energy Generation for Temperance Flat RM 274 Reservoir Alternative Plans

Item	Operations Integration				
	Friant Only	SWP/CVP/Friant		SWP/Friant	SWP/Friant
		Millerton Baseline	Millerton High		
		Transvalley Conveyance			
		SW/CVC/AE			AE
Impacted Kerckhoff Project Generation (GWh/year)	-518	-518	-518	-518	-518
Temperance Flat RM 274 Generation (GWh/year)	515	490	445	492	497
Additional Friant Generation (GWh/year)	13	14	13	14	16
Net Power Generation (GWh/year)	10	-14	-60	-12	-4
Percent of Impacted Generation Replaced	102%	97%	88%	98%	99%

Key:
AE = Arvin-Edison
CVC= Cross Valley Canal
CVP = Central Valley Project
GWh = gigawatt-hour
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project

Table 5-6 demonstrates that system integration would have insignificant effects to CVP and SWP system-wide energy generation and use. The balancing options would not alter these effects.

Table 5-6. Estimated System-Wide Energy Generation and Use for Temperance Flat RM 274 Reservoir Alternative Plans

Item		Operations Integration					
		Friant Only		SWP/CVP/Friant			
				Millerton Baseline		Millerton High	
				Transvalley Conveyance			
				SW/CVC/AE			
System		CVP	SWP	CVP	SWP	CVP	SWP
Average Annual Energy Generation (MWh/year)	No-Action	4,881	5,081	4,881	5,081	4,881	5,081
	Change from No-Action	0	2	2	66	4	67
Average Annual Energy Use (MWh/year)	No-Action	1,328	9,943	1,328	9,943	1,328	9,943
	Change from No-Action	7	8	33	255	38	267

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
MWh = megawatt-hour
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project

Flood Damage Reduction

Potential annual flood damage reduction benefits accomplished through the Temperance Flat RM 274 Reservoir alternative plans are listed in Table 5-7. Potential flood benefits range from $2.1 million to $4.2 million. Potential flood damage reduction benefits decrease with integration and conveyance as more water is stored in Temperance Flat Reservoir and Millerton Lake.

Table 5-7. Annual Flood Damage Reduction for Temperance Flat RM 274 Reservoir Alternative Plans (90 percent exceedence)

Item	Operations Integration			
	Friant Only	SWP/CVP/ Friant	SWP/ Friant	SWP/ Friant
		Transvalley Conveyance		
		SW/CVC/AE		AE
90% Exceedence Flood Space (TAF)	660	301	285	457
Annual Flood Damage Reduction ($million)	$4.2	$2.3	$2.1	$3.4

Key:
AE = Arvin-Edison Canal
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco Pipeline
SWP = State Water Project
TAF = thousand acre-feet

M&I Water Quality

Temperance Flat RM 274 Reservoir alternative plans that include exchanges to support operations integration could improve water quality in the California Aqueduct. Refinements to CALSIM operations modeling were used to quantify monthly changes in bromides, TDS, and organic carbon in the California Aqueduct resulting from the alternative plans. The monthly changes in constituent concentrations measured at the Edmonston Pumping Plant were then used to quantify the physical change in water quality from the alternative plans. These measures were then combined with an economic model of salinity management to estimate monetary benefits. The cost savings modeling results were increased by 50 percent to estimate potential benefits based on willingness to pay.

M&I water quality benefits accruing to customers of MWDSC that would be achieved through the Temperance Flat RM 274 alternative plans are listed in Table 5-8. Water quality benefits in terms of willingness to pay range from $0 million to $8.2 million. Water quality benefits increase with integration and conveyance as more water is stored in Temperance Flat RM 274 Reservoir and Millerton Lake.

Table 5-8. Annual M&I Water Quality WTP Benefits from Temperance Flat RM 274 Reservoir Alternative Plans

Item	Operations Integration			
	Friant Only	SWP/CVP/ Friant	SWP/ Friant	SWP/ Friant
		Transvalley Conveyance		
		SW/CVC/AE		AE
Average Change in TDS (mg/L)	0.2	-5.5	-5.0	-1.9
Annual M&I Water Quality WTP Benefit ($million)	$0.0	$8.2	$7.4	$2.8

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
M&I = municipal and industrial
Mg/L = milligrams per liter
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TDS = total dissolved solids
WTP = willingness to pay

Recreation Opportunities

Opportunities for recreation development vary depending on operations integration and reservoir balancing options. Simulation results of recreation opportunities for Temperance Flat RM 274 Reservoir alternative plans that generally maintain Millerton Lake water levels at baseline average monthly storage levels would improve recreation opportunities in the primary study area. Millerton Lake levels would be slightly higher than the baseline pool elevation during April through July, and moderately higher through August. The higher pool elevations under the baseline average monthly storage level option would provide a minor potential benefit to boaters while maintaining good shoreline use conditions. However, changing the reservoir balancing option to generally keep Millerton Lake higher than its average monthly baseline storage levels would improve early and late season boating opportunities in Millerton Lake, but degrade shoreline use conditions. Operations integration options do not demonstrate substantial differences in recreation opportunities for alternative plans.

Few areas near the Millerton Lake SRA were determined to have high or intermediate suitability for recreation development, and are on private property. Steep slopes, lack of road access, and remoteness from existing developed areas limit opportunities for recreation development within the SJRGMA. However, there is a large area of high suitability immediately upslope from existing recreation facilities within the SJRGMA.

Table 5-9 summarizes the recreation benefit results for Temperance Flat RM 274 Reservoir alternative plans, with estimates ranging from $6.7 million to $8.1 million. The recreation benefits are based on the recreation model estimates increased by 25 percent to account for uncertainty with respect to future visitor expenditure patterns and value of recreation activities at Millerton Lake. Boating and waterskiing activities generate the highest economic value, and represent more than 50 percent of the value in each scenario. This is followed by picnicking, which is also the second highest recreation activity by visitors.

Table 5-9. Estimates of Recreation Benefits for Temperance Flat RM 274 Reservoir Alternative Plans

Item	Operations Integration			
	Friant Only	SWP/Friant	SWP/CVP/ Friant	SWP/CVP/ Friant
			Millerton Baseline	Millerton High
Total ($million)	$6.7	$7.3	$7.3	$8.1

Key:
BL = Millerton baseline reservoir balancing option
CVP = Central Valley Project
High = Millerton high reservoir balancing option
RM = river mile
SWP = State Water Project

Primary Potential Effects

Primary potential effects are described below for aquatic biological resources, terrestrial biological resources, recreation resources, and cultural resources affected by the Temperance Flat RM 274 Reservoir alternative plans.

Aquatic Biological Resources

Potential effects on aquatic habitat conditions and species that may result from the Temperance Flat RM 274 Reservoir alternative plans are discussed below.

Habitat Conditions Temperance Flat RM 274 Reservoir alternative plans would produce a moderate increase in April-to-September shallow-water habitat over future without-project conditions in Millerton Lake. The Friant-only integration option for alternative plans would produce more shallow-water habitat than other reservoir operations options evaluated. The habitat increases would result from increased storage upstream from the Temperance Flat RM 274 Dam. The gains in shallow water would be substantial despite the relatively steep shoreline of this area of the basin.

The effects of the Temperance Flat RM 274 alternative plans on April-to-June quarter-month water level fluctuations would be generally similar for Temperance Flat RM 274 Reservoir and Millerton Lake. The mean reductions of water level in both reservoirs would be less than the magnitude of reductions under future without- project conditions. Centrarchid (black basses and sunfishes) spawning habitat would be more affected by water level reductions than increases because reductions may result in dewatered nests. Water level fluctuations in the Temperance Flat RM 274 Reservoir would likely have less effect on the shoreline spawning species than those in Millerton Lake because the Temperance Flat RM 274 Reservoir would have less shallow water surface area. Because of the greatly increased water surface elevation in the San Joaquin River portion of the primary study area, Temperance Flat RM 274 Reservoir would likely eliminate the American shad and striped bass spawning habitat downstream from the Kerckhoff and Kerckhoff No. 2 powerhouses. New spawning habitat for these species would potentially be created in the upper reach of the new reservoir, downstream from Kerckhoff Dam.

The Temperance Flat RM 274 alternatives would have a pronounced effect on water temperatures in the shallow depths of Millerton Lake. Water temperatures in Millerton Lake would be substantially cooler than under future without-project conditions. In contrast, water temperatures in the Temperance Flat RM 274 Reservoir would be warmer than in Millerton Lake under future without-project conditions. The changes in water temperatures would be somewhat greater in the 3- to 10-foot-depth interval, which corresponds to the optimal spawning depth range for largemouth bass, than nearer the surface. At greater depths, the changes in water temperatures would be comparable to those in the 3- to 10-foot interval.

At the top of active storage capacity (elevation 985), Temperance Flat RM 274 Reservoir alternative plans would inundate 49,919 feet of stream (lotic) habitat (Figure 5-1) in the San Joaquin River (between Kerckhoff Dam and Millerton Lake) and Big Sandy Creek, which is 46.5 percent of the total stream length for streams affected. The San Joaquin River from Millerton Lake up to Kerckhoff Dam would be completely inundated (46,488 feet) at the top of Temperance Flat RM 274 Reservoir active storage, while 3,431 feet (5.6 percent) of Big Sandy Creek would be inundated (Table 5-10). Within the inundation area for Temperance Flat RM 274 Reservoir alternative plans, Big Sandy Creek would have 400 feet (11.7 percent) of stream with gradients of less than 3 percent, while the San Joaquin River would have 32,200 feet under 3 percent (69 percent).

Table 5-10. Stream Inundation Effects of Temperance Flat RM 274 Reservoir and Temperance Flat RM 279 Reservoir Alternative Plans at Top of Active Storage

Stream	Total Stream Length (feet)	Total Stream Length Inundated (feet)	Percent of Total Stream Length Inundated	Stream Length Less Than 3% Gradient (feet)	Stream Length Less Than 3% Gradient Inundated (feet)	Percent of Total Inundated Stream Length Less Than 3% Gradient
Big Sandy Creek	60,801	3,431	5.6%	35,850	400	11.7%
San Joaquin River	46,488	46,488	100.0%	32,200	32,200	69.3%

Key: RM = river mile

Species The following sections describe potential effects to evaluated fish species for Temperance Flat RM 274 Reservoir alternative plans.

Largemouth and Spotted Bass Largemouth and spotted bass spawning and rearing production in Millerton Lake would be substantially reduced in the Temperance Flat RM 274 alternative plans. This reduction results from (1) the loss of warm, shallow water habitat in Millerton Lake upstream from RM 274, and (2) remaining shallow water habitat in Millerton Lake being cooler than without-project conditions. The loss of spawning production in Millerton Lake, however, would be substantially offset by a gain in production in warm, shallow water habitat created in Temperance Flat RM 274 Reservoir. The increase in spawning production upstream from RM 274 is particularly large for spotted bass.

Smallmouth Bass, Bluegill, and Black Crappie Effects of Temperance Flat RM 274 Reservoir alternative plans on production of smallmouth bass, bluegill, and black crappie are expected to be similar to described those for largemouth and spotted bass. Smallmouth bass, in particular, have very similar reservoir habitat requirements to those of largemouth bass, except they prefer cooler water temperatures relative to largemouth bass. As described earlier, remaining shallow water habitat in Millerton Lake is expected to be cooler than without-project conditions.

Striped Bass and American Shad Both striped bass and American shad forage in open water and prefer cool water temperatures. The Temperance Flat RM 274 Reservoir alternative plans would substantially increase the volume of deep, open water habitat compared to that of the future without-project reservoir, therefore increasing overall foraging habitat of both species. Compared to Millerton Lake under future without-project conditions, water temperatures in the open water habitat would be lower in Millerton Lake, but would be higher in Temperance Flat RM 274 Reservoir.

The current spawning habitat of striped bass and American shad in the upper extent of Millerton Lake and the San Joaquin River near Kerckhoff No. 2 Powerhouse would be completely eliminated. The loss of spawning habitat would not substantially affect the striped bass population because this population is largely sustained by stocking. However, American shad are not stocked and the loss of spawning habitat would potentially eradicate its population. This alternative plan has the potential to create new spawning habitat for American shad in the upper portion of the new Temperance Flat RM 274 Reservoir within the San Joaquin River channel below Kerckhoff Dam. At maximum pool, the new reservoir would inundate the entire river channel, but at lower reservoir levels, a large reach of the river would remain free-flowing. Flows from Kerckhoff Dam into this reach of the river may potentially provide excellent spawning conditions. Even with a full reservoir, the constrained character of this reach of the river would likely produce relatively riverine conditions in the reservoir. Therefore, as long as flow releases from Kerckhoff Dam were sufficient, the reservoir would potentially sustain shad spawning over a broad range of reservoir levels. More detailed analyses would be required to fully evaluate the potential of Temperance Flat RM 274 Reservoir alternative plans to support American shad spawning.

Construction of a dam at RM 274 would separate populations of American shad within Millerton Lake from spawning habitat upstream, assuming American shad were able to spawn in Temperance Flat RM 274 Reservoir. Unless they are able to spawn in the outflow from the new Temperance Flat RM 274 Dam, or sufficient numbers are entrained in the outflow, the population would be extirpated from Millerton Lake. The size of the total population of American shad between the two reservoirs would likely be smaller than the current population if Temperance Flat RM 274 Reservoir is not able to support as large a shad population as Millerton Lake currently supports.

Lotic Species Temperance Flat RM 274 Reservoir would affect a large portion of usable habitat for riverine fish species (Table 5-11). Under the assumption that rainbow trout and hardhead occupy the San Joaquin River and its tributaries, only 46.5 percent of usable rainbow trout habitat within the primary study area would be affected, while 63.5 percent of usable hardhead habitat in the primary study area would be affected. Within the primary study area, assuming rainbow trout, hardhead, and Kern brook lamprey inhabit only the San Joaquin River, all lotic habitat for the three riverine species would be affected by the Temperance Flat RM 274 (and Temperance Flat RM 279) alternative plans.

Table 5-11. Fish Habitat in the Primary Study Area Affected by Temperance Flat RM 274 Reservoir and Temperance Flat RM 279 Reservoir Alternative Plans

Riverine Species Affected	Distance of Usable Habitat Potentially Affected (feet)	
	San Joaquin River Residence Only	All Streams Residence[1]
Rainbow trout	46,488	49,919
Hardhead	32,200	32,600
Kern brook lamprey[2]	32,200	32,200

Note:
[1] Usable habitat potentially affected for rainbow trout equals the total inundated stream length. For hardhead, it is inundated stream length with less than a 3% gradient, and for Kern brook lamprey it is inundated stream length with less than a 3% gradient for the San Joaquin River only.
[2] Presence of Kern brook lamprey is uncertain.
Key:
RM = river mile

Terrestrial Biological Resources

The tables and discussion in this section summarize effects to terrestrial habitats and species in the inundation area under the Temperance Flat RM 274 Reservoir alternative plans.

Habitat Table 5-12 shows acreages of habitat types that would be inundated by the Temperance Flat RM 274 Reservoir alternative plans; a total vegetated habitat loss of 4,756 acres would occur. In addition, 31 acres of developed and barren land would be inundated, along with 200 acres of riverine habitat. These alternative plans would have the greatest effects on foothill pine oak woodland and blue oak woodland habitats. Smaller areas of shrub, grassland, and riparian habitats would also be impacted.

Table 5-12. Habitat Effects Under the Temperance Flat RM 274 Reservoir Alternative Plans

Habitat Types	Temperance Flat RM 274 Reservoir (acres)
	Inundation Area
Upland Woodland Habitat	
Foothill Pine Oak Woodland	3,339.8
Blue Oak Woodland	921.7
Live Oak Woodland	28.8
Foothill Pine Woodland	9.2
Foothill Pine Chaparral Woodland	4.8
Subtotal	**4,304.2**
Upland Shrub Habitat	
Buckbrush Chaparral	20.8
Bush Lupine Scrub	3.2
Subtotal	**24.0**
Upland Herbaceous Habitat	
Annual Grassland	129.7
Subtotal	**129.7**
Riparian Habitat	
White Alder Riparian	25.2
Mixed Riparian	2.1
Fig - Willow Riparian	2.6
Willow Woodland	1.9
Fig Riparian	0.5
Spanish Broom Scrub	0.5
Sycamore Woodland	0.4
Buttonbush Scrub	0.3
Subtotal	**33.5**
Herbaceous Wetland Habitat	
Seasonal Wetland[1]	263.9
Freshwater Seep	0.9
Subtotal	**264.8**
Aquatic Habitat	
Lacustrine Unconsolidated Bottom	437.0
Lacustrine Unconsolidated Shoreline[1]	286.9
Riverine	200.0
Subtotal	**923.9**
Other	
Barren	24.7
Developed	6.0
Subtotal	**30.7**
Total	**5,710.8**

Note:
1 Habitat types that are periodically inundated, because they are below the ordinary high water mark of Millerton Lake.
Key: RM = river mile

Species Terrestrial species effects that may result from Temperance Flat RM 274 Reservoir alternative plans are discussed below. Because the species analyses areas for the Temperance Flat RM 274 Reservoir and RM 279 Reservoir alternative plans overlap, the potential for species occurrence could not be distinguished between the alternatives. Therefore, tables for describing potential species occurrences in the following sections are provided for all alternatives in summary. Differentiations between the alternatives are discussed in the text, when applicable.

Rare Plants Nineteen special-status plant species were identified as either present or potentially occurring within the Temperance Flat RM 274 Reservoir inundation area. Of these, seven were found in the Temperance Flat RM 274 Reservoir alternative plans area during 2007 field surveys (Table 5-13).

Table 5-14 summarizes the status, habitat, and likelihood of occurrence for the special-status plant species present or potentially occurring within the primary study area for both Temperance Flat RM 274 Reservoir and RM 279 Reservoir alternative plans.

Table 5-13. Special-Status Plant Species Found in the Temperance Flat RM 274 Reservoir Inundation Area

Species	Occurrences[1]	Individuals
Tree anemone	1	6
Ewan's larkspur	1	23
Madera leptosiphon	1	~5,000
Michael's piperia	1	1
Farnsworth jewelflower	3	~1,300
Hall's wyethia	4	~1,900
Small-flowered monkeyflower	12	~10,200

Note:
1 An occurrence, as defined by CNPS and CNDDB, is a group of rare plants located within 0.25 miles of each other. Occurrences may consist of a number of individuals and clumps of individuals (colonies), the distribution of which may or may not differ between inundation areas and/or buffers.
Key:
CNPS = California Native Plant Society
CNDDB = California Natural Diversity Database
RM = river mile

Table 5-14. Special-Status Plant Species Known to Occur or with Potential to Occur in the Primary Study Area

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Likelihood of Presence
Mariposa pussypaws *Calyptridium pulchellum*	T	--	CNPS 1B.1	Bare sandy, gravelly granitic substrates at elevations between 1,300 to 4,000 feet in chaparral and woodland	Unlikely • Known to occur at higher elevations near but outside the primary study area • Loose, bare granitic sands provide at least marginal habitat in the primary study area • Species was not found during 2007 surveys
Tree anemone *Carpenteria californica*	--	T	CNPS 1B.2, MSCSm	Species generally occurs at elevations between 1,500 to 3,000 feet; occurs on granitic soils in chaparral or forests with shrub layer	Present • One known occurrence in primary study area and several populations very near inundation line at higher elevations • Known occurrence was relocated during 2007 surveys
Succulent owl's clover *Castilleja campestris ssp. succulenta*	T	E	CNPS 1B.2, MSCSm	Northern basalt flow vernal pools on table tops in the region and northern hardpan vernal pools downstream from Friant Dam	Unlikely • Documented on table tops above Millerton Lake and below Friant Dam • Soil and terrain conditions conducive to vernal pool formation do not appear to be present in primary study area • Neither species nor its habitat were found during 2007 surveys
Ewan's larkspur *Delphinium hansenii ssp. ewanianum*	--	--	CNPS 4.2	Rocky soils, bluffs, often acidic soils associated with woodland and grassland at elevations between 200 to 2,000 feet.	Present • Abundant potential habitat in primary study area • Increasing discoveries of this taxon in the Sierra Nevada foothills • Species was found in the primary study area during 2007 surveys
Dwarf downingia *Downingia pusilla*	--	--	CNPS 2.2	Northern basalt flow vernal pools on tables tops in the region and northern hardpan vernal pools downstream from Friant Dam	Unlikely • Documented on table tops above Millerton Lake and below Friant Dam • Soil and terrain conditions conducive to vernal pool formation do not appear to be present • Species was not found during 2007 surveys
Spiny-sepaled button-celery *Eryngium spinosepalum*	--	--	CNPS 1B.2, MSCSm	Vernal pools, wet swales below 1,000 feet, Tulare to San Joaquin counties	Unlikely • Documented on table tops above Millerton Lake and below Friant Dam • Soil and terrain conditions conducive to vernal pool formation do not appear to be present • Species was not found during 2007 surveys
Boggs Lake hedge-hyssop *Gratiola heterosepala*	--	E	CNPS 1B.2, MSCSm	Found in shallow water margins of vernal pools, also margins of small lakes and ponds, wet meadows	Unlikely • Not known in primary study area but occurs in nearby vernal pools on table tops • Vernal pools not recorded in primary study area, but possible for species to occur in more marginal habitat • No suitable soils in the primary study area • Neither species nor its habitat were found during 2007 surveys

Table 5-14. Special-Status Plant Species Known to Occur or with Potential to Occur in the Primary Study Area (contd.)

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Likelihood of Presence
Madera leptosiphon *Leptosiphon serrulatus*	--	--	CNPS 1B.2, MSCSm, BLM Sensitive	Cismontane woodland, lower montane coniferous forest	Present • Previously documented occurrence in the primary study area was not relocated during 2007 surveys, but two new occurrences were found in the primary study area
Congdon's lewisia *Lewisia congdonii*	--	R	CNPS 1B.3	Occurs in mesic rocky/outcrop habitats in chaparral, woodland coniferous forest at elevations between 1,500 and 8,400 feet	Unlikely • Many potential habitats in the primary study area, but species was not found during 2007 surveys; primary study area is below typical elevation range • Occurs in Merced River and Tuolumne River canyons to north and south, respectively
Orange lupine *Lupinus citrinus var. citrinus*	--	--	CNPS 1B.2, BLM Sensitive	Often occurs on decomposed granite in chaparral, cismontane woodland, or lower montane coniferous forest	Unlikely • Known to occur at higher elevations near but outside the primary study area • Suitable habitat occurs in primary study area, but this species was not found during 2007 surveys
Small-flowered monkeyflower *Mimulus inconspicuus* (includes *M. acutidens* and *M. grayi*)	--	--	CNPS 4.3	Mesic sites in chaparral, cismontane woodland, lower montane coniferous forest above elevation 1,300 feet	Present • Twelve occurrences were documented in the primary study area during 2007 surveys
Slender-stalked monkeyflower *Mimulus gracilipes*	--	--	CNPS 1B.2	Decomposed granite, disturbed sites often following fire in chaparral, woodland, and coniferous forest at elevations between 1,500 and 3,900 feet	Possible • Known to occur in the vicinity of the primary study area • Loose, bare granitic sands provide at least marginal habitat in the primary study area; this species was not found during surveys • 2007 was a poor year for this species because of below-average precipitation
San Joaquin Orcutt grass *Orcuttia inequalis*	T	E	CNPS 1B.1, MSCSm	Known from northern basalt flow vernal pools on table tops in the region and northern hardpan vernal pools downstream from Friant Dam	Unlikely • Documented on table tops above Millerton Lake and below Friant Dam • Soil and terrain conditions conducive to vernal pool formation do not appear to be present in primary study area • Neither species nor its habitat were found during 2007 surveys
Michael's piperia *Piperia michaelii*	--	--	CNPS 4.2	Coastal bluff scrub, closed-cone coniferous forest, chaparral, cismontane woodland, coastal scrub, lower montane coniferous forest between 10 and 3,000 feet in elevation	Present • Two occurrences of this species were found in the primary study area during 2007 surveys
Hartweg's golden sunburst *Pseudobahia bahiifolia*	E	E	CNPS 1B.1, MSCSm	Species is limited to grasslands and open woodlands on clay soil	Unlikely • Suitable soils do not occur in primary study area; this species was not found during surveys

Table 5-14. Special-Status Plant Species Known to Occur or with Potential to Occur in the Primary Study Area (contd.)

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Likelihood of Presence
Sanford's arrowhead *Sagittaria sanfordii*	--	--	CNPS 1B.2, BLM Sensitive	Shallow freshwater marsh habitats on margins of small lakes and ponds, sluggish waters of sloughs, creeks, rivers, canals, and ditches between 0 and 2,000 feet in elevation	Unlikely • Streams in the area support periodic high velocity flows, making them unsuitable for this species • No suitable habitat was observed in stock ponds • This species was not found during surveys conducted in 2007
Farnsworth's jewelflower *Streptanthus farnsworthianus*	--	--	CNPS 4.3	Cismontane woodland at elevations between 1,300 and 4,600 feet in elevation	Present • Three occurrences of this species were found in the primary study area during 2007 surveys
Oval-leaved viburnum *Viburnum ellipticum*	--	--	CNPS 2.3	Chaparral, cismontane woodland, and lower montane coniferous forest	Possible • Known to occur in vicinity of the primary study area • Reported on Squaw Leap Trail above primary study area • Suitable habitat occurs in primary study area, but this species was not found during surveys; 2007 was not an optimal year because of below-average precipitation
Hall's Wyethia *Wyethia elata*	--	--	CNPS 4.3	Cismontane woodland and lower montane coniferous forest typically between 3,000 to 4,600 feet in elevation	Present • Four occurrences of this species were found in the primary study area during 2007 surveys

Key:
-- =
BLM = U.S. Department of the Interior, Bureau of Land Management
CNPS = California Native Plant Society
MSCS = CALFED Multi-Species Conservation Strategy
Elevation xxx = elevation in feet above mean sea level

[1]**Federal Status**
E = Endangered
T = Threatened

[2]**State Status**
CSC = California Species of Special Concern
E = Endangered
FP = Fully Protected
R = Rare
T = Threatened

[3]**Other Status**
CNPS 1B.1: Rare, threatened, or endangered in California and elsewhere; seriously endangered in California
CNPS 1B.2: Rare, threatened, or endangered in California and elsewhere; fairly endangered in California
CNPS 1B.3: Rare, threatened, or endangered in California and elsewhere; not very endangered in California
CNPS 2.2: Rare, threatened, or endangered in California, but more common elsewhere; fairly endangered in California
CNPS 2.3: Rare, threatened, or endangered in California, but more common elsewhere; not very endangered in California
CNPS 4.2: Plants of limited distribution; fairly threatened in California
CNPS 4.3: Plants of limited distribution; not very threatened in California
MSCSm: CALFED Multi-Species Conservation Strategy goal=maintain
BLM Sensitive: BLM Sensitive Species

Wildlife Resources The following sections summarize the likelihood of special-status wildlife species to occur within the inundation area for the Temperance Flat RM 274 Reservoir alternative plans. The potential for special-status wildlife species to occur in general within the primary study area is summarized in Table 5-15.

Invertebrates The pipevine swallowtail is a butterfly species of management concern in the primary study area, because it is one of only two known nonmigratory populations. The California pipevine is the obligate host plant for this species; therefore, populations of this plant are of interest in the primary study area. Ten California pipevine populations were identified in the inundation area for Temperance Flat RM 274 Reservoir alternative plans during 2007 field surveys.

The elderberry (*Sambucus* sp.) shrub is the host plant of the valley elderberry longhorn beetle, Federally listed as threatened. During the grub stage, valley elderberry longhorn beetle lives in elderberry stems greater than 1 inch in diameter and chews an exit hole in the stem as it metamorphoses to an adult beetle. Shrubs with visible exit holes may, therefore, be occupied by valley elderberry longhorn beetle. Within the inundation area for Temperance Flat RM 274 Reservoir alternative plans, 139 elderberry shrubs with stems greater than 1 inch in diameter were identified. Four of these were observed to have exit holes. Although the valley elderberry longhorn beetle has not been documented in the primary study area, it is known to occur nearby (within approximately 1 mile) and is assumed to be present within the primary study area. In 2006, USFWS conducted a 5-year status review for valley elderberry longhorn beetle and recommended delisting.

Table 5-15. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Potential to Occur
Invertebrates					
Dutchman's pipe / Pipevine swallowtail *Battus philenor*	--	--	BLM	Plants from the pipevine family are hosts (e.g., Dutchman's pipe); found in mesic habitat in forest understory or with shrubs	Present • Multiple populations and host plant locations detected in primary study area • Suitable habitat occurs in riparian habitat throughout primary study area
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T	--	MSCSm	Elderberry shrubs are host; generally found in riparian areas, also open hillsides and rocky outcroppings	Likely • Species not documented in primary study area but known to occur in region; documented population east of Table Mountain • Many elderberry shrubs present; some older shrubs with evidence of exit holes; species presence suspected but not confirmed
Amphibians					
California tiger salamander *Ambystoma californiense*	T	CSC	MSCSm	Breeds in vernal pools or other temporary pools; spends most of life cycle in burrows	Possible • One undocumented report in San Joaquin River Gorge; occurs below Friant Dam and may use vernal pools on table tops; also documented in Auberry • No vernal pools in primary study area; potential movement corridors exist from table tops to Millerton Lake • Suitable habitat in primary study area, but may be absent in drier years
Relictual slender salamander *Batrachoseps relictus*	--	CSC	--	Preferred habitat is small mesic areas with tree canopy, shrubs, abundant rock, litter, woody debris	Likely • Has not been recorded in or near primary study area • Potential habitat is present in primary study area
California red-legged frog *Rana aurora draytonii*	T	CSC	MSCSm	Riparian, slow-water rivers, and lakes with emergent aquatic vegetation	Unlikely • Presence of bullfrogs and centrarchids restricts already limited habitat suitability
Foothill yellow-legged frog *Rana boylii*	--	CSC	BLM-S, MSCSm	Slow-moving water with sandy or gravelly substrate and various upland habitats, including valley foothill riparian, blue oak woodland, blue oak– foothill pine, mixed chaparral, and wet meadows	Possible • No recent records of occurrence in primary study area • Potential habitat is present, but bullfrogs and centrarchids present and greatly reduce potential of occurrence • Unlikely because of abundant predator populations in permanent water sources and lack of perennial stream habitat

Table 5-15. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area (contd.)

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Potential to Occur
Western spadefoot toad *Spea (=Scaphiopus) hammondi*	--	CSC	BLM-S, MSCSm	Preferred habitat is grasslands with temporary water pools, but does breed in permanent pools; occurs in foothills to elevation 4,400 feet	Likely • Known occurrences near but outside primary study area • Suitable habitat available • Likely to occur in the primary study area based on species range, and availability of potentially suitable habitat
Reptiles					
Western pond turtle *Clemmys marmorata*	--	CSC	BLM-S (SW pond turtle), MSCSm	Riparian areas, shallow, slow-moving water bodies with emergent aquatic vegetation and available basking areas	Present • Present in natural pools and stock ponds in Big Sandy Creek and along Patterson Bend Reach • Habitat conditions are marginal because of controlled water flows, extensive bedrock substrate
California (coast) horned lizard *Phrynosoma coronatum frontale*	--	CSC	BLM-S	Various, includes areas of gravelly, sandy soils in open shrublands, riparian woodlands, dry chamise chaparral, annual grasslands	Likely • No records of occurrence in or near primary study area; species may be present in low numbers • Likely to occur in the primary study area based on species range and availability of potentially suitable habitat
Birds					
Cooper's hawk *Accipiter cooperi*	--	CSC (nesting)	MSCSm	Typically inhabits oak savanna, woodlands, and open grassland habitats	Present • Present throughout the primary study area • Likely more common in denser canopied habitats, including riparian
Sharp-shinned hawk *Accipiter striatus*	--	CSC (nesting)	--	Nests and forages in woodlands, but may occur in the more open savanna woodland type habitats, such as blue oak woodland and blue oak–foothill pine	Present • Present in certain areas of the primary study area with relatively higher quality breeding habitat • Likely more common in denser forest and woodland canopied habitats, including riparian
Grasshopper sparrow *Ammodramus savannarum*	--	--	MSCSm	Inhabits grasslands, grassland-shrub areas, and ruderal areas	Unlikely • No recent records of occurrence in primary study area • Habitat in primary study area is marginal
Golden eagle *Aquila chrysaetos*	--	CSC, FP	BGEPA, MSCSm	Forages over open shrub and grasslands; nests on cliffs or large rock outcrops	Likely • Known to occur in primary study area; nests in cliffs above reservoir • Suitable forage habitat throughout area
Long-eared owl *Asio otus*	--	CSC (nesting)	MSCSm	Wide distribution but uncommon in habitats consisting of dense trees and shrubs and riparian	Unlikely • No records of occurrence in primary study area • Habitat in primary study area is marginal

Table 5-15. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area (contd.)

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Potential to Occur
Western burrowing owl *Athene cunicularia hypugea (=Athene cunicularia)*	--	CSC	BLM-S, BCC, MSCSm	Open dry grasslands and desert habitat	Unlikely • No recent records of occurrence in primary study area • Habitat in primary study area is marginal
Lawrence's goldfinch *Carduelis lawrencei*	--	--	BCC	Breeds in open woodland and chaparral near water; preferentially nests in oaks; distribution erratic and localized	Present • Detected multiple times in Patterson Bend Reach • Suitable habitat exists in primary study area along watercourses
Northern harrier *Circus cyaneus*	--	CSC (nesting)	MSCSm	Prefers annual and perennial grasslands, open meadows from sea level to elevation 10,000 feet; breeds from sea level to elevation 5,700 feet	Unlikely • Predominant forested habitats in primary study area are not optimal
Yellow warbler *Dendroica petechia*	--	CSC (nesting)	MSCSr	Breeds in mesic, deciduous thickets, especially riparian; preferred habitat includes moist areas with dense insect prey populations	Present, but unlikely to breed in primary study area • Detected in primary study area at Big Sandy Creek, but nonbreeding; riparian habitat is limited size and has unsuitable structure for breeding purposes
White-tailed kite *Elanus leucurus*	--	FP	MSCSm	Prefers coastal and lowland valleys; often associated with farmlands, meadows with emergent vegetation, grasslands	Unlikely • Not commonly known in primary study area; may be occasional migrant • Preferred habitat not present
Willow flycatcher *Empidonax traillii brewsterii*	--	E	MSCSr	Requires contiguous patches of multilayered riparian habitat with moist soils and/or standing water	Unlikely • No confirmed recent sightings in primary study area; BLM indicates species may be present in San Joaquin River Gorge; incidental occurrence as migrant is possible • Riparian habitat marginal—too limited in size, distribution, and structure
California horned lark *Eremophila alpestris actia*	--	CSC	--	Open grasslands and pasture	Unlikely • Limited suitable habitat in primary study area
Merlin *Falco columbarius*	--	CSC (winter)	--	Prefers open grasslands, savannas, and woodlands below elevation 4,000 feet	Possible • Uncommon winter migrant • Suitable habitat is limited in primary study area
Prairie falcon *Falco mexicanus*	--	CSC (nesting)	BCC	Forages over large areas of open habitats, nests in cliffs	Likely • Reported as nesting in San Joaquin River Gorge; breeds on cliffs above Millerton Lake and San Joaquin • Suitable habitat is available

Table 5-15. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area (contd.)

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Potential to Occur
American peregrine falcon *Falco peregrinus anatum*	--	E, FP	MSCSm	Forages in open fields, especially near water (e.g., large wetland complexes); nests on cliffs, tall buildings, or bridges	Possible • Occurrence in the primary study area is unknown; reported as occasional over the San Joaquin River east of Friant • Suitable breeding habitat is available, but foraging habitat is limited
Bald eagle *Haliaeetus leucocephalus*	--	E, FP	BGEPA, MSCSm	Forages in open water, roosts in adjacent trees, nests in tall, sturdy trees	Present • Pair nesting at southwestern edge of primary study area near Millerton Lake
Yellow-breasted chat *Icteria virens*	--	CSC (nesting)	--	Riparian thickets of willow, blackberry, wild grape, and other brushy tangles near watercourses	Unlikely • Suitable riparian habitat is limited in primary study area
Loggerhead shrike *Lanius ludovicianus*	--	CSC	BCC	Common winter visitor and resident in open habitats with scattered trees and shrubs; prefers habitats with abundant perches	Possible • Known to occur in primary study area as winter migrant • Suitable habitat is available in primary study area
Lewis's woodpecker *Melanerpes lewis*	--	--	BCC	Uncommon winter resident in open oak, conifer, or riparian woodland	Likely • Known to occur in region, but primary study area occurrence unknown • Suitable habitat occurs in primary study area
Osprey *Pandion haliaetus*	--	CSC	MSCSm	Forages on large bodies of water and rivers that have abundant fish in ponderosa pine and mixed conifer habitats	Possible • Observed around Millerton Lake; breeds north of primary study area • Foraging opportunities in Millerton Lake; habitats in the primary study area provide low suitability for reproduction and cover
California spotted owl *Strix occidentalis occidentalis*	--	CSC (nesting)	BLM-S	In the Sierra Nevada foothills, nests in oak woodlands located in or near riparian areas in deep-sided canyons at elevations of 1,000 to 8,000 feet	Likely • Detected immediately southeast of Kerckhoff Dam • Suitable breeding habitat is available in primary study area
Least Bell's vireo *Vireo bellii pusillus*	E	E	MSCSr	Requires larger contiguous stands of riparian habitat with lush to moderate understory cover	Unlikely • Riparian habitat marginal—too limited in size, distribution, and structure

Table 5-15. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area (contd.)

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Potential to Occur
Mammals					
Pallid bat *Antrozous pallidus*	--	CSC	BLM-S	Forages over wide range of habitats, including grasslands, scrub, woodlands, and forests; most common in open, dry areas with rocky areas for roosting; also roosts in large oaks and on buildings	Likely • Occurs in or near primary study area; known to breed on cliffs above lake • Suitable habitat is available in primary study area
Ringtail *Bassariscus astutus*	--	FP	MSCSm	Prefers riparian, brush habitats and most forest habitats, areas with talus or rocky elements or snags for cover; occurs in low to midlevel elevations	Likely • Species is known to occur in or near primary study area • Suitable habitat available in primary study area
Townsend's big-eared bat *Corynorhinus townsendii*	--	CSC	BLM-S	Found throughout California in wide range of habitats; roosts in colonies in caves, mines, or buildings	Present • Detected in rock outcrop near Millerton Bottoms portion of primary study area • Suitable roosting habitat is available in primary study area
Spotted bat *Euderma maculatum*	--	CSC	BLM-S	Species biology not well known; distribution limited to approximately 40 small areas in California; may forage in foothills, desert; breeds and roosts in rock crevices	Possible • Not known to occur in the primary study area • Suitable habitat may occur in primary study area
Western (California) mastiff bat *Eumops perotic californicus*	--	CSC	BLM-S, MSCSm	Found throughout California in wide range of habitats; nests on cliffs; intolerant of human activity	Present • Known to nest in cliffs above Millerton Lake • Suitable foraging habitat may occur in primary study area
American pine marten *Martes americana*	--	CSC	--	Optimal habitat is mixed evergreen forests with >40% cover, large trees and snags, red fir, and lodgepole pines	Unlikely • Not known to occur in primary study area • Optimal habitat is limited in primary study area
Western small-footed myotis *Myotis ciliolabrum*	--	--	BLM-S	Occurs in wide range of dry upland habitats in the Sierra Nevada; prefers scrub and woodlands near open water where it feeds; ranges from sea level to elevation 9,000 feet	Likely • Occurrence in primary study area is unknown • Suitable habitat occurs in primary study area

Table 5-15. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area (contd.)

Species	Federal Status[1]	State Status[2]	Other Status[3]	Habitat	Potential to Occur
Long-eared myotis *Myotis evotis*	--	--	BLM-S	Widespread but uncommon; prefers brushy, woodland, and forest habitats; roosts on buildings, in caves, under tree bark, in snags and rock crevices; distribution from elevation 0 to 9,000 feet	Likely • Occurrence in primary study area is unknown • Suitable habitat occurs in primary study area
Fringed myotis *Myotis thysanodes*	--	--	BLM-S	Distribution is widespread, but its abundance is irregular; optimal habitat is pinyon-juniper, valley foothill hardwood, and hardwood-conifer between elevation 4,000 and 7,000 feet	Possible • Occurrence in primary study area is unknown • Suitable habitat is limited in primary study area; elevation is below general distribution
Yuma myotis *Myotis yumanensis*	--	--	BLM-S	Common and widespread in California; wide range of habitats used; roosts in caves, mines, in buildings; optimal habitat is open woodlands and forests near open water	Present • Known to occur in region • Suitable habitat occurs in primary study area
San Joaquin pocket mouse *Perognathus inornatus inornatus*	--	--	BLM-S	Occurs in dry, open grasslands with fine-textured soils in the Central and Salinas valleys from elevation 1,000 to 2,000 feet	Possible • Distribution in primary study area unknown • Suitable habitat is limited in primary study area
American badger *Taxidea taxus*	--	CSC	--	Drier open grassland, shrub, and forest habitats with friable soils	Possible • Species occurs in vicinity of primary study area • Suitable habitat is present in primary study area

Key:
BLM = U.S. Department of the Interior, Bureau of Land Management
Elevation xxx = elevation in feet above mean sea level
MSCS = CALFED Multi-Species Conservation Strategy
USFWS = U.S. Fish and Wildlife Service

[1]**Federal Status**
E = Endangered
T = Threatened

[2]**State Status**
CSC = California species of special concern
E = Endangered
FP = Fully Protected

[3]**Other Status**
BCC = USFWS Birds of Conservation Concern
BGEPA = Federal Bald and Golden Eagle Protection Act
BLM-S = BLM Sensitive Species
BLM = Species of management concern to BLM
MSCSm = CALFED Multi-Species Conservation Strategy goal=maintain.
MSCSr = CALFED Multi-Species Conservation Strategy goal=Contribute to recovery

Amphibians and Reptiles Four aquatic features were identified within the inundation area of the Temperance Flat RM 274 Reservoir alternative plans during 2007 surveys that may provide potential breeding habitat for California tiger salamander. Each feature was evaluated during surveys for potential suitability, and classified as either suitable or marginal. Two of the features were considered to be marginal and two were classified as suitable habitat. The determination of potential suitability of these features is conservative; bullfrogs were observed in at least one pond, which is also known to permanently hold water.

Potentially suitable western pond turtle habitat was mapped and western pond turtle presence and habitat features were surveyed across the primary study area. Western pond turtle has been previously documented in the primary study area and was observed during 2007 Investigation surveys in Big Sandy Creek (three individuals outside the inundation area of Temperance Flat RM 274 Reservoir alternative plans) and the San Joaquin River (one individual in the inundation area of both Temperance Flat RM 274 and RM 279). Based on surveys in 2007, 437.4 acres of potential western pond turtle habitat were identified in the Temperance Flat RM 274 Reservoir area. The most suitable habitat (providing more suitable basking sites, aquatic vegetation, and food sources) was identified along the San Joaquin River.

During 2007 surveys, potentially suitable and marginal habitat for the foothill yellow-legged frog was identified. Approximately 12,105 linear feet of potentially suitable and marginal stream habitat would be affected by Temperance Flat RM 274 Reservoir alternative plans. While potentially suitable habitat was identified within the primary study area, no recent sightings of foothill yellow-legged frogs have been documented near the area. Based on the presence of nonnative predators (bullfrogs and centrarchids) in the San Joaquin River and adjacent streams, foothill yellow-legged frog are unlikely to be found within the inundation area for Temperance Flat RM 274 Reservoir alternative plans.

Birds Several raptor species (American kestrel, Cooper’s hawk, red-tailed hawk, sharp-shinned hawk) were incidentally observed in the primary study area during 2007 field surveys. Existing information and data collected during 2007 surveys suggest that raptors and other special-status bird species may nest in the area. These species are most vulnerable to human intrusions into their habitats when nesting. A bald eagle nest was identified near the Temperance Flat RM 274 Dam site, but is located outside the inundation area of both Temperance Flat RM 274 and RM 279.

Mammals A number of special-status bat species have potential to occur within the area that would be inundated under Temperance Flat RM 274 Reservoir alternative plans. Suitable roost sites occur throughout the primary study area. One Townsend's big-eared bat was observed in a rock outcrop within an area potentially affected by Temperance Flat RM 274 Reservoir alternative plans during 2007 surveys. Western mastiff bats are known to breed on the cliffs above the primary study area and are likely to occupy portions of the primary study area during most behavioral activities.

Recreation Resources

Temperance Flat RM 274 Reservoir alternative plans would create a relatively narrow and winding lake extending about 18.5 miles up the San Joaquin River to Kerckhoff Dam, with 4,680 surface acres at the top of active storage (elevation 985). The reservoir would be more than 1.25 miles wide at its widest extent, but would be quite narrow in the upstream third of the pool, within the San Joaquin River Gorge. The most remote, undeveloped, and scenic portion of the Millerton Lake SRA would be substantially affected, as would the full length of the SJRGMA along the San Joaquin River.

The Temperance Flat RM 274 Reservoir would inundate an on-boat campground, a boat-in campground, and other campgrounds in the Millerton Lake SRA, and impact portions of the San Joaquin River trail. Facilities within the BLM SJRGMA would also be affected, such as an extension of the San Joaquin River Trail, a footbridge, a primitive campground, and a reproduction Native American village. Recreation facilities affected by this alternative plan are shown in Figure 5-1.

With a 275- to 600-acre increase in reservoir surface area, the shoreline of Millerton Lake would be accessible less often for recreation with the Temperance Flat RM 274 Reservoir alternative plan. However, the increased surface area would somewhat improve boating conditions on Millerton Lake.

Cultural Resources

Prior archaeological surveys examined 26.4 percent of the Temperance Flat RM 274 Reservoir area, and a total of 36 archaeological sites were previously recorded. These include 27 prehistoric sites, five historic-era sites, and four sites with prehistoric and historic components. No historical structures were recorded. Local Native American tribes expressed opposition to the Temperance Flat RM 274 Reservoir alternative, indicating that the area is very sensitive, with 20 identified areas of concern, including village sites, gathering areas, and religious areas. Some Native American groups specified that some of the more sensitive and important locations are in the Temperance Flat and Squaw Leap areas, and that a new nearby dam would be very detrimental.

Sensitivity analyses were conducted for prehistoric and historic-era sites across the alternatives to address data gaps using methods tailored to each data set. The sensitivity analyses estimate the number of archaeological sites that may exist if the entire area were surveyed. Although the goal of the sensitivity analysis is to accurately estimate the actual number of existing archaeological sites, it is possible that the number of sites could be substantially less or greater than the number of sites estimated. Based on the sensitivity analyses, approximately 155 archaeological sites and historical resources are estimated within the Temperance Flat RM 274 Reservoir area, including 89 historic-era resources (mostly mining-related) and 66 prehistoric resources (Table 5-16).

Table 5-16. Estimated Number of Archaeological Sites Affected Under Temperance Flat RM 274 Reservoir Alternative Plans

Archaeological Sites	Temperance Flat RM 274 Reservoir (1,260 TAF)
Historic-Era Resources	***89***
Homestead-related sites	9
Sites associated with structures	5
Mines and mining patents	9
Sites within Big Bend Mining Claim concentration	21
Sites within Temperance Flat/Crook Mountain Mining Claim concentration	42
Roads	0
Hydroelectric/water engineering facilities	3
Recorded structures	0
Prehistoric Resources	***66***
Residential sites	24
All other sites	42
Total Resources	**155**

Key: RM = river mile TAF = thousand acre-feet

Economics

This section summarizes information for estimated costs and potential benefits of the Temperance Flat RM 274 Reservoir alternative plans.

Estimated Costs

Estimated costs for construction of Temperance Flat RM 274 Reservoir are presented in Table 5-17. This appraisal-level cost estimate for Temperance Flat RM 274 Reservoir is subject to change as the feasibility study progresses. The magnitude of contingencies would also decrease as the feasibility study progresses and uncertainties regarding site conditions decrease.

Table 5-17. Cost Estimate Summary for Temperance Flat RM 274 Reservoir Alternative Plans

Item	Estimated Cost[1,2] ($million)
Features	
Embankment Dam	$430
Diversion Structures	$510
Spillway	$400
Outlet Works	$100
Power Features	$990
Affected Infrastructure	$10
Temperature Control Device at Friant Dam	$155
TOTAL FIELD COST[3]	**$2,595**
Non-Contract Costs	
Planning, Engineering, Design and Construction Management (10%)	$260
Acquisition of Private Lands	$16
Replacement Recreation Facilities	$7
Environmental Mitigation	$17
Cultural Resources Mitigation	$6
TOTAL CONSTRUCTION COST	**$2,901**
Interest During Construction	$457
TOTAL CAPITAL COST	**$3,358**
Interest and Amortization	$165
Annual Operations and Maintenance	$4
Annual Replacement Power	$0
Annual Transvalley Exchange Power	NE
TOTAL ANNUAL COST[4]	**$169**

Notes:
General: This appraisal-level cost estimate is preliminary and subject to revision in the Feasibility Report.
1 Costs are presented in 2006 dollars
2 Values may not add to totals because of rounding.
3 The embankment dam costs include the following allowances: 5 percent mobilization, 10 percent unlisted items, and 20 percent construction contingency. All other features include allowances of 5, 15, and 25 percent, respectively.
4 Based on 4-7/8 discount rate and 100-year period of analysis.
Key:
NE = not estimated
RM = river mile

Potential Benefits

Estimated potential monetary benefits for the Temperance Flat RM 274 Reservoir alternative plans, developed for several categories using methods described previously in this chapter, are summarized in Tables 5-18.

Table 5-18. Potential Annual Benefits for Temperance Flat RM 274 Reservoir Alternative Plans

<table>
<tr><th rowspan="4">Item</th><th colspan="5">Operations Integration</th></tr>
<tr><th rowspan="3">Friant Only</th><th colspan="2">SWP/CVP/ Friant</th><th>SWP/ Friant</th><th>SWP/ Friant</th></tr>
<tr><th colspan="4">Transvalley Conveyance</th></tr>
<tr><th colspan="3">SW/CVC/AE</th><th>AE</th></tr>
<tr><td colspan="6">Potential Monetary Benefits ($million)</td></tr>
<tr><td>Agricultural Water Supply Reliability</td><td>$46.1</td><td colspan="2">$55.2</td><td>$50.4</td><td>$48.4</td></tr>
<tr><td>M&I Water Supply Reliability</td><td>$1.7</td><td colspan="2">$57.3</td><td>$74.2</td><td>$38.4</td></tr>
<tr><td>M&I Water Quality</td><td>$0.0</td><td colspan="2">$8.2</td><td>$7.4</td><td>$2.8</td></tr>
<tr><td>Flood Damage Reduction</td><td>$4.2</td><td colspan="2">$2.3</td><td>$2.1</td><td>$3.4</td></tr>
<tr><td>Hydropower Generation</td><td>$0.6</td><td>-$0.4</td><td>-$2.6</td><td>-$0.3</td><td>$0.03</td></tr>
<tr><td>Recreation</td><td>$6.7</td><td>$7.3</td><td>$8.1</td><td>$7.3</td><td>$7.3</td></tr>
<tr><td>Emergency Water Supply</td><td>$8.0</td><td colspan="2">$14.6</td><td>$14.5</td><td>$11.2</td></tr>
<tr><td>Ecosystem</td><td>$24.5</td><td colspan="2">$24.5</td><td>$24.5</td><td>$24.5</td></tr>
<tr><td>Total Potential Monetary Benefits</td><td>$91.8</td><td>$169.0</td><td>$167.6</td><td>$180.1</td><td>$136.0</td></tr>
</table>

Note:
[1] Millerton Baseline reservoir balancing option listed on the left and Millerton High reservoir balancing option listed on the right.

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
M&I = municipal and industrial
RM = river mile
SLIS = selective level intake structure
SWP = State Water Project
SW = Shafter-Wasco
TCD = temperature control device

Regional Economic Effects

Regional economic evaluations are discussed in the sections on Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans and Temperance Flat RM 279 Reservoir alternative plans.

Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans

This section describes the components, accomplishments, potential effects, and economics of the Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans.

Plan Components

Surface water storage measures, water temperature management measures, and energy generation measures for this grouping of alternative plans are the same as described previously for the Temperance Flat RM 274 Reservoir alternative plans.

Increase Transvalley Conveyance Capacity Measures

The Trans Valley Canal would have a conveyance capacity of 1,000 cfs. A conceptual alignment for the canal is over 50 miles long, and includes a connection to the Friant-Kern Canal near Porterville at the Tulare Check Structure and a connection to the California Aqueduct south of the Tulare Lake bed. It is assumed that the Trans Valley Canal would be configured to flow both east-to-west and west-to-east, as needed, to facilitate exchanges. Primary components of this conveyance would be the penstock from the California Aqueduct to the valley floor, a canal across the valley floor, and a lift canal on the valley's eastern slope. The Trans Valley Canal could have several potential alternative configurations and alignments. This measure is also being studied by the FWUA-MWDSC Partnership and the SJRRP.

Reservoir Operations and Water Management Measures

Alternative plans for Temperance Flat RM 274 Reservoir with Trans Valley Canal were evaluated under four distinct operations scenarios associated with the reservoir operations and water management measures. These scenarios vary according to the options applied for the extent of operations integration, available transvalley conveyance, and reservoir balancing. These three options within the four operations scenarios are summarized in Table 5-19 and as described previously under water management measures for Temperance Flat RM 274 Reservoir alternative plans.

Table 5-19. Four Reservoir Operations Scenarios Simulated for Temperance Flat RM 274 with Trans Valley Canal Alternative Plans

Alternative Plans	Operations Integration Option	Transvalley Conveyance Option	Reservoir Balancing Option
Temperance Flat RM 274 Reservoir + Trans Valley Canal	CVP/Friant	TVC/SW/CVC/AE	Millerton Baseline
	SWP/Friant	TVC/SW/CVC/AE	Millerton Baseline
	SWP/CVP/Friant	TVC/SW/CVC/AE	Millerton Baseline
	SWP/CVP/Friant	TVC/AE	Millerton Baseline

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
N/A = not applicable
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TVC = Trans Valley Canal

Potential Accomplishments

This section summarizes the potential accomplishments of the Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans, including water supply reliability, water temperature, energy generation, flood damage reduction, M&I water quality, recreation opportunities, emergency water supply, and ecosystem enhancement.

Water Supply Reliability

Table 5-20 summarizes average annual changes in water deliveries from without-project conditions for the Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans, based on CALSIM simulations. Increasing conveyance capacity with the Trans Valley Canal would substantially increase deliveries compared to alternative plans without the canal, as indicated by the “TVC increment” column in the table. The operations scenario involving the SWP, CVP, and Friant Division would produce the largest average annual increase in delivery, but the SWP/Friant operations scenario would result in the greatest increase in M&I and dry year deliveries.

On average, the Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans would provide between 177 to 240 TAF per year of additional agricultural and M&I water deliveries, depending on operations scenario.

Table 5-20. Average Annual Change in Delivery for Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration							
	SWP/ CVP/Friant		SWP/Friant		CVP/Friant		SWP/CVP/Friant	
	Transvalley Conveyance							
	TVC/SW/CVC/AE						TVC/AE	
	Change in Delivery	TVC Increment	Change in Delivery	TVC Increment	Change in Delivery	TVC Increment	Change in Delivery	TVC Increment
Total (TAF)								
Dry & Critical Years	254	+86	230	+59	168	+48	206	+90
All Years	240	+60	177	+20	214	+47	211	+86
Friant Division (TAF)								
Dry & Critical Years	105	-1	107	+1	107	-1	104	-3
All Years	106	-2	107	0	109	-1	105	-4
CVP (TAF)								
Dry & Critical Years	47	+26	-1	+3	103	+57	38	+36
All Years	68	+30	-3	-1	112	+45	58	+58
SWP (TAF)								
Dry & Critical Years	102	+61	123	+55	-43	-8	64	+57
All Years	67	+31	74	+20	-7	+3	48	+32

Note:
All dry and critical year values are reported based on the Sacramento River Index. Reporting of changes in Friant Division deliveries based on the San Joaquin River Index would result in higher dry and critical year values.

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TVC = Trans Valley Canal

Emergency Water Supply

Emergency water supply benefits to SOD urban water users that would be achieved through the Temperance Flat RM 274 alternative plans are listed in Table 5-21. Emergency water supply benefits range from $19.3 million to $23.8 million, depending on the operations scenario.

Table 5-21. Annual Emergency Water Supply Benefits from Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration		
	SWP/CVP/Friant	SWP/Friant	SWP/CVP/Friant
	Transvalley Conveyance		
	TVC/SW/CVC/AE		TVC/AE
Avg. Emergency Water Supply, 20-Island Breach (TAF)	500	456	424
Annual Benefits, 20-Island Breach ($million)	$23.8	$22.0	$19.3

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TVC = Trans Valley Canal

Ecosystem and Water Temperature

Water temperature evaluations for Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans demonstrated improvements in ability to preserve and manage cold water compared to future without-project conditions. Relative improvements, or in some cases, decreases, in total cold water volume at or below 52ºF in Temperance Flat RM 274 Reservoir and Millerton Lake are shown in Figure 5-3. As described previously, changes in total cold water volume are based on cold water volume multipliers equal to cold water volume developed by alternatives divided by the volume of cold water available under future without-project conditions. Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans improve the ability to preserve and manage cold water for releases to the San Joaquin River, especially during summer and fall months.

The Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plan was not specifically evaluated for monetary ecosystem benefits. The results of this alternative plan are expected to be similar to those for the Temperance Flat RM 274 alternative plans.

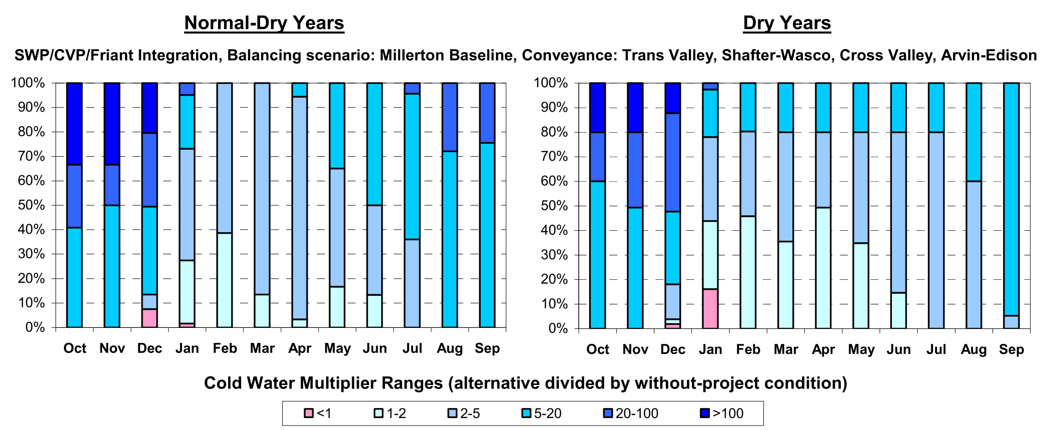

Figure 5-3. Changes in Cold Water Volume Below 52ºF for Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans

Energy Generation

As shown in Table 5-22, energy generation for the Temperance Flat RM 274 Reservoir with Trans Valley Canal would replace about 94 percent of the average annual Kerckhoff Project generation impacted by the alternative plans. The differences in conveyance capacity between the operations scenarios evaluated had almost no effect on power generation. Changes to CVP and SWP system-wide energy generation and use were not simulated for this grouping of alternative plans.

Table 5-22. Estimated Net Energy Generation for Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration	
	SWP/CVP/Friant	
	Transvalley Conveyance	
	TVC/SW/CVC/AE	TVC/AE
Impacted Kerckhoff Project Generation (GWh/year)	-518	-518
Temperance Flat RM 274 Generation (GWh/year)	473	474
Additional Friant Generation (GWh/year)	13	14
Net Power Generation (GWh/year)	-32	-30
Percent of Impacted Generation Replaced	94%	94%

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
GWh = gigawatt-hour
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TVC = Trans Valley Canal

Flood Damage Reduction

Potential annual flood damage reduction benefits accomplished through the Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans are listed in Table 5-23. Potential flood damage reduction benefits range from $1.3 to almost $1.9 million.

Table 5-23. Annual Flood Damage Reduction for Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans (90 percent exceedence)

Item	Operations Integration		
	SWP/CVP/Friant	SWP/Friant	SWP/CVP/Friant
	Transvalley Conveyance		
	TVC/SW/CVC/AE		TVC/AE
90% Exceedence Flood Space (TAF)	210	257	209
Annual Flood Damage Reduction ($million)	$1.4	$1.9	$1.3

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TVC = Trans Valley Canal

M&I Water Quality

M&I water quality benefits that would be achieved through the Temperance Flat RM 274 alternative plans with Trans Valley Canal are listed in Table 5-24. Water quality benefits range from $11.1 million to $16.4 million.

Table 5-24. Annual M&I Water Quality WTP Benefits from Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration		
	SWP/CVP/Friant	SWP/Friant	SWP/CVP/Friant
	Transvalley Conveyance		
	TVC/SW/CVC/AE		TVC/AE
Average Change in TDS (mg/L)	-15.4	-13.8	NE
Annual M&I Water Quality Benefit ($million)	$16.4	$15.2	$11.1

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
M&I = municipal and industrial
mg/L = milligrams per liter
NE = not estimated
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TDS = total dissolved solids
TVC = Trans Valley Canal
WTP = willingness to pay

Recreation Opportunities

The Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans were not specifically evaluated for effects on recreation opportunities. The results of these alternative plans are expected to be similar to those of the Temperance Flat RM 274 alternative plans.

Primary Potential Effects

Primary potential effects are described below for aquatic biological resources, terrestrial biological resources, recreation resources, and cultural resources that would be affected by the Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans.

Aquatic Biological Resources

Temperance Flat RM 274 with Trans Valley Canal alternative plans are likely to have the same effects on aquatic resources in the primary study area as Temperance Flat RM 274 Reservoir alternative plans. Impact analyses for the Trans Valley Canal measure for this alternative have not yet been conducted, but will be completed for the Feasibility Report and EIS/EIR.

Terrestrial Biological Resources

Potential effects of Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans on terrestrial biological resources within the inundation area for the alternatives would be the same as the effects described above for Temperance Flat RM 274 Reservoir alternative plans. Effects of the Trans Valley Canal measure for these alternative plans have not been evaluated, but will be completed for the Feasibility Report and EIS/EIR.

Recreation Resources

Temperance Flat RM 274 with Trans Valley Canal alternative plans are likely to have the same effects on recreation resources in the primary study area as Temperance Flat RM 274 Reservoir alternative plans. Impact analyses for the Trans Valley Canal measure for this alternative have not yet been conducted, but will be completed for the Feasibility Report and EIS/EIR.

Cultural Resources

Potential effects on cultural resources associated with the Temperance Flat RM 274 Reservoir for these alternative plans would be the same as the potential effects described above for the Temperance Flat RM 274 alternative plans. Impact analyses for the Trans Valley Canal measure for this alternative have not yet been conducted, but will be completed for the Feasibility Report and EIS/EIR.

Economics

This section summarizes information for estimated costs and potential benefits of the Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans.

Estimated Costs

Estimated costs for construction of Temperance Flat RM 274 Reservoir and the Trans Valley Canal are presented in Table 5-25. The cost information for the Trans Valley Canal is based on pre-appraisal level cost estimates prepared on behalf of the FWUA-MWDSC Partnership. The potential benefits estimates and water operations modeling were both based on a bidirectional Trans Valley Canal. Unidirectional canal cost estimates were expanded to provide a preliminary indication of the relative magnitude of costs for a bidirectional Trans Valley Canal. This cost information was used to facilitate comparison to the incremental benefits provided by the Trans Valley Canal to determine whether more detailed study is warranted.

Table 5-25. Cost Estimate Summary for Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans

Item	Estimated Cost[1,2] ($millions)
Features	
Embankment Dam	$430
Diversion Structures	$510
Spillway	$400
Outlet Works	$100
Power Features	$990
Affected Infrastructure	$10
Temperature Control Device at Friant Dam	$155
Trans Valley Canal	$490
TOTAL FIELD COST[3]	**$3,085**
Non-Contract Costs	
Planning, Engineering, Design and Construction Management[4]	$358
Acquisition of Private Lands	$19
Replacement Recreation Facilities	$7
Environmental Mitigation[5]	$17
Cultural Resources Mitigation	$8
TOTAL CONSTRUCTION COST	**$3,494**
Interest During Construction	$551
TOTAL CAPITAL COST	**$4,045**
Interest and Amortization	$199
Annual Operations and Maintenance	$5
Annual Replacement Power	$0
Annual Cross Valley Exchange Power	NE
TOTAL ANNUAL COST[6]	**$204**

Notes:
General: This appraisal-level cost estimate is preliminary and subject to revision in the Feasibility Report.
1 Costs are presented in 2006 dollars.
2 Values may not add to totals due to rounding.
3 The embankment dam costs include the following allowances: 5 percent mobilization, 10 percent unlisted items, and 20 percent construction contingency. The Trans Valley Canal costs include allowances of 5, 20, and 30 percent, respectively. All other features include allowances of 5, 15, and 25 percent, respectively.
4 The planning, engineering, design, and construction management cost for the dam features and Trans Valley Canal is 10 and 20 percent of each feature's field cost, respectively.
5 Environmental mitigation has not been estimated for the Trans Valley Canal.
6 Based on 4-7/8 discount rate and 100-year period of analysis.
Key:
NE = not estimated
RM = river mile

Potential Benefits

Estimated potential monetary benefits for the Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans, developed for several categories using methods described previously in this chapter, are summarized in Table 5-26.

Table 5-26. Potential Annual Benefits for Temperance Flat RM 274 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration		
	SWP/CVP/ Friant	SWP/Friant	SWP/CVP/Friant
	Transvalley Conveyance		
	TVC/SW/CVC/AE		TVC/AE
Potential Monetary Benefits ($million)			
Agricultural Water Supply Reliability	$59.1	$50.4	$55.8
M&I Water Supply Reliability	$81.9	$93.2	$70.0
M&I Water Quality	$16.4	$15.2	$11.1
Flood Damage Reduction	$1.4	$1.9	$1.3
Hydropower Generation	-$1.2	-$0.3	-$1.1
Recreation	$7.3	$7.3	$7.3
Emergency Water Supply	$23.8	$22.0	$19.3
Ecosystem	$24.5	$24.5	$24.5
Total Potential Monetary Benefits	**$213.2**	**$214.2**	**$188.2**

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
M&I = municipal and industrial
RM = river mile
SLIS = selective level intake structure
SW = Shafter-Wasco
SWP = State Water Project
TCD = temperature control device
TVC = Trans Valley Canal

Regional Economic Effects

Table 5-27 presents the results of the Friant Division and Statewide regional economic model simulations for Temperance Flat Reservoir RM 274 Reservoir with Trans Valley Canal alternative plans.

Table 5-27. Regional Economic Impacts by Impact Area for Temperance Flat RM 274 with Trans Valley Canal Alternative Plans

Item	Output ($million)		Income ($million)		Employment (jobs)	
Impact Area	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Friant Division	$31.1	$42.9	$6.4	$10.1	190	290
Statewide	$45.5	$70.8	$12.7	$22.9	270	460

Key:
RM = river mile

For Temperance Flat RM 274 Reservoir with the Trans Valley Canal and SWP/CVP/Friant operations integration and SW/CVC/AE/TVC conveyance options scenario, the direct impact to industries would be $31.1 million within the Friant Division counties, and about $45.5 million in the State. These direct impacts would yield indirect and induced impacts throughout the region and the State, respectively. “Indirect impacts” accrue largely to input supply and support industries, but accrue to many other sectors as well. “Induced impacts” are the change in overall output throughout the region as a result of greater household spending. The combined total of direct, indirect, and induced impacts would result in a total economic impact of $42.9 million annually in the Friant Division and $70.8 million statewide.

The second measure of regional impacts is “Personal Income,” the sum of employee compensation and proprietor income, and a measure of benefit for the RED account. The direct impact in the Friant Division would be $6.4 million; after accounting for indirect and induced impacts, the total impact on personal income in the Friant Division counties would be just over $10.1 million annually. In California, the direct impact on personal income would be $12.7 million, and the total impact would be $22.9 million.

Employment impacts are measured in total jobs, whether full- or part-time, of the businesses producing the output. In the Friant Division, the direct impact would be about 190 jobs, mostly to those involved in crop production. This leads to a total impact of about 290 jobs in those counties. Across the state, the direct impact would be 270 jobs, with a total impact of 460 jobs.

Temperance Flat RM 279 Reservoir Alternative Plans

This section describes the components, accomplishments, potential effects, and economics of the Temperance Flat RM 279 Reservoir alternative plans.

Plan Components

Temperance Flat RM 279 Reservoir would be created through construction of a dam in the upstream portion of Millerton Lake at RM 279.

Surface Water Storage Measures

The Temperance Flat RM 279 Dam site is located approximately 11.6 miles upstream from Friant Dam near the upstream extent of Millerton Lake. Permanent features would include a main dam with an uncontrolled spillway to pass flood flows, a powerhouse to generate electricity, and an outlet works for other controlled releases. Upstream and downstream cofferdams would be required for river diversion, and to keep Millerton Lake out of the construction zone. Diversion tunnels to route river flows around the construction zone would be required during construction. Figure 5-4 shows the extent of Temperance Flat RM 279 Reservoir and power features, and affected features in the reservoir area.

At the top of active storage capacity (elevation 985), Temperance Flat RM 279 Reservoir would provide about 690 TAF additional storage (705 TAF total storage, 17 TAF of which would overlap with Millerton Lake), and would have a surface area of about 3,490 acres. The reservoir would extend about 13.6 miles upstream from RM 279 to Kerckhoff Dam. At top of active storage capacity, the reservoir would reach about 12 feet below the crest of Kerckhoff Dam. Temperance Flat RM 279 Reservoir would reduce Millerton Lake storage volume and acreage at the top of active storage to 507 TAF and 4,540 acres, respectively.

RCC and embankment dam types have been recently considered for the RM 279 dam site, and a formal decision has not yet been made regarding which dam type would be selected. Embankment dam types were assumed for the designs and cost estimates in the PFR. The dam would be about 545 feet high, from about elevation 460 in the bottom of Millerton Lake (San Joaquin River channel) at the upstream face to the dam crest at elevation 1,005. No saddle dams would be required.

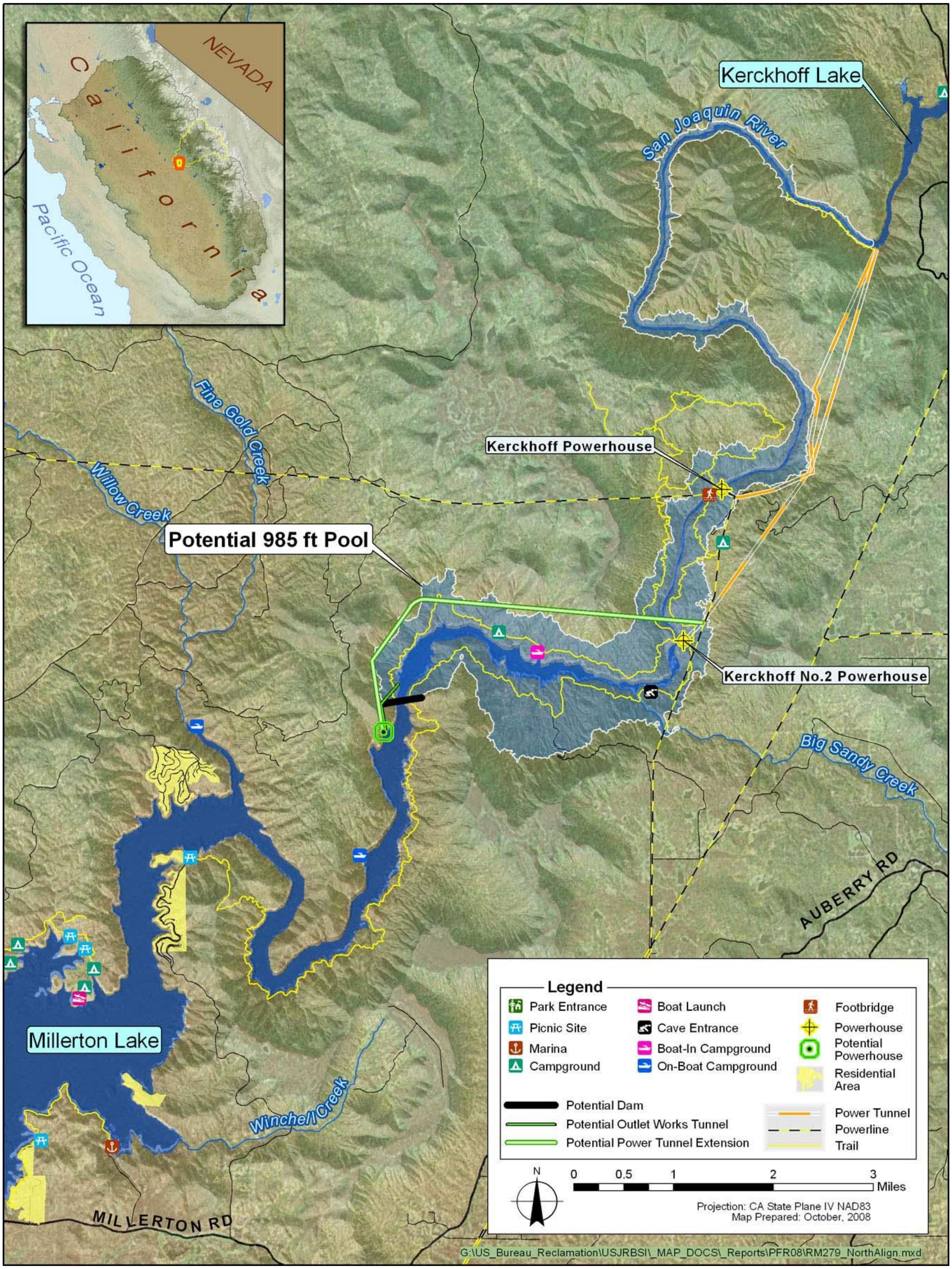

Figure 5-4. Potential Temperance Flat RM 279 Reservoir

Water Temperature Management Measures

Potential river restoration measures include a SLIS on the main dam and a TCD on Friant Dam. A multiple-port SLIS could be constructed for Temperance Flat RM 279 Dam to improve management of the cold water pool in the reservoir for releases to Millerton Lake. The SLIS would be designed and operated to withdraw water from the highest level in the reservoir that would meet temperature targets, thereby preserving colder water at lower elevations in the reservoir. Without a SLIS, water would be drawn from the reservoir at the same elevation as the outlet works.

A TCD on Friant Dam would be operated in a manner similar to above. TCDs also could be constructed on the canal and river outlets at Friant Dam to divert warmer water from the upper portion of the reservoir and preserve colder water for release to the river.

Energy Generation Measures

Temperance Flat RM 279 Reservoir would inundate the Kerckhoff and Kerckhoff No. 2 powerhouses. These facilities would be decommissioned and abandoned. Temperance Flat RM 279 Reservoir alternative plans include features to mitigate the loss of generation from the Kerckhoff Project powerhouses. These features would involve modifying and extending the Kerckhoff No. 2 Powerhouse tunnel to route water from Kerckhoff Lake to a new powerhouse and release valves downstream from Temperance Flat RM 279 Dam that would discharge into Millerton Lake, as shown in Figure 5-4. Tunnel extension alignments both north and south of the San Joaquin River have been considered; the northern alignment was assumed for the appraisal-level designs and cost estimates in the PFR. Water not routed through the extended tunnel would flow into Temperance Flat RM 279 Reservoir from Kerckhoff Lake. This configuration would make use of the relatively constant head in Kerckhoff Lake to maximize power generation. The powerhouse would have a capacity of 135 MW, with 120 MW from three 40-MW units on the extended Kerckhoff No. 2 Powerhouse tunnel, and one 15-MW unit on an outlet works tunnel from Temperance Flat RM 279 Reservoir. The configuration of power features is subject to change as the feasibility study progresses.

During normal releases, all flows would pass through the turbines. During turbine outages, the outlet valves would be operated as necessary to maintain water operations flows. During periods of high inflow, the outlet works release valves could be used to supplement releases, in combination with the spillway, as necessary.

Reservoir Operations and Water Management Measures

Alternative plans for Temperance Flat RM 279 Reservoir were evaluated under six distinct operations scenarios associated with the reservoir operations and water management measures. These scenarios vary according to the options applied for the extent of operations integration, available transvalley conveyance, and reservoir balancing. These three options within the six operations scenarios are summarized in Table 5-28 and described in the following sections and as described previously under water management measures for Temperance Flat RM 274 Reservoir alternative plans.

Table 5-28. Six Reservoir Operation Scenarios Simulated for Temperance Flat RM 279 Alternative Plans

Alternative Plans	Operations Integration Options	Transvalley Conveyance Options	Reservoir Balancing Options
Temperance Flat RM 279 Reservoir	Friant Only	N/A	Millerton Baseline
	SWP/Friant	AE	Millerton Baseline
	SWP/Friant	SW/CVC/AE	Millerton Baseline
	CVP/Friant	SW/CVC/AE	Millerton Baseline
	SWP/CVP/Friant	SW/CVC/AE	Millerton Baseline
	SWP/CVP/Friant	SW/CVC/AE	Millerton High

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
N/A = not applicable
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project

Potential Accomplishments

This section summarizes the potential accomplishments of the Temperance Flat RM 279 Reservoir alternative plans, including water supply reliability, water temperature, energy generation, flood damage reduction, M&I water quality, recreation opportunities, emergency water supply, and ecosystem enhancement.

Water Supply Reliability

Table 5-29 summarizes average annual changes in water deliveries for the Temperance Flat RM 279 operations scenarios, based on CALSIM simulations. The reservoir balancing options have a minimal effect on deliveries and are not shown. The operations scenario involving the SWP, CVP, and Friant Division would produce the largest average annual increase in delivery, but the SWP/Friant with full conveyance operations scenario would result in the greatest increase in M&I and dry year deliveries.

The last column in the table assumes transvalley conveyance capacity would only be available in AE, and illustrates the sensitivity of delivery results on available conveyance for exchanges. For the SWP/Friant operations integration options, annual average SWP delivery decreased by about 13 TAF when conveyance capacity was assumed to be limited to AE.

On average, the Temperance Flat RM 279 Reservoir alternative plans would provide between 83 to 132 TAF per year of additional agricultural and M&I water deliveries, depending on operations scenario.

Table 5-29. Average Annual Change in Delivery for Temperance Flat RM 279 Reservoir Alternative Plans

Item	Operations Integration				
	Friant Only	SWP/ CVP/Friant	SWP/Friant	CVP/Friant	SWP/Friant
		Transvalley Conveyance			
		SW/CVC/AE[1]			AE
Total (TAF)					
Dry & Critical Years	82	120	103	85	81
All Years	83	132	107	128	94
Friant Division (TAF)					
Dry & Critical Years[2]	84	81	81	83	81
All Years	86	83	83	85	83
CVP (TAF)					
Dry & Critical Years[2]	-4	20	1	31	-4
All Years	-5	32	1	53	-1
SWP (TAF)					
Dry & Critical Years[2]	2	19	21	-29	4
All Years	2	17	23	-9	12

Notes:
[1] Reservoir balancing option has negligible effect on water deliveries.
[2] All dry and critical values are reported based on the Sacramento River Index. Reporting changes in Friant Division deliveries based on the San Joaquin River Index would result in higher dry and critical year values.

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet

Emergency Water Supply

Alternatives to increase surface water storage in the upper San Joaquin River Basin offer the potential to provide emergency water supplies in the event of a disruption in the Delta. Emergency water supply benefits are the value of water supplies in upper San Joaquin River Basin storage facilities that can be used to increase supplies to urban water users in the event of a major levee failure in the Delta that would significantly degrade water quality. Table 5-30 presents the annual emergency water supply benefits for Temperance Flat RM 279 Reservoir. As shown, annual benefits range from $6.4 to $11.5 million, depending on operations scenario.

Table 5-30. Annual Emergency Water Supply Benefits from Temperance Flat RM 279 Reservoir Alternative Plans

Item	Operations Integration			
	Friant Only	SWP/CVP/ Friant	SWP/ Friant	SWP/ Friant
		Transvalley Conveyance		
		SW/CVC/AE		AE
Avg. Emergency Water Supply, 20-Island Breach (TAF)	131	246	235	209
Annual Benefits, 20-Island Breach ($million)	$6.4	$11.5	$11.1	$9.5

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project

Ecosystem and Water Temperature

Several reservoir water temperature simulations were performed for Temperance Flat RM 279 Reservoir alternative plans for the various operations scenarios. All scenarios evaluated for alternatives were effective in preserving the total volume of cold water in Millerton Lake and Temperance Flat RM 279 reservoirs, and improving the ability to manage cold water volumes for releases to the San Joaquin River. Results demonstrating the relative improvements, or in some cases, decreases, in total cold water volume at or below 52ºF in Temperance Flat RM 279 Reservoir and Millerton Lake for Temperance Flat RM 279 Reservoir alternative plans are shown in Figure 5-5. Reservoir balancing and operations integration options for the Temperance Flat RM 279 Reservoir alternative plans do not appear to have substantial differences in the ability to manage and release cold water to the San Joaquin River for support of assumed restoration temperature thresholds throughout the year.

The alternative plans would provide the opportunity to improve the probability of meeting temperature thresholds during the critical spawning and incubation periods for salmon of September through December. As noted above, the differences among operation scenarios were small relative to the limited precision of the applied temperature modeling and economic estimation. Therefore, the results were applied uniformly to each alternative plan. The preliminary annual ecosystem benefits for Temperance Flat RM 279 Reservoir alternative plans are $24.5 million.

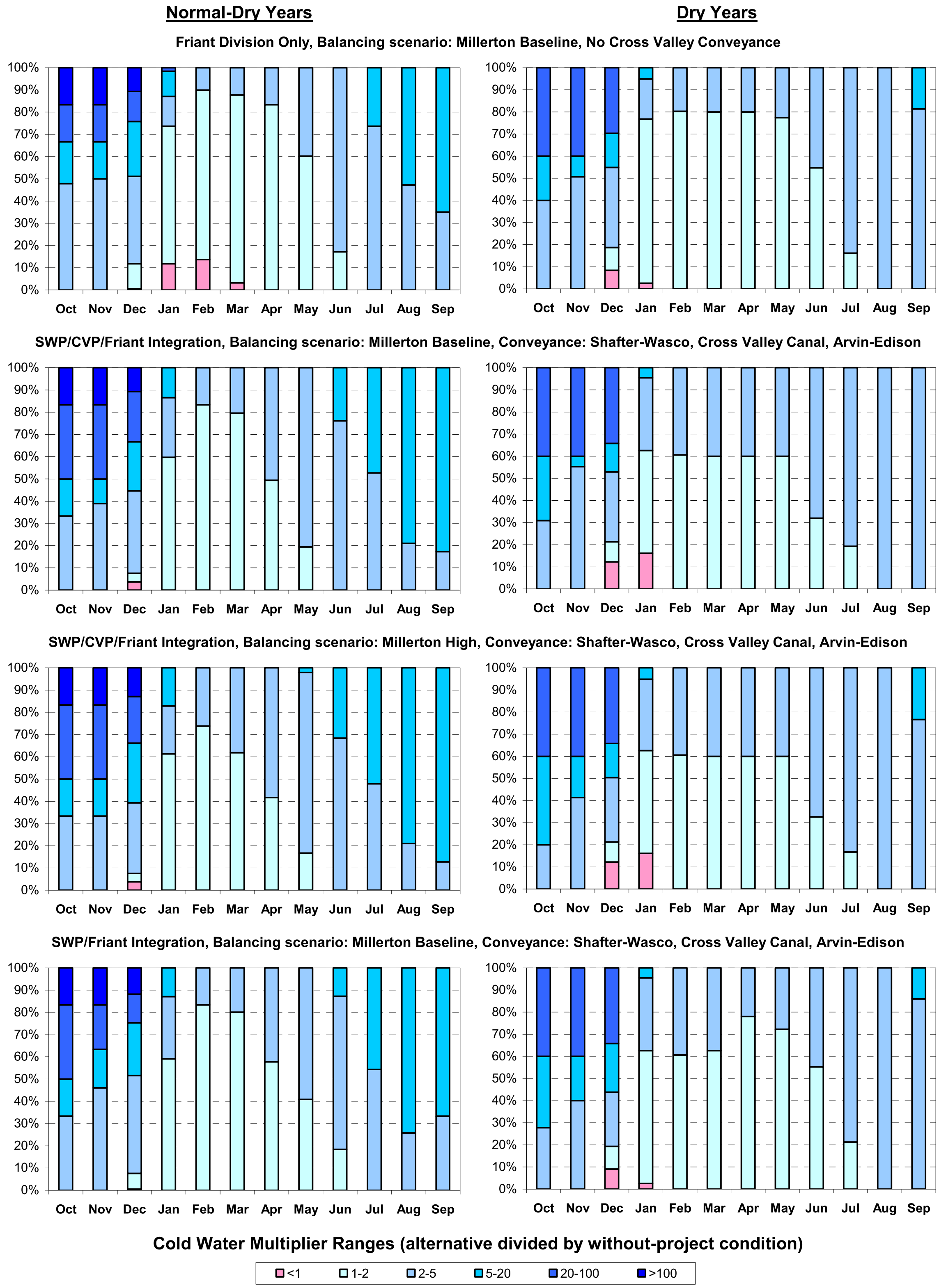

Figure 5-5. Changes in Cold Water Volume Below 52ºF for Temperance Flat RM 279 Reservoir Alternative Plans

Energy Generation

Most of the hydropower generation for the Temperance Flat RM 279 Reservoir alternatives would be accomplished by diverting flow into the Kerckhoff No. 2 Powerhouse tunnel at Kerckhoff Lake and discharging flow through a new powerhouse just downstream from Temperance Flat RM 279 Dam into Millerton Lake. Releases from Temperance Flat RM 279 Reservoir would also be used for power generation. As shown in Table 5-31, this grouping of alternative plans would generate enough energy to replace all or most of the energy lost through inundation of the Kerckhoff Project powerhouses, on an average annual basis.

Operations integration with SWP and/or CVP would result in slightly less power generation compared to the Friant Division only because of reduced available head. The lower heads with operations integration would occur as storage increases in both Millerton Lake and Temperance Flat as Delta supplies are delivered to Friant Division users and water levels increase in Millerton Lake and Temperance Flat RM 279 Reservoir. The Millerton High balancing option would result in less hydropower generation than the Millerton Baseline option, also due to reduced available head. For SWP/CVP integration with Millerton Baseline balancing, the power features could replace approximately 100 percent of the impacted Kerckhoff generation; therefore, even with operations integration, the impacted generation could generally be replaced.

Table 5-31. Estimated Energy Generation and Losses for Temperance Flat RM 279 Reservoir Alternative Plans

Item	Operations Integration				
	Friant Only	SWP/CVP/Friant		SWP/Friant	SWP/Friant
		Millerton Baseline	Millerton High		
		Transvalley Conveyance			
		SW/CVC/AE			AE
Impacted Kerckhoff Project Generation (GWh/year)	518	518	518	518	518
Temperance Flat Generation (GWh/year)	525	509	479	510	512
Additional Friant Generation (GWh/year)	8	11	18	10	11
Net Power Generation (GWh/year)	15	2	-21	2	5
Percent of Impacted Generation Replaced	103%	100%	96%	100%	101%

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
GWh = gigawatt-hour
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project

Table 5-32 demonstrates that operations integration would have insignificant effects to CVP and SWP system-wide energy generation and use. The balancing options would not have an effect on these impacts.

Table 5-32. Estimated System-Wide Energy Generation and Use for Temperance Flat RM 279 Reservoir Alternative Plans

Item		Operations Integration					
		Friant Only		SWP/CVP/Friant			
				Millerton Baseline		Millerton High	
				Transvalley Conveyance			
				SW/CVC/AE			
System		CVP	SWP	CVP	SWP	CVP	SWP
Average Annual Energy Generation (MWh)	Base	4,881	5,081	4,881	5,081	4,881	5,081
	Change from Base	0	1	3	54	3	41
Average Annual Energy Use (MWh)	Base	1,328	9,943	1,328	9,943	1,328	9,943
	Change from Base	5	4	0	209	30	162

Key:
CVP = Central Valley Project
MWh = megawatt-hour
RM = river mile
SWP = State Water Project

Flood Damage Reduction

Potential annual flood damage reduction benefits accomplished through the Temperance Flat RM 279 Reservoir alternative plans are listed in Table 5-33. Potential flood damage reduction benefits range from $0.7 to $2.3 million.

Table 5-33. Annual Flood Damage Reduction for Temperance Flat RM 279 Reservoir Alternative Plans (90 percent exceedence)

Item	Operations Integration			
	Friant Only	SWP/ CVP/Friant	SWP/Friant	SWP/Friant
		Transvalley Conveyance		
		SW/CVC/AE		AE
90% Exceedence Flood Space (TAF)	312	191	191	213
Annual Flood Damage Reduction ($million)	$2.3	$0.7	$0.7	$1.4

Key:
% = percent
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW= Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet

M&I Water Quality

M&I water quality benefits through the Temperance Flat RM 279 alternative plans are listed in Table 5-34. The estimated benefits based on willingness to pay range from $0.0 million to $7.5 million.

Table 5-34. Annual M&I Water Quality WTP Benefits from Temperance Flat RM 279 Reservoir Alternative Plans

<table>
<tr><th rowspan="4">Item</th><th colspan="4">Operations Integration</th></tr>
<tr><th rowspan="3">Friant Only</th><th>SWP/CVP/ Friant</th><th>SWP/Friant</th><th>SWP/Friant</th></tr>
<tr><th colspan="3">Transvalley Conveyance</th></tr>
<tr><th colspan="2">SW/CVC/AE</th><th>AE</th></tr>
<tr><td>Average Change in TDS (mg/L)</td><td>0.2</td><td>-5.0</td><td>-5.0</td><td>-2.0</td></tr>
<tr><td>Annual M&I Water Quality WTP Benefit ($million)</td><td>$0.0</td><td>$7.5</td><td>$7.4</td><td>$3.0</td></tr>
</table>

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet

Recreation Opportunities

As described earlier, opportunities for recreation development vary depending on operations scenarios. Simulation results of recreation opportunities for Temperance Flat RM 279 Reservoir alternative plans that generally maintain Millerton Lake water levels at baseline average monthly storage levels would improve recreation opportunities in the primary study area. Millerton Lake levels would be slightly higher than the baseline pool elevation during April through July, and moderately higher through August. The higher pool elevations under the baseline average monthly storage level option would provide a minor potential benefit to boaters while maintaining good shoreline use conditions. However, changing the reservoir balancing option to generally keep Millerton Lake higher than its average monthly baseline storage levels would improve early and late season boating opportunities in Millerton Lake, but degrade shoreline use conditions. Operations integration options do not demonstrate substantial differences in recreation opportunities for alternative plans.

Highly suitable areas for recreation development are similar to those described above for Temperance Flat RM 274 Reservoir alternative plans. Few areas near the Millerton Lake SRA were determined to have high or intermediate suitability for recreation development, and are mostly on private property. Steep slopes, lack of road access, and remoteness from existing developed areas limit opportunities for recreation development within the SJRGMA. However, there is a large area of high suitability immediately upslope from existing recreation facilities within the SJRGMA.

Table 5-35 summarizes the recreation benefit results for Temperance Flat RM 279 Reservoir alternative plans, with estimates ranging from $4.0 million to $7.3 million.

Table 5-35. Estimates of Recreation Benefits for Temperance Flat RM 279 Reservoir Alternative Plans

Item	Operations Integration			
	Friant Only	SWP/Friant	SWP/CVP/ Friant	SWP/CVP/ Friant
			Millerton Baseline	Millerton High
Total ($million)	$5.4	$4.0	$4.0	$7.3

Key:
BL = Millerton baseline reservoir balancing option
CVP = Central Valley Project
High = Millerton high reservoir balancing option
RM = river mile
SWP= State Water Project

Primary Potential Effects

Primary potential effects are described below for aquatic biological resources, terrestrial biological resources, recreation resources, and cultural resources affected by the Temperance Flat RM 279 Reservoir alternative plans.

Aquatic Biological Resources

Potential effects that may result from Temperance Flat RM 279 Reservoir alternative plans to aquatic habitat conditions and species are discussed below.

Habitat Conditions The effects of Temperance Flat RM 279 Reservoir alternative plans on reservoir fish habitat would generally be similar to those described above for Temperance Flat RM 274 Reservoir alternative plans. These alternatives would produce a moderate increase in April-to-September shallow water habitat over future without-project conditions in Millerton Lake. The increase would result from increased storage upstream from Temperance Flat RM 279 Reservoir and Dam, although these alternative plans have less storage in the upstream reservoir than the Temperance Flat RM 274 Reservoir alternative plans.

April-to-June quarter-month water level fluctuations for the Temperance Flat RM 279 Reservoir alternative plans could be more variable than for Temperance Flat RM 274 Reservoir alternative plans. Both the mean reductions and increases of water level in Millerton Lake would be less than those under future without-project conditions. For the Temperance Flat RM 279 Reservoir, the increases and reductions in water level for two of the scenarios, the Friant-only integration and the SWP/CVP/Friant integration with SW/CVC/AE conveyance (Millerton Lake Baseline) scenarios, would be much smaller than future without-project water level fluctuations in Millerton Lake, while for the SWP/CVP/Friant integration with SW/CVC/AE conveyance (Millerton Lake High) scenario, the water level increases and reductions would be slightly larger.

American shad and striped bass spawning habitat downstream from the Kerckhoff and Kerckhoff No. 2 powerhouses would be eliminated with the Temperance Flat RM 279 Reservoir alternative plans. New spawning habitat for these species would potentially be created in the upper reach of the new reservoir, downstream from Kerckhoff Dam, as described for the Temperance Flat RM 274 Reservoir alternative plans.

The loss of lotic habitat under the Temperance Flat RM 279 Reservoir alternative plans would be identical to the effects described above for the Temperance Flat RM 274 Reservoir alternative plans (Table 5-10).

Species The following sections describe potential effects to evaluated fish species for Temperance Flat RM 279 Reservoir alternative plans.

Largemouth and Spotted Bass Results of the largemouth and spotted bass model runs for Temperance Flat RM 279 Reservoir alternative plans are similar to the results described for Temperance Flat RM 274 Reservoir alternative plans. Spawning and rearing production in Millerton Lake would be reduced from that of the current reservoir under future without-project conditions, but offset by increased production in the reservoir created upstream from RM 279 for Temperance Flat RM 279 Reservoir alternative plans.

Smallmouth Bass, Bluegill, and Black Crappie Effects of Temperance Flat RM 279 Reservoir alternative plans on production of smallmouth bass, bluegill, and black crappie are expected to be similar to those described for the Temperance Flat RM 274 Reservoir alternative plans. Conditions for these species are expected to be degraded in Millerton Lake, and improved within the area of the reservoir upstream from RM 279.

Striped Bass and American Shad As described for the Temperance Flat RM 274 Reservoir alternative plans, these alternative plans would substantially increase the volume of deep, open water foraging habitat for striped bass and American shad, but would entirely eliminate the current spawning habitat of the species. The potential for creating new spawning habitat for American shad with these alternative plans, and the effects of the Temperance Flat dam on the new Millerton Lake, are likely to be much the same as those described for the Temperance Flat RM 274 Reservoir alternative plans.

Lotic Species Loss of useable fish habitat under Temperance Flat RM 279 Reservoir alternative plans would be the same as described earlier for the Temperance Flat RM 274 Reservoir alternative plans (Table 5-11).

Terrestrial Biological Resources

The following tables and discussion summarize effects to terrestrial habitats and species in the inundation area for the Temperance Flat RM 279 Reservoir alternative plans.

Habitat Table 5-36 shows acreages of habitat types that would be inundated by the Temperance Flat RM 279 Reservoir alternative plans. A total of 3,065 acres of vegetated habitat would be affected, along with 31 acres of developed and barren land, and 200 acres of riverine habitat. As is the case for Temperance Flat RM 274 Reservoir alternative plans, the greatest effect under these alternative plans would occur to foothill pine oak woodland and blue oak woodland habitats. Smaller areas of shrub, grassland, and riparian habitats would also be impacted.

Species Terrestrial species effects that may result from Temperance Flat RM 279 Reservoir alternative plans are discussed below. Species effects are similar to effects previously discussed for Temperance Flat RM 274 Reservoir alternative plans.

Rare Plants Of the 19 special-status plant species identified as either present or potentially occurring within the inundation area for Temperance Flat RM 274 Reservoir alternative plans, five were found within the inundation area for Temperance Flat RM 279 Reservoir alternative plans during 2007 field surveys (Table 5-37).

Table 5-14 summarizes the status, habitat, and likelihood of occurrence for the special-status plant species present or potentially occurring within the primary study area for both Temperance Flat RM 274 and RM 279 reservoir alternative plans.

Wildlife Resources The following sections summarize the likelihood of special-status wildlife species to occur within the inundation area for Temperance Flat RM 279 Reservoir alternative plans. As discussed above, potential wildlife species distribution is similar across the alternatives. The potential for special-status wildlife species to occur in the primary study area is summarized in Table 5-15. The following text highlights differences between the alternatives, when applicable.

Invertebrates As under the Temperance Flat RM 274 Reservoir alternatives, 10 California pipevine swallowtail butterfly populations were identified in the inundation area for the Temperance Flat RM 279 Reservoir alternative plans during 2007 field surveys.

Eighty-six elderberry shrubs with stems greater than 1 inch in diameter were identified within the inundation area for the Temperance Flat RM 279 Reservoir alternative plans. Four of these shrubs were observed to have valley elderberry longhorn beetle exit holes.

Table 5-36. Habitat Effects Under Temperance Flat RM 279 Reservoir Alternative Plans

Habitat Types	Temperance Flat RM 279 Reservoir (acres)
Foothill Pine Oak Woodland	2,152.4
Blue Oak Woodland	618.4
Live Oak Woodland	23.2
Foothill Pine Woodland	9.2
Foothill Pine Chaparral Woodland	4.8
Subtotal	**2,808.0**
Upland Shrub Habitat	
Buckbrush Chaparral	20.8
Bush Lupine Scrub	2.4
Subtotal	**23.2**
Upland Herbaceous Habitat	
Annual Grassland	47.7
Subtotal	**47.7**
Riparian Habitat	
White Alder Riparian	25.2
Mixed Riparian	2.1
Fig - Willow Riparian	2.6
Willow Woodland	1.9
Fig Riparian	0.5
Spanish Broom Scrub	0.5
Sycamore Woodland	0.4
Buttonbush Scrub	0.3
Subtotal	**33.5**
Herbaceous Wetland Habitat	
Seasonal Wetland[1]	152.4
Freshwater Seep	0.5
Subtotal	**152.9**
Aquatic Habitat	
Lacustrine Unconsolidated Bottom	78.1
Lacustrine Unconsolidated Shoreline[1]	114.0
Riverine	200.0
Subtotal	**392.1**
Other	
Barren	24.7
Developed	6.0
Subtotal	**30.7**
Total	**3,488.1**

Note:
[1] Habitat types that are periodically inundated, because they are below the ordinary high water mark of Millerton Lake.

Key:
RM = river mile

Table 5-37. Special-Status Plant Species Found in the Temperance Flat RM 279 Reservoir Inundation Area

Species	Occurrences[1]	Individuals
Tree anemone	1	6
Ewan's larkspur	none observed, but likely to occur	
Madera leptosiphon	1	~5,000
Michael's piperia	none observed, but likely to occur; observed just outside primary study area boundary	
Farnsworth jewelflower	3	~1,300
Hall's wyethia	4	~1,900
Small-flowered monkeyflower	8	~9,400

Note:
[1] An occurrence, as defined by CNPS and CNDDB, is a group of rare plants located within 0.25 miles of each other. Occurrences may consist of a number of individuals and clumps of individuals (colonies), the distribution of which may or may not differ between inundation areas and/or buffers.
Key:
CNPS = California Native Plant Society
CNDDB = California Natural Diversity Database
RM = river mile

Amphibians and Reptiles Three aquatic features that may provide potential breeding habitat for California tiger salamander were identified within the inundation area for Temperance Flat RM 279 Reservoir alternative plans during 2007 surveys. Each feature was evaluated during surveys for potential suitability, and classified as either suitable or marginal. One of the features was considered to be marginal and two were classified as suitable habitat. The determination of potential suitability of these features is conservative; bullfrogs were observed in at least one pond, which is also known to hold water permanently.

Potentially suitable western pond turtle habitat was mapped, and western pond turtle presence and habitat features were surveyed across the primary study area. Western pond turtle was previously documented in the primary study area and was observed during 2007 Investigation surveys in Big Sandy Creek (three individuals outside the inundation area of Temperance Flat RM 279 Reservoir alternative plans) and the San Joaquin River (one individual in the inundation area). Based on 2007 surveys, 82.3 acres of potential western pond turtle habitat were identified in the inundation area for Temperance Flat RM 279 Reservoir alternative plans. The most suitable habitat (providing more suitable basking sites, aquatic vegetation, and food sources) was identified along the San Joaquin River.

Approximately 8,955 linear feet of potentially suitable and marginal stream habitat would be affected by Temperance Flat RM 279 Reservoir alternative plans. While potentially suitable habitat was identified in the study area, no recent sightings of foothill yellow-legged frogs have been documented near the primary study area. Based on the presence of nonnative predators (bullfrogs and centrarchids) in the San Joaquin River and adjacent streams, foothill yellow-legged frogs are unlikely to be present in the inundation area for the Temperance Flat RM 279 Reservoir alternative plans.

Birds As described for the Temperance Flat RM 274 Reservoir alternative plans, several raptor species (American kestrel, Cooper's hawk, red-tailed hawk, sharp-shinned hawk) were incidentally observed in the primary study area during 2007 field surveys. Existing information and data collected during 2007 surveys suggest that raptors and other special-status bird species may nest in the area.

Mammals Potential effects to special-status bat species for the Temperance Flat RM 279 Reservoir alternative plans are similar to those discussed for the Temperance Flat RM 274 Reservoir alternative plans. Suitable roost sites occur throughout the primary study area, and one Townsend's big-eared bat was sighted during 2007 surveys in a rock outcrop within the inundation area for Temperance Flat RM 279 Reservoir alternative plans. Western mastiff bats are known to breed on the cliffs above the primary study area and are likely to occupy portions of the area.

Recreation Resources

A relatively narrow and winding lake extending about 13.5 miles up the San Joaquin River to Kerckhoff Dam, with about 3,482 surface acres at the top of active storage (elevation 985), would be created with the Temperance Flat RM 279 Reservoir alternative plans. The reservoir would be over 1.25 miles wide at Temperance Flat (about RM 281) but would be quite narrow in the upstream third of the pool, farther up the river gorge. Only the uppermost 2 miles of Millerton Lake within the SRA and adjacent lands would be substantially affected. The full length of the SJRGMA along the San Joaquin River would be impacted.

Recreational facilities upstream from RM 279 that would be affected by the Temperance Flat RM 279 Reservoir alternative plans include the Temperance Flat Boat-In Campground within the Millerton Lake SRA, the San Joaquin River Trail, and San Joaquin River Trail bridge at Big Sandy Creek. Within the BLM SJRGMA, an extension of the San Joaquin River Trail, a footbridge over the San Joaquin River, a primitive campground, and a reproduction Native American village would be affected by the Temperance Flat RM 279 Reservoir alternative plans. Figure 5-4 shows the extent of Temperance Flat RM 279 Reservoir and affected recreation features in the reservoir area.

The Temperance Flat RM 279 Reservoir alternative plans would result in reduced informal shoreline access throughout the season. The substantially higher pool elevation and resulting 1,000- to 1,700-acre increase in reservoir surface area would improve boating conditions in the primary study area.

Cultural Resources

Previously, archaeological surveys inventoried 35.2 percent of the Temperance Flat RM 279 Reservoir area and recorded a total of 28 archaeological sites, which were mostly prehistoric resources. No historical structures were recorded in the Temperance Flat RM 279 Reservoir area. Similar to the Temperance Flat RM 274 Reservoir alternative plans, local Native American tribes expressed opposition to the Temperance Flat RM 279 alternative and suggested that a new nearby dam would be very detrimental. Tribes indicated that the area is very sensitive, with 19 identified areas of concern, including village sites, gathering areas, and religious areas. According to some Native American groups, the most sensitive and important locations are in the Temperance Flat and Squaw Leap areas.

Based on the sensitivity analyses conducted for the Temperance Flat RM 279 alternative, approximately 108 archaeological sites and historical resources are estimated within the Temperance Flat RM 279 Reservoir area. This estimate includes 60 historic-era resources (mostly mining related) and 48 prehistoric resources (see Table 5-38). The actual number of archaeological sites could be substantially less or greater than the number of sites estimated.

Table 5-38. Estimated Number of Archaeological Sites for Temperance Flat RM 279 Reservoir Alternative Plans

Archaeological Sites	Temperance Flat RM 279 Reservoir (690 TAF)
Historic-Era Resources	**60**
Homestead-related sites	6
Sites associated with structures	3
Mines and mining patents	6
Sites within Big Bend Mining Claim concentration	0
Sites within Temperance Flat/Crook Mountain Mining Claim concentration	42
Roads	0
Hydroelectric/water engineering facilities	3
Recorded structures	0
Prehistoric Resources	**48**
Residential sites	18
All other sites	30
Total Resources	**108**

Key:
RM = river mile
TAF = thousand acre-feet

Economics

This section summarizes information for estimated costs and potential benefits of the Temperance Flat RM 279 Reservoir alternative plans.

Estimated Costs

Estimated costs for construction of Temperance Flat RM 279 Reservoir are presented in Table 5-39. This appraisal-level cost estimate for Temperance Flat RM 279 Reservoir is subject to change as the feasibility study progresses. The magnitude of contingencies would also decrease as the feasibility study progresses and uncertainties regarding site conditions decrease.

Table 5-39. Cost Estimate Summary for Temperance Flat RM 279 Reservoir Alternative Plans

Item	Estimated Cost[1,2] ($million)
Features	
Embankment Dam	$300
Diversion Structures	$390
Spillway	$470
Outlet Works	$90
Power Features	$880
Affected Infrastructure	$10
Temperature Control Device at Friant Dam	$155
TOTAL FIELD COST[3]	**$2,295**
Non-Contract Costs	
Planning, Engineering, Design and Construction Management (10%)	$230
Acquisition of Private Lands	$11
Replacement Recreation Facilities	$7
Environmental Mitigation	$11
Cultural Resources Mitigation	$6
TOTAL CONSTRUCTION COST	**$2,559**
Interest During Construction	$403
TOTAL CAPITAL COST	**$2,962**
Interest and Amortization	$146
Annual Operations and Maintenance	$4
Annual Replacement Power	$0
Annual Transvalley Exchange Power	NE
TOTAL ANNUAL COST[4]	**$150**

Notes:
General: This appraisal-level cost estimate is preliminary and subject to revision in the Feasibility Report.
[1] Costs are presented in 2006 dollars
[2] Values may not add to totals because of rounding.
[3] The embankment dam costs include the following allowances: 5 percent mobilization, 10 percent unlisted items, and 20 percent construction contingency. All other features include allowances of 5, 15, and 25 percent, respectively.
[4] Based on 4-7/8 discount rate and 100-year period of analysis.
Key:
NE = not estimated
RM = river mile

Potential Benefits

Estimated potential monetary benefits for the Temperance Flat RM 279 Reservoir alternative plans, developed for several categories using methods described previously in this chapter, are summarized in Table 5-40.

Table 5-40. Potential Annual Benefits for Temperance Flat RM 279 Reservoir Alternative Plans

Item	Operations Integration				
	Friant Only	SWP/CVP/ Friant[1]		SWP/ Friant	SWP/ Friant
		Transvalley Conveyance			
		SW/CVC/AE			AE
Monetary Benefits ($million)					
Agricultural Water Supply Reliability	$40.0	$44.4		$40.0	$38.9
M&I Water Supply Reliability	$1.1	$36.5		$46.3	$31.3
M&I Water Quality	$0.0	$7.5		$7.4	$3.0
Flood Damage Reduction	$2.3	$0.7		$0.7	$1.4
Hydropower Generation	$0.8	$0.3	-$0.8	$0.3	$0.4
Recreation	$5.4	$4.0	$7.3	$4.0	$4.0
Emergency Water Supply2	$6.4	$11.5		$11.1	$9.5
Ecosystem	$24.5	$24.5		$24.5	$24.5
Total Monetary Benefits	$80.5	$129.5	$131.7	$134.4	$113.0

Note:
[1] Millerton Baseline reservoir balancing option listed on the left and Millerton High reservoir balancing option listed on the right.

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
M&I = municipal and industrial
RM = river mile
SLIS = selective level intake structure
SW = Shafter-Wasco
SWP = State Water Project
TCD = temperature control device

Regional Economic Effects

Table 5-41 presents the results of the Friant Division and statewide regional economic model simulations for Temperance Flat Reservoir RM 279 Reservoir.

Table 5-41. Regional Economic Effects by Impact Area for Temperance Flat RM 279 Alternative Plans

Item	Output ($million)		Income ($million)		Employment (jobs)	
Impact Area	Direct	Total	Direct	Total	Direct	Total
Friant Division	$23.3	$32.0	$4.8	$7.5	140	210
Statewide	$29.8	$46.6	$8.1	$14.6	170	300

Key:
RM = river mile

Temperance Flat RM 279 Reservoir with Trans Valley Canal Alternative Plans

This section describes the components, accomplishments, potential effects, and economics of the Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans.

Plan Components

Surface water storage measures, water temperature management measures, and energy generation measures for this grouping of alternative plans are the same as described previously for the Temperance Flat RM 279 Reservoir alternative plans.

Increase Transvalley Conveyance Capacity Measures

This measure would be the same as described under the Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans.

Reservoir Operations and Water Management Measures

Alternative plans for Temperance Flat RM 279 Reservoir with Trans Valley Canal were evaluated under three distinct operations scenarios, which vary according to the approaches applied for the extent of operations integration, available transvalley conveyance, and reservoir balancing, as summarized in Table 5-42 and as described previously under water management measures for Temperance Flat RM 274 and RM 279 reservoir alternative plans.

Table 5-42. Three Reservoir Operation Scenarios Simulated for Temperance Flat RM 279 with Trans Valley Canal Alternative Plans

Alternative Plans	Integration Scenario Options	Transvalley Conveyance Options	Reservoir Balancing Options
Temperance Flat RM 279 Reservoir + Trans Valley Canal	SWP/Friant	TVC/SW/CVC/AE	Millerton Baseline
	CVP/Friant	TVC/SW/CVC/AE	Millerton Baseline
	SWP/CVP/Friant	TVC/SW/CVC/AE	Millerton Baseline

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TVC = Trans Valley Canal

Potential Accomplishments

This section summarizes the potential accomplishments of the Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans, including water supply reliability, water temperature, energy generation, flood damage reduction, M&I water quality, recreation opportunities, emergency water supply, and ecosystem enhancement.

Water Supply Reliability

Table 5-43 summarizes average annual changes in water deliveries for the Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans, based on CALSIM simulations. The operations scenarios involving the SWP, CVP, and Friant Division, and CVP/Friant only would produce the largest average annual increase in delivery. The SWP/Friant operations scenario would result in the greatest increase in both total and dry year SWP deliveries.

On average, the Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans would provide between 120 to 162 TAF per year of additional agricultural and M&I water deliveries, depending on operations scenario.

Table 5-43. Average Annual Change in Delivery for Temperance Flat RM 279 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration					
	SWP/CVP/Friant		SWP/Friant		CVP/Friant	
	Transvalley Conveyance SW, CVC, AE					
	Change in Delivery	TVC Increment	Change in Delivery	TVC Increment	Change in Delivery	TVC Increment
Total (TAF)						
Dry & Critical Years	137	+17	126	+22	124	+39
All Years	158	+26	120	+13	162	+34
Friant Division (TAF)						
Dry & Critical Years	81	-1	81	0	82	-1
All Years	82	-1	83	-1	84	-1
CVP (TAF)						
Dry & Critical Years	29	+9	1	+0	75	+44
All Years	51	+19	1	+0	87	+34
SWP (TAF)						
Dry & Critical Years	27	+8	44	+22	-33	-4
All Years	25	+8	36	+13	-8	+1

Note:
All dry and critical year values are reported based on the Sacramento River Index. Reporting of changes in Friant Division deliveries based on the San Joaquin River Index would result in higher dry and critical year values.
Key:
AE = Arvin-Edison Canal
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco Pipeline
SWP = State Water Project
TAF = thousand acre-feet
TVC Trans Valley Canal

Emergency Water Supply

Emergency water supply benefits associated with Temperance Flat RM 279 alternatives are presented in Table 5-44. As shown, annual benefits range from $15.0 to $15.8 million.

Table 5-44. Annual Emergency Water Supply Benefits from Temperance Flat RM 279 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration	
	SWP/CVP/Friant	SWP/Friant
	Transvalley Conveyance TVC/SW/CVC/AE	
Avg. Emergency Water Supply, 20-Island Breach (TAF)	330	307
Annual Benefits, 20-Island Breach ($million)	$15.8	$15.0

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TVC = Trans Valley Canal

Ecosystem and Water Temperature

Water temperature evaluations for Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans were not conducted during plan formulation. Based on results of water temperature analyses performed for Temperance Flat RM 279 Reservoir and Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans, scenarios for these alternatives are likely to be effective in preserving cold water volumes in Millerton Lake and Temperance Flat RM 279 reservoirs.

The Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans were not evaluated specifically for monetary ecosystem benefits. The results of these alternative plans are expected to be similar to those for the Temperance Flat RM 279 alternative plans.

Energy Generation

Hydropower simulations were not performed for this grouping of alternative plans. However, energy generation decreases associated with the Trans Valley Canal would be similar to those of Temperance Flat RM 274 with Trans Valley Canal alternative plans.

Flood Damage Reduction

Potential annual flood damage reduction benefits accomplished through the Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans are listed in Table 5-45. Potential flood damage reduction benefits range from almost $0.1 to $0.3 million.

Table 5-45. Annual Flood Damage Reduction for Temperance Flat RM 279 Reservoir with Trans Valley Canal Alternative Plans (90 percent exceedence)

Item	Operations Integration	
	SWP/CVP/ Friant	SWP/ Friant
	Transvalley Conveyance TVC/SW/CVC/AE	
90% Exceedence Flood Space (TAF)	172	180
Annual Flood Damage Reduction ($million)	$0.1	$0.3

Key:
AE = Arvin-Edison
CVC= Cross Valley Canal
CVP = Central Valley Project
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TVC = Trans Valley Canal

M&I Water Quality

M&I water quality benefits through the Temperance Flat RM 279 with Trans Valley Canal alternative plans are listed in Table 5-46. The estimated benefits based on willingness to pay range from $13.0 million to $15.7 million.

Table 5-46. Annual M&I Water Quality WTP Benefits from Temperance Flat RM 279 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration	
	SWP/CVP/ Friant	SWP/Friant
	Transvalley Conveyance TVC/SW/CVC/AE	
Average Change in TDS (mg/L)	NE	8.7
Annual M&I Water Quality Benefit ($million)	$15.7	$13.0

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
M&I = municipal and industrial
mg/L = milligrams per liter
NE = not estimated
RM = river mile
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TDS = total dissolved solids
TVC = Trans Valley Canal

Recreation Opportunities

The Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans were not evaluated for effects on recreation opportunities. The results of these alternative plans are expected to be similar to those for the Temperance Flat RM 279 alternative plans.

Primary Potential Effects

Primary potential effects are described below for aquatic biological resources, terrestrial biological resources, recreation resources, and cultural resources affected by the RM 279 Reservoir with Trans Valley Canal alternative plans.

Aquatic and Fisheries Biological Resources

Temperance Flat RM 279 with Trans Valley Canal alternative plans are likely to have the same effects on recreation resources in the primary study area as Temperance Flat RM 279 Reservoir alternative plans. Impact analyses for the Trans Valley Canal measure for this alternative have not yet been conducted, but will be completed for the Feasibility Report and EIS/EIR.

Terrestrial Biological Resources

Effects of Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans on terrestrial biological resources within the inundation area for the alternatives would be the same as the effects described above for Temperance Flat RM 279 Reservoir alternative plans. Potential effects for the Trans Valley Canal measure for these alternative plans have not been evaluated, but will be completed for the Feasibility Report and EIS/EIR.

Recreation Resources

Potential effects on recreation resources in the primary study area for the Temperance Flat RM 279 with Trans Valley Canal alternative plans are likely to be the same as potential effects described for the Temperance Flat RM 279 Reservoir alternative plans. Impact analyses for the Trans Valley Canal measure for this alternative have not yet been conducted, but will be completed for the Feasibility Report and EIS/EIR.

Cultural Resources

Potential effects on cultural resources associated with the Temperance Flat RM 279 Reservoir for these alternative plans would be the same as the potential effects described above for the Temperance Flat RM 279 alternative. Impact analyses for the Trans Valley Canal measure for this alternative have not yet been conducted, but will be completed for the Feasibility Report and EIS/EIR.

Economics

This section summarizes information for estimated costs and potential benefits of the Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans.

Estimated Costs

Estimated costs for construction of Temperance Flat RM 279 Reservoir and the Trans Valley Canal are presented in Table 5-47.

The cost information for the Trans Valley Canal is based on pre-appraisal level cost estimates prepared on behalf of the FWUA-MWDSC Partnership and provide a preliminary indication of the relative magnitude of costs for the Trans Valley Canal to facilitate comparison with the incremental benefits provided by the Trans Valley Canal to determine whether more detailed study is warranted.

Table 5-47. Cost Estimate Summary for Temperance Flat RM 279 Reservoir with Trans Valley Canal Alternative Plans

Item	Estimated Cost[1,2] ($millions)
Features	
Embankment Dam	$300
Diversion Structures	$390
Spillway	$470
Outlet Works	$90
Power Features	$880
Affected Infrastructure	$10
Temperature Control Device at Friant Dam	$155
Trans Valley Canal	$490
TOTAL FIELD COST[3]	**$2,785**
Non-Contract Costs	
Planning, Engineering, Design and Construction Management[4]	$328
Acquisition of Private Lands	$19
Replacement Recreation Facilities	$7
Environmental Mitigation[5]	$17
Cultural Resources Mitigation	$7
TOTAL CONSTRUCTION COST	**$3,163**
Interest During Construction	$499
TOTAL CAPITAL COST	**$3,662**
Interest and Amortization	$180
Annual Operations and Maintenance	$5
Annual Replacement Power	$0
Annual Cross Valley Exchange Power	NE
TOTAL ANNUAL COST[6]	**$185**

Notes:

General: This appraisal-level cost estimate is preliminary and subject to revision in the Feasibility Report.

1 Costs are presented in 2006 dollars.

2 Values may not add to totals due to rounding.

3 The embankment dam costs include the following allowances: 5 percent mobilization, 10 percent unlisted items, and 20 percent construction contingency. The Trans Valley Canal costs include allowances of 5, 20, and 30 percent, respectively. All other features include allowances of 5, 15, and 25 percent, respectively.

4 The planning, engineering, design, and construction management cost for the dam features and Trans Valley Canal is 10 and 20 percent of each feature's field cost, respectively.

5 Environmental mitigation has not been estimated for the Trans Valley Canal.

6 Based on 4-7/8 discount rate and 100-year period of analysis.

Key:
NE = not estimated
RM = river mile

Potential Benefits

Estimates of potential monetary benefits for the Temperance Flat RM 279 Reservoir with Trans Valley Canal alternative plans, developed for several categories using methods described previously in this chapter, are summarized in Table 5-48.

Table 5-48. Potential Annual Benefits for Temperance Flat RM 279 Reservoir with Trans Valley Canal Alternative Plans

Item	Operations Integration	
	SWP/CVP/ Friant	SWP/Friant
	Transvalley Conveyance TVC/SW/CVC/AE	
Potential Monetary Benefits ($million)		
Agricultural Water Supply Reliability	$45.0	$40.0
M&I Water Supply Reliability	$41.2	$57.1
M&I Water Quality	$15.7	$13.0
Flood Damage Reduction	$0.1	$0.3
Hydropower Generation	$0.3	$0.3
Recreation	$4.0	$4.0
Emergency Water Supply	$15.8	$15.0
Ecosystem	$24.5	$24.5
Total Potential Monetary Benefits	**$146.6**	**$154.2**

Key:
AE = Arvin-Edison
CVC = Cross Valley Canal
CVP = Central Valley Project
M&I = municipal and industrial
RM = river mile
SLIS = selective level intake structure
SW = Shafter-Wasco
SWP = State Water Project
TAF = thousand acre-feet
TCD = temperature control device
TVC = Trans Valley Canal

Chapter 6
Comparison of Alternative Plans

This chapter compares the four groupings of alternative plans for the Investigation based on the information available at this stage of the feasibility study planning process; presents the rationale for selection of a grouping of alternative plans at a single storage site; and rationale for continuation of the feasibility study. Technical studies will continue to refine and complete analyses of potential effects, potential benefits, and estimated costs in the next stage of the feasibility study.

Alternative Plans Comparison

This section includes comparisons of the groupings of alternative plans described and evaluated in Chapter 5. These comparisons of alternative plans will inform the selection of a grouping of alternative plans at a single surface water storage site, from which a recommended plan will be identified in the Final Feasibility Report. Four types of comparison summaries for the groupings of alternative plans are discussed below:

1. Accomplishments, benefits, and costs.
2. Ability to address the stated planning objectives, opportunities, constraints, and considerations.
3. Evaluation based on the planning criteria of completeness, effectiveness, efficiency, and acceptability, as identified in the P&G.
4. Potential effects of the four P&G accounts, the NED, RED, EQ, and OSE, at this stage of the planning process.

Accomplishments, Benefits, and Costs

Table 6-1 summarizes accomplishments, potential benefits, and estimated costs for the alternative plans that had the highest potential monetary benefits within each grouping. For each alternative plan grouping, several operational scenarios were formulated and evaluated to assess the sensitivity of accomplishments for the alternatives to different operational strategies. The operational scenarios vary according to the approaches applied for the extent of operations integration, available transvalley conveyance, and reservoir balancing.

Table 6-1. Summary of Potential Alternative Plan Accomplishments, Potential Benefits, and Estimated Costs

Item	No-Action/ No-Project Alternative	Temperance Flat RM 274 Reservoir		Temperance Flat RM 274 Reservoir with Trans Valley Canal		Temperance Flat RM 279 Reservoir		Temperance Flat RM 279 Reservoir with Trans Valley Canal	
		Operations Integration							
		SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant
Physical Characteristics									
Additional Storage Capacity (TAF)	0	1,260				690			
Additional Conveyance Capacity (cfs)	0	N/A		1,000		N/A		1,000	
Accomplishments									
Dry and Critical Year Increase in Delivery (TAF)[1]	0	168	171	254	230	120	103	137	126
Long-Term Avg. Increase in Delivery (TAF)[1]	0	180	158	240	177	132	107	158	120
Increase in Cold-Water Volume in All Year-Types	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Replacement of Impacted Hydropower Generation (%)	N/A	97%	98%	94%	NE	100%	100%	NE	NE
Available Flood Space at 90% Exceedence (TAF)	170	301	285	210	257	191	191	172	180
Potential Annual Benefits and Estimated Costs ($ million)[2]									
Agricultural Water Supply Reliability	$0	$55.2	$50.4	$59.1	$50.4	$44.4	$40.0	$45.0	$40.0
M&I Water Supply Reliability	$0	$57.3	$74.2	$81.9	$93.2	$36.5	$46.3	$41.2	$57.1
M&I Water Quality	$0	$8.2	$7.4	$16.4	$15.2	$7.5	$7.4	$15.7	$13.0
Flood Damage Reduction	$0	$2.3	$2.1	$1.4	$1.9	$0.7	$0.7	$0.1	$0.3
Net Hydropower Generation[3]	$0	-$0.4	-$0.3	-$1.2	-$0.3	$0.3	$0.3	$0.3	$0.3
Recreation	$0	$7.3	$7.3	$7.3	$7.3	$4.0	$4.0	$4.0	$4.0
Emergency Water Supply	$0	$14.6	$14.5	$23.8	$22.0	$11.5	$11.1	$15.8	$15.0
Ecosystem	$0	$24.5	$24.5	$24.5	$24.5	$24.5	$24.5	$24.5	$24.5
Total Potential Monetary Benefits ($million)	$0	$169.0	$180.1	$213.2	$214.2	$129.5	$134.4	$146.6	$154.2
Total Estimated Capital Cost ($million)	$0	$3,358		$4,045		$2,962		$3,662	
Total Estimated Annual Cost ($million)[4]	$0	**$169.1**		**$204.1**		**$149.7**		**$185.2**	
Potential Net Benefits ($million)	N/A	-$0.2	$11.0	$9.1	$10.2	-$20.2	-$15.3	-$38.6	-$31.0
Preliminary Benefit-Cost Ratio	N/A	1.00	1.06	1.04	1.05	0.87	0.90	0.79	0.83

Notes:
General: All alternative plans listed in this table assume available transvalley conveyance capacity in Shafter-Wasco Pipeline, Cross Valley Canal, and Arvin-Edison Canal.
General: Potential benefits for alternative plans listed in this table are based on the Millerton Baseline reservoir balancing option.
General: All costs and benefits are preliminary and subject to revision in the Feasibility Report.
[1] Increase in water supply deliveries compared to the No-Action/No-Project Alternative. Dry and critical years as defined by the Sacramento River hydrologic index.
[2] Based on October 2006 price levels.
[3] Net hydropower generation benefits include hydropower generation in the primary study area and minor effects to hydropower generation in the CVP/SWP system.
[4] Based on 4-7/8 discount rate and 100-year period of analysis.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
Avg. = average
M&I = municipal and industrial
N/A = not applicable
NE = not estimated
RM = river mile
SWP = State Water Project
TAF = thousand acre-feet

All of the alternative plans can provide a wide variety of accomplishments and benefits. The major portion of the monetary benefits of the alternative plans, between 70 and 80 percent, is attributed to water supply-related benefits. Ecosystem benefits account for 10 to 20 percent of the monetary benefits across the alternative plans, and benefits related to other opportunities (hydropower, flood damage reduction, M&I water quality, and recreation) represent about 10 to 15 percent of the monetary benefits.

At this stage in the planning process, the estimates of potential net benefits and the benefit-cost ratios are preliminary and subject to further refinement, but are useful for comparison purposes. Temperance Flat RM 274 Reservoir operated for SWP and Friant integration has the greatest preliminary net benefits and highest preliminary benefit cost-ratio. The alternative plans including Temperance Flat RM 274 Reservoir shown in Table 6-1 have a benefit-cost ratio ranging from 1.00 to 1.06. Alternative plans including Temperance Flat RM 279 have a preliminary benefit-cost ratio ranging from 0.79 to 0.90.

Planning Objectives, Opportunities, Constraints, and Considerations

Table 6-2 summarizes how well alternative plans address planning objectives and opportunities, and meet planning constraints and considerations. For the planning objective of enhancing water temperature and flow conditions in the San Joaquin River, the Temperance Flat RM 274 Reservoir and Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans provide the greatest improvement in the capability, reliability, and flexibility to store and release water at suitable temperatures for anadromous fish downstream from Friant Dam. These improvements are illustrated in Table 6-2 through the change in cold water volume from September to December compared to future without-project conditions. The period of September to December corresponds to months that Investigation alternatives may provide the most benefits associated with enhancing water temperature conditions in the San Joaquin River. In other months of the year, the TCDs allow release of water at warmer temperatures than in the without-project conditions, but still at or below target temperatures, thus preserving additional cold water for later months.

A comparison of cold-water management flexibility for the Temperance Flat RM 274 and RM 279 reservoir alternative plans, indicated by cold-water volume multipliers (alternative divided by without-project conditions), is shown in Figure 6-1. All of the alternative plans evaluated demonstrate substantial improvements in the volume of cold water that would be available for management and release to the San Joaquin River to support assumed restoration targets throughout the year. Based on cold-water multiplier ranges observed for these alternatives, Temperance Flat RM 274 Reservoir alternative plans show more improvement in cold-water volume compared to Temperance Flat RM 279 Reservoir alternative plans. All alternative plans are comparable in their ability to provide flows to the San Joaquin River below Friant Dam during critically low years.

Table 6-2. Summary Comparison of Alternative Plans Related to Planning Objectives, Opportunities, Constraints, and Considerations

Planning Objectives, Constraints, and Considerations	No-Action/ No-Project Alternative	Temperance Flat RM 274 Reservoir		Temperance Flat RM 274 Reservoir with Trans Valley Canal		Temperance Flat RM 279 Reservoir		Temperance Flat RM 279 Reservoir with Trans Valley Canal	
		Operations Integration Option							
		SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant	SWP/CVP/ Friant	SWP/ Friant
OBJECTIVES									
Enhance water temperature and flow conditions in the San Joaquin River									
Dry Year Increase in Cold-Water Volume Below 52°F (September to December) (TAF)	0	119	119	134	NE	61	63	NE	NE
Dry Year Increase in Cold-Water Volume Below 60°F (September to December) (TAF)	0	184	184	205	NE	123	116	NE	NE
Long-Term Avg. Increase in Cold-Water Volume Below 52°F (September to December) (TAF)	0	365	359	396	NE	183	178	NE	NE
Long-Term Avg. Increase in Cold-Water Volume Below 60°F (September to December) (TAF)	0	553	543	596	NE	313	305	NE	NE
Ability to Provide Restoration Flows to the San Joaquin River Below Friant Dam During Critical Years	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Increase Water Supply Reliability and System Operational Flexibility									
Dry and Critical Year Change in Delivery (TAF)	0	168	171	254	230	120	103	137	126
Long-Term Avg. Change in Delivery (TAF)	0	180	158	240	177	132	107	158	120
Operational Flexibility	Very Low	High	High	High	High	Medium	Medium	Medium	Medium
ADDRESSES PLANNING OPPORTUNITIES	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MEETS PLANNING CONSTRAINTS	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MEETS PLANNING CONSIDERATIONS	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
COMBINED RANKING FOR ADDRESSING OBJECTIVES, AND MEETING PLANNING CONSTRAINTS AND CRITERIA	**VERY LOW**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**MEDIUM**	**MEDIUM**	**MEDIUM**	**MEDIUM**

Key:
Avg. = average
cfs = cubic feet per second
CVP = Central Valley Project
ºF = degrees Fahrenheit
M&I = municipal and industrial
N/A = not applicable
NE = not estimated
RM = river mile
SWP = State Water Project
TAF = thousand acre-feet

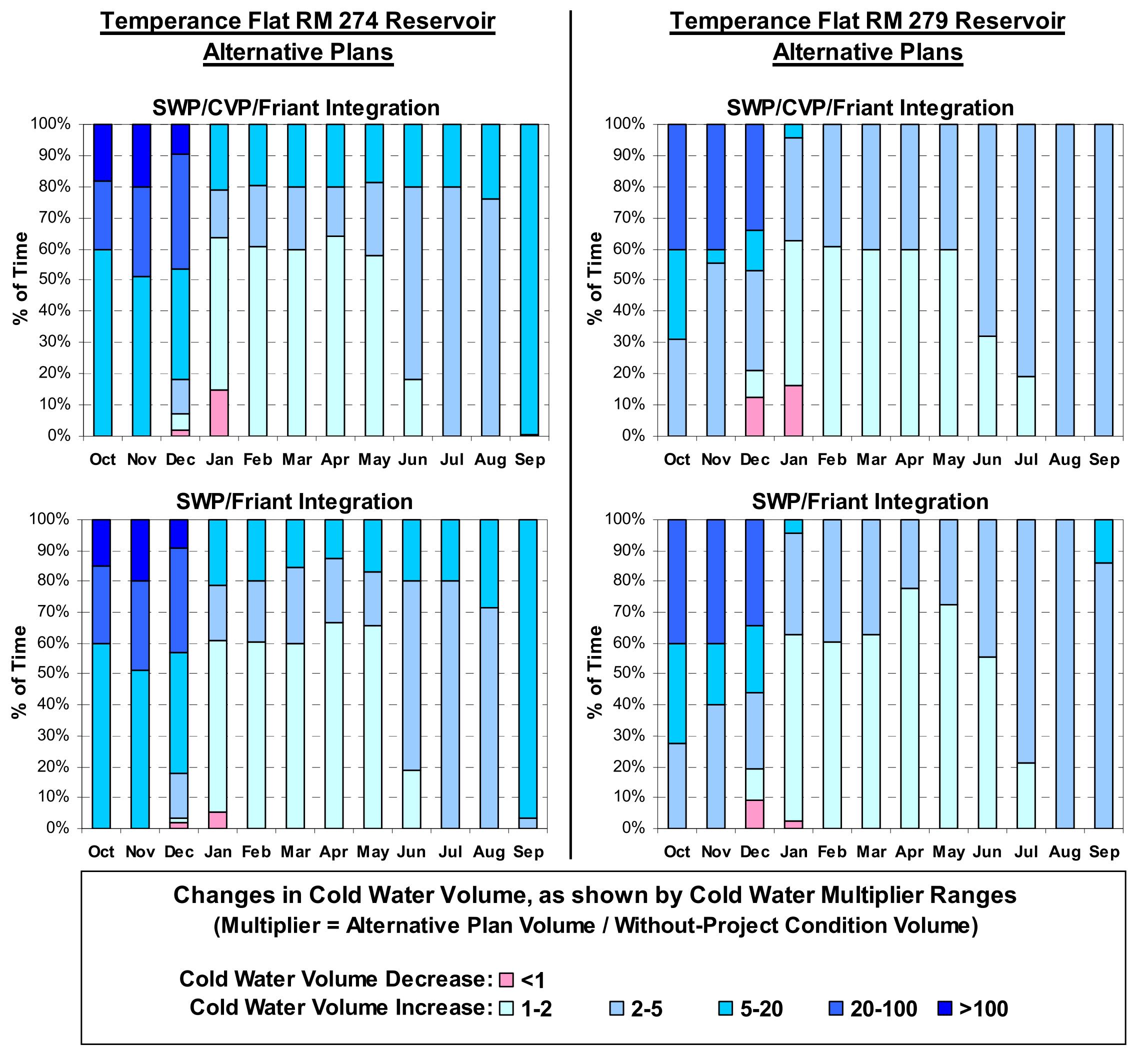

Figure 6-1. Changes in Cold-Water Volume Below 52ºF for Temperance Flat RM 274 Reservoir and Temperance Flat RM 279 Reservoir Alternative Plans

For the planning objective of increasing water supply reliability and system operational flexibility, the Temperance Flat RM 274 Reservoir and Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans provide the greatest ability to increase water supply reliability through developing the most change in water deliveries compared to future without-project conditions.

The smaller storage capacity associated with Temperance Flat RM 279 Reservoir alternative plans appears to limit the amount of water than can be exchanged, thus reducing the additional water supply developed compared to Temperance Flat RM 274 Reservoir alternative plans. Without the Trans Valley Canal, the Temperance Flat RM 274 Reservoir alternative plans could provide, on average, about 50 percent more water supply than the Temperance Flat RM 279 alternative plans.

Temperance Flat RM 274 Reservoir and Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans were also ranked high in their ability to improve system operational flexibility due to greater water storage and transvalley conveyance capacity for integrated operations of Friant Dam with SWP and/or CVP facilities outside the Friant Division.

Opportunities for the Investigation are described in Chapter 2. All alternative plans (except the No-Action/No-Project Alternative) were formulated to address opportunities for the Investigation, and provide benefits associated with the opportunities to varying degrees.

Basic constraints and other considerations specific to the Investigation were developed and identified to guide the feasibility study and help formulate, evaluate, and compare the alternative plans. At this stage in the planning process, all alternative plans meet planning constraints and considerations identified for the Investigation.

Federal Planning Criteria for Evaluating Alternative Plans Evaluations

Table 6-3 compares the groupings of alternative plans for the four P&G planning criteria: (1) effectiveness, (2) efficiency, (3) acceptability, and (4) completeness (WRC, 1983). The following sections describe each criterion and the comparative rankings for the alternative plans. At this stage of the planning process, the effectiveness criterion was given twice the weight compared to each of the efficiency, acceptability, and completeness criteria in determining a combined ranking.

Table 6-3. Summary of Alternative Plan Comparison Related to Planning Criteria

Criterion	No-Action/ No-Project Alternative	Temperance Flat RM 274 Reservoir	Temperance Flat RM 274 Reservoir with Trans Valley Canal	Temperance Flat RM 279 Reservoir	Temperance Flat RM 279 Reservoir with Trans Valley Canal
Effectiveness	N/A	High	High	Medium	Medium
Enhance water temperature and flow conditions in the San Joaquin River	N/A	High	High	Medium	Medium
Increase Water Supply Reliability and System Operational Flexibility	N/A	High	High	Medium	Medium
Efficiency	N/A	High	High	Medium	Medium
Acceptability	N/A	Medium	Medium	High	High
Completeness	N/A	High	Medium	High	Medium
COMBINED RANKING[1]	**N/A**	**HIGH**	**HIGH**	**MEDIUM**	**MEDIUM**

Note:
[1] In developing a combined ranking, the effectiveness criterion was given twice the weight compared to each of the efficiency, acceptability, and completeness criteria.

Key:
N/A = not applicable
RM = river mile

Effectiveness

As described in Chapter 4, effectiveness is the extent to which an alternative plan addresses planning objectives and opportunities. Accomplishments for alternative plans related to addressing planning objectives and opportunities are shown in Table 6-2. The No-Action/No-Project Alternative does not address any of the planning objectives for the Investigation, and is not ranked for effectiveness. The Temperance Flat RM 274 Reservoir and Temperance Flat RM 274 Reservoir with Trans Valley Canal alternative plans rank highest in their ability to enhance water temperature and flow conditions in the San Joaquin River, and to improve water supply reliability (Table 6-3). These alternatives also rank highest in their ability to address opportunities for the Investigation.

Efficiency

Chapter 4 describes the efficiency planning criterion as the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment. The most efficient plans would best address the planning objectives with the least cost and adverse environmental effects. Table 6-1 shows costs, benefits, and benefit-cost ratios for alternative plans. Because the No-Action/No-Project Alternative does not address the planning objectives for the Investigation, this alternative was not ranked for efficiency

Temperance Flat RM 274 Reservoir alternative plans were ranked high for the efficiency criterion. With and without the Trans Valley Canal, the Temperance Flat RM 274 Reservoir alternative plans have higher ratios of potential annual monetary benefits to estimated costs than Temperance Flat RM 279 Reservoir alternative plans. Based on pre-appraisal-level cost estimates, and economic analyses conducted during plan formulation, incremental estimated costs and incremental potential benefits associated with the Trans Valley Canal above those with Temperance Flat RM 274 Reservoir without transvalley conveyance, are approximately equivalent.

Acceptability

As described in Chapter 4, acceptability is the workability and viability of the alternative plans with respect to acceptance by Federal, State, and local entities and the public, and compatibility with existing laws, regulations, and public policies. An alternative plan with less support is not infeasible or unacceptable; rather, it is simply less preferred. The No-Action/No-Project Alternative was not ranked for acceptability. Although this alternative is workable and viable, it addresses none of the planning objectives.

Each of the action alternative plans evaluated is compatible with existing laws, regulations, and public policies. Some additional subfactors pertinent to acceptability discussed in Chapter 4 include potential to develop adequate mitigation in the project vicinity, and willingness of private landowners to sell affected lands. Considering all subfactors for acceptability, Temperance Flat RM 279 Reservoir alternative plans were ranked higher than Temperance Flat RM 274 alternative plans.

Completeness

Chapter 4 describes completeness as the extent to which a given alternative plan provides and accounts for all necessary investments and other actions to ensure realization of the planned effects. The completeness of each alternative is identified through determining that all necessary components of actions are identified, including the adequate mitigation of significant adverse impacts, other types of public or private plans if the other plans are crucial to realization of the contributions to the objective, and degree of uncertainty (or reliability) of achieving the intended planning objectives. The No-Action/No-Project Alternative was not ranked for completeness. Although this alternative requires no additional action, it addresses none of the planning objectives.

Assessing completeness is conceptual at this phase of the feasibility study, with information on specific mitigation needs, and detailed designs and cost estimates under development. Temperance Flat RM 274 Reservoir and Temperance Flat RM 279 Reservoir alternative plans were ranked the same for the completeness criterion. Additional engineering, environmental, and economic studies related to the Trans Valley Canal are under development. Therefore, alternative plans that include the Trans Valley Canal were ranked medium.

Four Accounts of Potential Economic and Environmental Effects

The P&G (WRC, 1983) identify four "accounts" (NED, RED, EQ, and OSE) to assess and display the potential effects when evaluating alternatives. A preliminary analysis of potential NED benefits is shown in Table 6-1. Other information required by law, or that would have a material bearing on the decision-making process, is considered in the other accounts (EQ, RED, and OSE).

- The NED account assesses changes in the economic value of the national output of goods and services.
- The RED account indicates the regional incidence of NED effects, income transfers, and employment effects.
- The EQ account shows effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that cannot be easily or effectively measured in monetary terms.
- The OSE account shows urban, rural, and community impacts and effects on life, health, and safety.

National Economic Development Account

Table 6-1 summarizes the total potential monetary NED benefits for each alternative plan. The benefits are displayed in millions of dollars annually; values are annualized assuming the project has been completed and is operating at full capacity.

Associated with each alternative plan is a summary of the annualized cost. This provides an opportunity to compare the annual benefits to costs, net benefits (difference), and the preliminary benefit-cost ratio based on these estimates. A review of the benefit-cost ratios for all alternatives indicates that three of the four alternative plans that include Temperance Flat RM 274 Reservoir have benefit-cost ratios at or above 1.0. In contrast, the alternatives that include Temperance Flat RM 279 Reservoir are all below 1.0. Temperance Flat RM 274 Reservoir with SWP/Friant operations integration could yield about $11.0 million in annual net benefits, and would have a benefit-cost ratio of approximately 1.06 to 1. The total benefits are highest, at $214.2 million per year, for Temperance Flat RM 274 Reservoir with the Trans Valley Canal and SWP/Friant operations integration. This alternative also has the most physical component features and, hence, the highest cost. Temperance Flat RM 279 Reservoir with SWP/CVP/Friant operations integration has the lowest total benefits, at $129.5 million annually.

Regional Economic Development Account

Potential RED impacts have been estimated at both the California and the Friant Division regional levels for two representative alternatives involving Temperance Flat RM 274 or RM 279 reservoir (Table 6-4). With additional water supply, the value of agricultural output (in the Friant Division) increases, primarily reflected in an increase in farm income. The change in agricultural income is the largest driver of RED impacts at this phase in the Investigation, although additional changes in agricultural output and recreation expenditures are also included.

For the California State model, the agricultural output change extends to an area larger than the six counties of the Friant Division, and the direct effects are larger. In addition to agricultural income and output, a change in personal income is included that reflects cost savings that would be associated with the water quality improvement (i.e., a decrease in water rates resulting from lower treatment costs). Additional RED analyses will be conducted for all alternatives studied in the feasibility phase. Nevertheless, the impacts in the RED account are expected to be similar across the alternatives, but proportional to the respective NED benefits.

Table 6-4. Representative RED Impacts

Alternative Plan	Impact Area	Output ($million)		Income ($million)		Employment (jobs)	
		Direct	Total	Direct	Total	Direct	Total
Temperance Flat RM 274 Reservoir with Trans Valley Canal	Friant Division	$31.1	$42.9	$6.4	$10.1	190	290
	Statewide	$45.5	$70.8	$12.7	$22.9	270	460
Temperance Flat RM 279 Reservoir	Friant Division	$23.3	$32.0	$4.8	$7.5	140	210
	Statewide	$29.8	$46.6	$8.1	$14.6	170	300

Key: RM = river mile

Environmental Quality Account

In addition to biological and cultural effects, the alternative plans could have an effect on ecosystem improvement leading to protection or recovery of ESA-listed species, and biodiversity enhancement. Benefits may also occur related to climate change adaptation. Ecosystem restoration generates value either because services induce specific economic uses or because the ecosystem restoration services themselves are valued. However, not all values can be measured in the market, and not all values can or should reasonably be measured in quantitative terms. Nevertheless, these benefits should be recognized and will influence the decision of selecting a recommended alternative plan among the alternatives. A limited effort has been made to address issues that would fall within the EQ account. The SJRRP, while not specifically related to the alternatives, can be an important source of information in the feasibility study for analysis and inclusion in the EQ account. EQ will be developed further in the next stage of the feasibility study, and results will be presented in the Feasibility Report and EIS/EIR. Differences in the effects of the alternatives related to the EQ account have not been evaluated at this phase of the Investigation.

Other Social Effects Account

As defined in the P&G, urban, rural, and community impacts and effects of the alternatives on life, health, and safety are included in the OSE account. The OSE have not been investigated or documented in detail for this PFR. However, some of the most significant effects are addressed in general terms in this section. The alternative plans would result in increased agricultural output (sales), net farm income, and personal income. Alternatives may also provide limited opportunities for increased employment in other sectors of the economy. However, it is useful to examine how the changes in personal income are distributed among socioeconomic sectors in the affected area. Although the counties encompassing the Friant Division are among the highest in terms of revenue from agricultural products, average incomes among those employed in agriculture are generally less than in other sectors of the economy. Increases in employment would accrue largely to agricultural workers. The extent to which the alternatives would provide benefits to lower income groups will be examined in the feasibility study.

In addition to income and employment distribution, the effect of the alternative plans on communities is also important to note. The effect on communities can take the form of the types and geographic location of affected communities, quality of community life, and fiscal impacts on local and regional governments and the services they provide. The affected counties in the Friant Division include several large cities and suburbs, plus many small, agriculturally based towns and unincorporated areas. The prominence of agriculture in the economic base of the region, combined with the direct effect of the alternatives on agricultural production, is likely to result in demonstrable community benefits.

The extended study area is a region of considerable ethnic and cultural diversity, high population growth, and an increasing proportion of minority representation. In addition, agricultural workers in the region are one of the poorest and most disadvantaged socioeconomic groups, and highly represented among minorities. The alternative plans have the potential of having a significant effect on these population groups. The alternative plans include features that would allow water to be exchanged with urban water users outside the Friant Division. Urban areas in the SOD service area could see a reduction in water costs stemming from reduced water treatment costs. The effects are likely to be widespread and positive, while having little, if any, disproportionate effect on a particular population or socioeconomic group.

Finally, there could be some short term effects associated with all the storage alternative plans:

- Temporary construction-related benefits could derive to local communities in the areas of the alternative plan features.

- Potential short-term adverse effects could occur for those directly affected by construction, related to pressures on housing, public services, transportation, and schools.

OSE will be developed further in the next stage of the feasibility study, and results will be presented in the Feasibility Report and EIS/EIR. Differences in the effects of the alternative plans related to the OSE account have not been evaluated at this phase of the Investigation.

Storage Site Selection

Chapter 4 of this document concluded with the identification of Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF) as retained surface water storage measures for alternative plans. The four groupings of alternative plans were further evaluated in Chapter 5 and compared above in this chapter. This section summarizes the rationale for selection of a grouping of alternative plans that will be considered in detail in the Feasibility Report and EIS/EIR, and will inform the selection of a recommended plan.

Temperance Flat RM 274 (1,260 TAF) and Temperance Flat RM 279 (690 TAF) Alternative Plans

The Temperance Flat RM 274 Reservoir grouping of alternative plans is retained for further evaluation in the feasibility phase of the Investigation and the Temperance Flat RM 279 Reservoir grouping of alternative plans will not be retained for further evaluation for the following major reasons:

- Temperance Flat RM 274 Reservoir (1,260 TAF) alternative plans have greater benefits, greater net benefits, and a higher benefit-cost ratio compared to the Temperance Flat RM 279 Reservoir (690 TAF) alternative plans.

- Most of the Temperance Flat RM 274 Reservoir (1,260 TAF) alternative plans provide positive net benefits, but Temperance Flat RM 279 Reservoir (690 TAF) alternative plans do not provide positive net benefits.

- Temperance Flat RM 274 Reservoir (1,260 TAF) alternative plans address the planning objectives of enhancing water temperature and flow conditions in the San Joaquin River, and increasing water supply reliability and operational flexibility to a greater degree than Temperance Flat RM 279 Reservoir (690 TAF) alternative plans.

- Based on comparing the groupings of alternative plans according to the four P&G planning criteria, Temperance Flat RM 274 Reservoir (1,260 TAF) alternative plans ranked higher than Temperance Flat RM 279 Reservoir (690 TAF) alternative plans.

Trans Valley Canal Component of Alternative Plans

As discussed in Chapter 5, there is a high degree of uncertainty related to the specific features, operations, and estimated costs of the Trans Valley Canal. Cost and design information for the Trans Valley Canal component of alternative plans has not been developed at the same level of analysis as the surface water storage components. Potential operations and alignments of the Trans Valley Canal are also very preliminary. With the extent of information collected at this phase in the planning process (based on pre-appraisal cost estimates for the Trans Valley Canal), in combination with Temperance Flat RM 274 Reservoir alternative plans, it appears that the estimated annual costs for the Trans Valley Canal are approximately equivalent to the potential incremental benefits it would provide. The Trans Valley Canal provides greater benefits in combination with the larger storage capacity of Temperance Flat RM 274 Reservoir than with Temperance Flat RM 279 Reservoir.

The Trans Valley Canal will not be retained for further evaluation in the feasibility phase of the Investigation. The ranking of alternative plans and benefit-cost ratios are not substantially affected by including the Trans Valley Canal with the Temperance Flat reservoirs, and the canal is not needed to achieve a positive benefit-cost ratio. The Trans Valley Canal is a potentially beneficial increment that could be added to an alternative at a later time. As other studies related to a potential Trans Valley Canal progress, benefits, costs and effects of this potential facility would be taken into account. It is likely that such a facility would be jointly pursued by a variety of local, regional, State, and/or Federal water interests, and its justification would likely not be specifically attached to Investigation alternatives.

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Chapter 7 Implementation Considerations, Study Management, and Outreach

Development of this PFR revealed several factors, considerations, and related requirements that will need to be evaluated as part of the Investigation. Combined, these various issues represent implementation considerations the Investigation will seek to resolve through its study management structure, and with the active participation of stakeholders and the public. This chapter describes (1) implementation responsibilities, (2) preliminary cost allocation, (3) regulatory and related requirements for environmental compliance, (4) the Investigation management structure, (5) the Investigation's current and future public outreach and involvement activities, and (6) schedule and status of the feasibility study.

Implementation Responsibilities

On the basis of studies to date, it appears that there could be multiple project purposes. Potential project purposes include agricultural water supply, M&I water supply and water quality, ecosystem enhancement, hydropower, recreation, and flood damage reduction. For each of the potential purposes, a non-Federal sponsor needs to be identified.

For most, and maybe all, of the project purposes, the non-Federal sponsor would need to be willing to, at a minimum, share in the cost for the recommended plan and, in some cases, depending on the purpose, agree to share in the O&M of the completed works. In addition to these responsibilities, it is likely that other Federal and non-Federal obligations and requirements would need to be developed and agreed on. These obligations and requirements will be described in the Feasibility Report. A preliminary allocation of costs between the purposes is included in the next section of this chapter.

A non-Federal sponsor has not been officially identified at this stage of the Investigation, but potential non-Federal sponsors include DWR and/or FWUA. Through operational integration, benefits could also accrue to a larger geographic region, including the CVP and SWP SOD service areas. PG&E has expressed interest in operating any new hydropower facilities.

Preliminary Cost Allocation

This section contains proposed approaches and processes for allocating project costs among purposes and between Federal and non-Federal partners, as required by the P&G. A preliminary cost allocation was developed for the Temperance Flat RM 274 Reservoir alternative plan with Friant Division and SWP operations integration, which has the highest benefit-cost ratio based on estimates developed in this PFR. A cost allocation for the recommended plan will be included in the Feasibility Report.

Cost allocations are made for Federal water resources projects to derive an equitable distribution of project costs among authorized project purposes, or those purposes proposed for authorization, in accordance with existing law. The three basic steps associated with cost allocation are (1) identifying costs to be allocated, (2) allocating costs to project purposes; and (3) determining reimbursability. Costs to be allocated in this exercise are annualized construction costs (including field costs and non-contract costs), IDC, O&M costs, and net power costs. It should be noted that cost allocation is a financial analysis rather than an economic evaluation. Consequently, project costs may be presented differently in a cost allocation than in an NED analysis.

Cost Allocation Approach

The preferred method of cost allocation for Federal water projects is known as the Separable Cost - Remaining Benefits (SCRB) approach (WRC, 1983). In this approach, separable costs identified for each purpose are subtracted from the lesser of benefits or single-purpose alternative project costs to derive remaining benefits. Next, joint costs are allocated in proportion to the distribution of remaining benefits. Joint project costs are then assigned to a project purpose based on the proportion of their remaining benefits. Total cost allocated to a purpose is the sum of its separable and apportioned joint costs.

Another method for allocating project costs is the Alternative Justifiable Expenditure (AJE) method. The AJE method is a modified SCRB method used in situations when derivation of the separable costs is not feasible. Cost allocation under the AJE method is the same as under the SCRB method, except that specific costs (i.e., costs for project components that contribute to a single purpose and exclude the costs of a change in project design due to inclusion) replace separable costs. The remaining (joint) costs are apportioned among project purposes based on their remaining benefits. At this stage of the Investigation, single-purpose alternative projects have not been developed and alternative costs have not been determined. As such, a full SCRB analysis cannot be presented and the AJE approach is used for this preliminary cost allocation.

Preliminary Cost Allocation Purposes

As described in Chapter 2, the Investigation planning objectives that guide the formulation of alternatives relate to increasing water supply reliability and system operational flexibility, and enhancing water temperature and flow conditions in the San Joaquin River in support of anadromous fish restoration efforts. Other related opportunities include: improve management of flood flows at Friant Dam; preserve and increase energy generation, and improve energy management in the study area; preserve and increase recreation opportunities in the study area; improve San Joaquin River water quality; and improve the quality of water supplies delivered to urban areas. The objectives and opportunities led to the development of the eight benefit categories for the Investigation described in Chapter 5.

For the preliminary cost allocation, the benefit categories are grouped into five purposes supported by existing legislation. The two primary project purposes for cost allocation are water supply and fish and wildlife enhancement. The agricultural water supply reliability, M&I water supply reliability, M&I water quality, and emergency water supply benefit categories are all associated with the water supply purpose, and the ecosystem benefits related to improvements in water temperature for anadromous fish are associated with the fish and wildlife enhancement purpose. Flood damage reduction, recreation, and hydropower generation are considered secondary purposes.

Cost Apportionment Approach

The cost allocation process is designed so that costs associated with project purposes can be apportioned for repayment. Once costs are allocated to appropriate purposes, they can be apportioned to the Federal government and non-Federal sponsor(s) based on specific project authorization and/or established Federal cost-sharing laws and regulations. Federal costs are designated as either reimbursable or non-reimbursable. Reimbursable costs are those that, through some form of up-front cost sharing, repayment, or other financial agreement, are paid to the Federal government. Non-reimbursable costs are those that can be borne by the Federal government. Based on existing legislation, costs allocated to agricultural and M&I water supply and hydropower purposes are fully reimbursable.

Cost sharing for Federal water resources projects is based on the principle that beneficiaries pay for benefits received. For the Investigation, the general principle for the Federal share of costs is established by Public Law 108-361, Section 107(b):

> (b) Payment for Benefits – The Secretary shall ensure that all beneficiaries, including beneficiaries of environmental restoration and other CALFED program elements, shall pay for the benefit received from all projects or activities carried out under the CALFED Bay-Delta Program.

Assumptions and Results

Specific costs have been identified only for the fish and wildlife enhancement purpose associated with temperature control devices to be installed on Friant Dam and a selective level intake structure on Temperance Flat RM 274 Dam. All other costs are considered joint costs. For hydropower generation, the power feature costs are not considered specific costs because the features are necessary for replacement of affected generation due to inundation of the Kerckhoff Project powerhouses within the alternative footprint. For the alternative selected for cost allocation, there would still be a net loss in generation value, although power operations and features will continue to be refined and may have a net benefit in the Feasibility Report. Since the net loss of generating capacity and cost of power features are associated with the multipurpose project, the costs are considered joint costs. The recreation feature costs are not considered specific costs because the features are associated with replacement of the existing recreation facilities that would be inundated by the alternative. Thus, those costs are also necessary for the multipurpose project.

Table 7-1 provides the results of the cost allocation procedure based on the AJE approach. The annualized capital costs, annual O&M, and annual net decrease in hydropower generation value total $169.4 million. For the purpose of the preliminary cost allocation, hydropower is treated as a cost instead of as a negative benefit. In the rest of the PFR, hydropower is treated as a benefit category. Only the fish and wildlife enhancement purpose has specific costs that can be separated from the remaining costs. The remaining benefits, and the proportion by category, are shown in the table after removing specific costs. The allocated joint costs are calculated based on apportioning these remaining costs. Finally, the allocated costs for each benefit category are the sum of specific costs and allocated joint costs. Based upon this procedure, the largest share of total annual costs of $169.4 million is allocated to M&I water supply reliability, followed by agricultural water supply reliability.

Cost apportionment percentages and related authorities are summarized in Table 7-2 for each of the project purposes and benefit categories within those purposes. This cost apportionment will be revisited in the Feasibility Report, pending further developments with potential non-Federal sponsors. Cost apportionment of project costs between the Federal government and non-Federal sponsors is presented in Table 7-3 for the AJE approach. The apportionment of costs is determined by applying the percentages shown in Table 7-2. As indicated in Table 7-3, a large portion ($136.6 million, or 80.6 percent) of annual project costs is anticipated to be Federal reimbursable.

Table 7-1. Preliminary Cost Allocation for Temperance Flat RM 274 Reservoir Alternative Based on an Alternative Justifiable Expenditure Approach

Purpose	Annual Benefits	Specific Costs	Remaining Benefits[1]	% Distribution of Remaining Benefits	Allocated Joint Costs[2]	Total Allocated Costs[3]	Overall % Cost Allocation
Water Supply	$146.5	$0	$146.5	88.0%	$136.8	$136.8	80.8%
Agricultural Water Supply Reliability	*$50.4*	*$0*	*$50.4*	*30.3%*	*$47.1*	*$47.1*	*27.8%*
M&I Water Supply Reliability	*$74.2*	*$0*	*$74.2*	*44.6%*	*$69.3*	*$69.3*	*40.9%*
Emergency Water Supply	*$14.5*	*$0*	*$14.5*	*8.7%*	*$13.5*	*$13.5*	*8.0%*
M&I Water Quality	*$7.4*	*$0*	*$7.4*	*4.4%*	*$6.9*	*$6.9*	*4.1%*
Fish and Wildlife Enhancement	$24.5	$13.9	$10.6	6.4%	$9.9	$23.8	*14.0%*
Ecosystem (Water Temperature)	*$24.5*	*$13.9*	*$10.6*	*6.4%*	*$9.9*	*$23.8*	*14.0%*
Flood Damage Reduction	$2.1	$0	$2.1	1.3%	$2.0	$2.0	1.2%
Recreation	$7.3	$0	$7.3	4.4%	$6.8	$6.8	4.0%
Hydropower Generation	$0	$0	$0	0.0%	$0	$0	0.0%
Total	**$180.4**	**$13.9**	**$166.5**	**100.0%**	**$155.5**	**$169.4**	**100.0%**

Notes:
General. Cost and benefit information presented is based on annual values.
General. Values may not sum to total due to rounding.
[1] Remaining benefits = Benefits less specific costs, but must be greater than $0.
[2] Total project costs less sum of specific costs, times share of remaining benefits.
[3] Sum of specific costs and allocated joint costs.
Key:
% = percent
M&I = municipal and industrial

Table 7-2. Preliminary Cost Apportionment Authority and Percentage Summary

Purpose	Pertinent Legislation	Federal Reimbursable		Federal Non-Reimbursable		Non-Federal	
		Capital	O&M	Capital	O&M	Capital	O&M
Water Supply	Reclamation Project Act of 1939, as amended						
Agricultural Water Supply Reliability		100%	100%	–	–	–	–
M&I Water Supply Reliability		100%	100%	–	–	–	–
Emergency Water Supply		100%	100%	–	–	–	–
M&I Water Quality[1]		100%	–	–	–	–	100%
Fish and Wildlife Enhancement	Federal Water Project Recreation Act of 1965,as amended by the Water Resources Development Act of 1974						
Ecosystem (Water Temperature)		–	–	75%	75%	25%	25%
Flood Damage Reduction	Reclamation Project Act of 1939, section 9(c)	–	–	100%	100%	–	–
Recreation	Federal Water Project Recreation Act of 1965, as amended by the Reclamation Recreation Management Act	–	–	50%	–	50%	100%
Hydropower Generation	Apportioned similar to M&I water supply	100%	–	–	–	–	100%

Notes:
[1] M&I water quality is considered to be closely tied to water supply reliability, so its capital costs are likewise apportioned. However, since M&I water quality benefits may accrue to non-Federal entities, it is assumed that O&M costs would be non-Federal.

Key:

IDC = interest during construction
O&M = operations and maintenance

Table 7-3. Cost Apportionment for Temperance Flat RM 274 Alternative Based on the Alternative Justifiable Expenditure Approach

Purpose	Total Allocated Costs	Federal – Reimbursable	Federal – Non-Reimbursable	Non-Federal
Water Supply	$136.8	$136.6	$0	$0.2
Agricultural Water Supply Reliability	*$47.1*	*$47.1*	*$0*	*$0*
M&I Water Supply Reliability	*$69.3*	*$67.3*	*$0*	*$0*
Emergency Water Supply	*$13.5*	*$13.5*	*$0*	*$0*
M&I Water Quality	*$6.9*	*$6.7*	*$0*	*$0.2*
Fish and Wildlife Enhancement	$23.8	$0	$17.8	$5.9
Ecosystem (Water Temperature)	*$23.8*	*$0*	*$17.8*	*$5.9*
Flood Damage Reduction	$2.0	$0	$2.0	$0
Recreation	$6.8	$0	$3.3	$3.5
Hydropower Generation	$0	$0	$0	$0
Total Apportioned Costs	**$169.4**	**$136.6**	**$23.1**	**$9.6**

Notes:

General. Cost and benefit information presented is based on annual values.

General. Values may not sum to total due to rounding.

Regulatory and Related Requirements for Environmental Compliance

Construction of a new reservoir in the upper San Joaquin River basin would be subject to the requirements of numerous Federal, State, and local laws, policies, and regulations. Reclamation is the lead agency for NEPA compliance, and DWR is the lead agency for CEQA compliance. Moreover, Reclamation would need to obtain various permits and meet regulatory requirements before beginning any project construction, and comply with a number of environmental regulatory requirements as part of the NEPA and CEQA compliance process. Table 7-4 lists the major requirements for project implementation.

In addition to the major Federal, State, and local environmental requirements listed in Table 7-4, the alternatives considered may be subject to other laws, policies, or plans. Table 7-5 lists many of the other laws, policies, and plans that may potentially affect the development of any alternative.

Table 7-4. List of Regulatory Requirements Potentially Affecting Project Implementation

Agency and Associated Permit Action	Recommended Prerequisites for Submittal[1]	Estimated Processing Time[2]
FEDERAL		
USACE Clean Water Act Section 404 Individual Permit Rivers and Harbors Act Section 10 Permit	• Application • ASIP for submittal to USFWS/NMFS/DFG • Section 401 Water Quality Certification permit or application • NEPA documentation (environmental compliance documents) • Section 106 compliance documentation • Wetland delineation • Section 404 (b)(1) evaluation and identification of the Least Environmentally Damaging Practical Alternative • Mitigation and monitoring plan	24 months
USFWS/NMFS Endangered Species Act Section 7 Consultation	• Informal technical consultation regularly • ASIP • Alternative description	12 months
USFWS Fish and Wildlife Coordination Act Report	• Informal technical consultation regularly • ASIP • Alternative description	12 months
SHPO/ACHP National Historic Preservation Act, Section 106	• Cultural Survey Report • Documentation of consultation with Native American representatives	9 months
STATE		
RWQCB Clean Water Act Section 401 Water Quality Certification	• Application • Fish and Game Code Section 1602 Application • CWA Section 404 permit or application • Draft environmental compliance documents • Mitigation and monitoring plan (if needed)	6 months
RWQCB NPDES General Permit for Storm Water Discharges Associated with Construction Activity (General Permit) Water Quality Order 99-08-DWQ	• Application • SWPPP	3 months
DFG California Endangered Species Act Section 2081: Incidental Take Permit or 2080.1 Consistency Determination	• Informal technical consultation • Application, if requesting a 2081 Incidental Take Permit • Biological opinion and incidental take statement, if requesting a consistency determination (preferred approach)	6 months after Biological Opinion issued
DFG Fish and Game Code Section 1602 Streambed Alteration Agreement	• Application • Section 401 Water Quality Certification permit or application • CWA Section 404 permit or application • Draft environmental compliance documents • Mitigation plan	9 months
The Reclamation Board California Code of Regulations, Title 23: Encroachment Permit	• Application	9 months
SWRCB Amended water right	• Application • Draft (possibly final) environmental compliance documents	12 months
State Lands Commission Land Use Lease	• Application • Draft environmental compliance documents	9 months
LOCAL		
SJVAPCD Dust Control Plan	• Dust Control Plan • Dust Control Training Course • Preapplication meeting (encouraged)	2 months
SJVAPCD Authority to Construct and Permit to Operate	• Application • Preapplication meeting (encouraged)	6 months

Notes:
[1] All permit applications require detailed project description information. Anticipated processing time is estimated based on initial permit applications submittal to permit issuance.
[2] From accepted permit application submittal.

Key:
ACHP = Advisory Council on Historic Preservation
ASIP = Action-Specific Implementation Plan
CWA = Clean Water Act
DFG = California Department of Fish and Game
NEPA = National Environmental Policy Act
NMFS = National Marine Fisheries Service
NPDES = National Pollutant Discharge Elimination System
RWQCB = Regional Water Quality Control Board
SHPO = State Historic Preservation Officer
SJVAPCD = San Joaquin Valley Air Pollution Control District
SWPP = Stormwater Pollution Prevention Plan
SWRCB = State Water Resources Control Board
The Reclamation Board = The Reclamation Board of the State of California
USACE = U.S. Army Corps of Engineers
USFWS = U.S. Fish and Wildlife Service

Table 7-5. List of Applicable Laws, Policies, and Plans Potentially Affecting the Investigation

Level	Laws, Policies, and Plans
Federal	Federal Endangered Species Act
	Magnuson-Stevens Fishery Conservation and Management Act
	1996 Sustainable Fisheries Act
	Section 404 of the Clean Water Act
	Section 401 of the Clean Water Act
	Section 402 of the Clean Water Act-National Pollutant Discharge Elimination System
	Clean Air Act
	National Environmental Policy Act
	Rivers and Harbors Act Section 10
	National Historic Preservation Act, Section 106 (1966)
	Migratory Bird Treaty Act
	Fish and Wildlife Coordination Act
	Executive Order 11990 (Wetlands Policy), Executive Order 11988 (Flood Hazard Policy), Executive Order 12898 (Environmental Justice Policy)
	Indian Trust Assets
	Americans with Disabilities Act (1990)
	Rehabilitation Act
	Farmland Protection Policy Act
	Federal Transit Administration Activities and Programs
	Architectural Barriers Act
	Federal Cave Resources Protection Act (1988)
	Executive Order 11312 (National Invasive Species Management Plan)
	Federal Land Use Policies
	Federal Energy Regulatory Commission Permitting Requirements
	U.S. Army Corps of Engineers – Reservoir Regulation for Flood Control at Friant Dam and Millerton Lake
	U.S. Coast Guard Activities and Programs
	Uniform Relocations Assistance and Real Properties Acquisition Act of 1970, as amended (Public Law 91-646 and Public Law 100-17)
State	California Public Resources Code
	California Endangered Species Act
	California Fish and Game Code – Fully Protected Species
	California Fish and Game Code Section 1602 – Streambed Alteration
	Porter-Cologne Water Quality Control Act
	California Native Plant Society Species Designations
	Reclamation Board Encroachment Permit
	California Water Rights
	State Lands Commission Land Use Lease
	State of California General Plan Guidelines
	California Land Conservation Act of 1965 (Williamson Act)
	California Native Plant Protection Act
Local	San Joaquin Valley Air Pollution Control District Dust Control Plan
	San Joaquin Valley Air Pollution Control District Authority to Construct and Permit to Operate
	Other Local Permits and Requirements

Study Management

The SMT consists of Project Managers from Reclamation, DWR, the consultant team, and members of technical teams, including water operations, environmental resources, economics, engineering, and hydropower. During SMT meetings, each study component is to be adequately represented by the varied backgrounds of team members. Participation in team meetings is subject to the topic discussed, and additional expertise is included, as necessary. The SMT directs work performed by the technical teams, coordinates results into the overall study, and directs public involvement activities.

Public Involvement Plan

The Investigation is addressing issues of interest and concern to stakeholders engaged in local and regional water resources planning and several Federal and State agencies with regulatory and management responsibilities related to natural resources in the study area.

From the inception of the Investigation in late 2001, the Investigation has maintained a very active public and agency involvement program that has included a wide range of activities. A Public Involvement Plan was initiated at the beginning of the Investigation that is designed to provide meaningful opportunities for stakeholder participation and to inform the public. Specifically, the Public Involvement Plan is designed to address issues of interest and concern to stakeholders engaged in local and regional water resources planning. The Public Involvement Plan supports Reclamation's efforts to work with all stakeholders to develop a community consensus alternative. The plan has evolved as the Investigation has continued. The plan provides a system by which the following four objectives are met:

- **Stakeholder Identification** – This effort is ongoing and consists of identifying individuals, groups, and other entities that have an expressed or implied interest in the Investigation. No individual, group, or entity is to be excluded from the process, which includes complying with Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.

- **Project Transparency** – Success of the Investigation relies on project transparency, a practice of providing information and study results to stakeholders and other interested parties in a timely, unbiased fashion. Distributing study information occurs through the media, Web postings, public meetings, stakeholder meetings, public presentations, mailings, and other means.

- **Issues and Concerns Resolution** – Equally important as project transparency is gaining awareness of the issues and concerns of stakeholders, and establishing a mechanism for the Investigation team to learn of problems early. Using various public involvement processes, the Investigation team has addressed, and will continue to address, issues and concerns in an effective and timely manner.

- **Project Implementation** – Critical to developing an implementable project is ensuring that planning objectives are met, and, to the extent possible, that opportunities are also met. In addition, the project would need to address other issues, and not harm the environment, people, or people's property. Accordingly, one goal of the plan has been to build a communication network in which policy-makers understand the objectives and benefits of the project, and can conclude for themselves that the project has met all requirements necessary to be implemented. Ensuring policy-makers receive the necessary information to make this informed decision is an important component of the plan.

The Public Involvement Plan maintains two primary themes: outreach and information. Associated with these themes are procedures that enable the overall Investigation to satisfy the public involvement requirements of NEPA and CEQA for development of an EIS/EIR.

The interactive components of the Public Involvement Plan focus on ensuring that stakeholders and the public have the opportunity to effectively participate in the development of the Investigation. Stakeholders in the Investigation study area bring a high level of experience and local knowledge to the process, and provide a variety of recommendations, responses, and reviews that likewise inform the plan formulation process. Outreach components are designed to provide information and materials to a broad group of interested parties. The outreach components disseminate information widely, bring additional stakeholders and interested parties to the process, and enhance coordination with related water resources planning and management groups.

Information Dissemination

To ensure project transparency and to keep stakeholders and the public informed, study-related information has been, and will be, disseminated in a number of ways. Information dissemination methods include the following:

- **Investigation Newsletters** – Investigation updates have been developed, and more are planned. The timing of notices to date has coincided with major study milestones. The Investigation newsletters provide stakeholders with "snapshots" about the feasibility study and alert them to major upcoming events. The most recent Investigation update was completed in November 2007 (Reclamation, 2007b).

- **Website** – An Investigation Website, hosted by Reclamation, contains technical documents prepared for the Investigation to date, presentations used at public workshops and meetings, the Phase 1 Investigation Report, (Reclamation, 2003), the IAIR (Reclamation, 2005), the PFR, contact information for the Reclamation Project Manager, other related documents, and a gateway for contacting the Investigation team. The Website has been a key feature in outreach efforts and will continue to be used as the Investigation proceeds. The address of the Website is http://www.usbr.gov/mp/sccao/storage.

- **Media Relations** – Media relations for the study have included news releases, media advisories, calendar activities, and editorial board visits. The media relations effort is flexible to ensure prompt responses to comments, questions, or information regarding the Investigation.

Outreach

Since the beginning of the study, Investigation team members have provided periodic updates through the following:

- Structured series of interactive public meetings and workshops
- Briefings for governmental and nongovernmental agencies and coalitions
- Briefings for tribal representatives
- Coordination with local water resources planning and management groups
- Coordination with agencies
- Interviews with water management agency representatives
- Tours of Millerton Lake and portions of the upper San Joaquin River
- Distribution of informative brochures, fact sheets, and documents that provided background and updates on the Investigation's progress
- Distribution of Investigation documents via a Website

Agency Involvement

During Phase 1, the involvement of Federal, State, and regional agencies and Native American tribes in the Investigation was considered informal. Agency representatives attended numerous public meetings and stakeholder workshops, and participated in tours. Informal briefings were organized for Native American tribes. Following initiation of the NEPA/CEQA compliance process, a more formalized approach to agency coordination and participation was established through cooperating agency technical teams.

Cooperating Agency Technical Teams

Several cooperating agency technical teams were formed to focus on specific technical issues of importance in the Investigation. Reclamation prepared agreements that identify roles, responsibilities, and technical team assignments for each cooperating agency. Cooperating agency technical teams were formed to address water supply operations, reservoir area environmental resources, river restoration, hydropower, flood damage reduction, engineering, economics, and conjunctive management. Cooperating agencies are listed in Table 7-6.

Table 7-6. Technical Team Cooperating Agencies

Federal	State	Local/Other
U.S. Department of the Interior, Bureau of Land Management	California Department of Fish and Game	Central Valley Regional Water Quality Control Board
U.S. Department of the Interior, Bureau of Indian Affairs	California Department of Parks and Recreation	Friant Water Users Authority
U.S. Fish and Wildlife Service	State Water Resources Control Board	San Joaquin River Exchange Contractors Water Authority
U.S. Army Corps of Engineers		San Luis and Delta-Mendota Water Authority
National Marine Fisheries Service		Western Area Power Administration
Federal Environmental Protection Agency		

Coordination with Native American Representatives

Several tribes in the vicinity of Millerton Lake and elsewhere in the study area have expressed interest in the Investigation. Investigation representatives have met regularly with Native American tribal representatives to provide updates on Investigation progress and to receive input on issues of concern to the tribes. In general, tribal briefings coincide with public meetings at key Investigation milestones. As the Investigation proceeds, coordination will continue with the tribes in accordance with Federal guidance.

Public Meetings and Stakeholder Workshops

Substantial efforts have been made to date to communicate with stakeholders and the public about the Investigation. During Phase 1, a structured series of workshops and meetings were held at which participants had opportunities to hear presentations by the study team, take part in discussions regarding preliminary plan formulation, and provide input about the planning process, analyses, and project documents. This process included six general workshops and one topic-oriented working session. Workshop participants included representatives of water agencies, counties, Federal and State agencies, water districts, environmental interest groups, and others with an interest in the Investigation. The workshops, which were held in a variety of locations within the study area, and were announced via e-mail, mailed postcards, and the project Web site, were well attended. Each workshop included multiple interactive segments during which participants expressed their concerns, asked questions, and discussed issues central to the Investigation.

Since Phase 1, the Investigation team has conducted three public meetings to provide participants with updates on progress of the Investigation. Public meetings and workshops have had, and will continue to play, a major role in the overall study process. Future public meetings and workshops will be scheduled at important points in the Investigation.

Public Scoping

Scoping allows agencies, stakeholders, and interested parties the opportunity to identify or suggest resources to be evaluated, issues that may require environmental review, reasonable alternatives to consider, and potential mitigation if substantial adverse effects of a planned action are identified.

An environmental compliance process consistent with NEPA and CEQA was initiated in February 2004 when Reclamation issued an NOI and DWR issued an NOP. During the week of March 15, 2004, Reclamation and DWR convened a set of public scoping meetings in Sacramento, Modesto, Friant, and Visalia, California, to inform interested groups and individuals about the Investigation and to solicit ideas and comments.

The environmental scoping process allows stakeholders and interested parties to suggest potential issues that may require environmental review, reasonable alternatives to consider, and potential mitigation strategies to reduce or avoid substantial adverse environmental impacts. Scoping also allows lead agencies to clearly set the parameters of the environmental compliance process by determining which issues will or will not be addressed, and rationale for those determinations. In addition, scoping provides decision-makers with insight on the analyses that the public believes should be considered as part of the decision-making process.

An Environmental Scoping Report was prepared consistent with Reclamation guidance and in compliance with NEPA requirements, and released in December 2004 (Reclamation, 2004b). The report describes the scoping process, comments received during scoping, and how these comments would be addressed as part of the Investigation. Input received through stakeholder/public outreach has been, and will continue to be, incorporated into the development of the Investigation.

Study Area Tours

From the onset of the Investigation, staff members have participated in several tours of Millerton Lake, the upper San Joaquin River, and the Friant Division service area. With the exception of two tours of Millerton Lake that were organized by the Investigation, all other events were organized by other groups with an interest in regional water resources issues. During each tour, Investigation staff provided updates on Investigation status and recent technical findings. The tours provided interested parties a firsthand view of several of the surface storage sites under consideration, the San Joaquin River, and other features of interest in the eastern San Joaquin Valley. As the Investigation proceeds, staff will continue to participate in regional events that address water and other natural resources management issues to the extent possible.

Interviews with Local Stakeholders

As part of the approach to identify and evaluate conjunctive management opportunities that have the potential to support Investigation purposes, DWR staff conducted one-on-one interviews with local stakeholders regarding regional, cooperative opportunities for groundwater storage and banking. These interviews identified a high level of interest among the stakeholders. During the interviews, some possible projects were identified that could be considered for their applicability to support Investigation objectives and opportunities. In addition, many stakeholders made note of important physical and legal constraints that could affect implementation of conjunctive management options and suggested programmatic concepts to address institutional and financial barriers to increasing conjunctive management.

Future Public Involvement Opportunities

Continued public and stakeholder involvement will be a critical component during the final phase of the Investigation, which will culminate with release of the Final Feasibility Report and its accompanying EIS/EIR. All activities will be geared to continued compliance with NEPA, Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), and the President's April 29, 1994, memorandum regarding the engagement of federally recognized tribal governments.

The SMT plans to continue outreach activities through distribution of informational materials to interested parties, and coordination of public and stakeholder briefings, meetings and workshops, and media relations. Listed below is a brief overview of planned future outreach activities:

- Public open houses and workshops to review the PFR and collect comments from the public and other interested parties
- Briefings for Federal and State elected officials
- Workshops and one-on-one briefings with CVP and SWP contractors
- Coordination with federally and non-federally recognized Native American tribes
- Coordination with potentially affected power interests

Distribution of informational materials to support various stages of the Investigation

Chapter 8
Findings and Future Actions

This chapter summarizes major findings regarding storage site selection, Federal and State interest, and uncertainties and refinements. Future actions and the schedule for the Investigation are also summarized in this chapter.

Storage Site Selection

The Temperance Flat RM 274 Reservoir grouping of alternative plans is retained for further evaluation in the feasibility phase of the Investigation, and the Temperance Flat RM 279 Reservoir grouping of alternative plans will not be retained for further evaluation for the following major reasons:

- Temperance Flat RM 274 Reservoir alternative plans have greater benefits, greater net benefits, and a higher benefit-cost ratio compared to the Temperance Flat RM 279 Reservoir alternative plans.
- Most of the Temperance Flat RM 274 Reservoir alternative plans provide positive net benefits, but Temperance Flat RM 279 Reservoir alternative plans do not provide positive net benefits.
- Temperance Flat RM 274 Reservoir alternative plans address the planning objectives of enhancing water temperature and flow conditions in the San Joaquin River, and increasing water supply reliability and operational flexibility to a greater degree than Temperance Flat RM 279 Reservoir alternative plans.
- Based on comparing the alternative plans according to the four P&G criteria, Temperance Flat RM 274 Reservoir alternative plans ranked higher than Temperance Flat RM 279 Reservoir alternative plans.

The Trans Valley Canal will also not be retained for further evaluation in the feasibility phase of the Investigation. The ranking of alternative plans and benefit-cost ratios are not substantially affected by including the Trans Valley Canal with the Temperance Flat reservoirs, and the canal is not needed to achieve a positive benefit-cost ratio. The Trans Valley Canal is a potentially beneficial increment that could be added to an alternative at a later time.

Federal and State Interest

This PFR concludes there is a Federal and State interest to continue the Investigation to determine the feasibility of a potential project in the Upper San Joaquin River Basin to meet objectives associated with M&I, agricultural, and environmental water supply reliability; anadromous fish survival; power; incremental flood damage reduction; and recreation. The degree and magnitude of the Federal and State interest in a potential project will be refined and quantified in the Feasibility Report, EIS/EIR, and supporting documentation.

Alternative plans have been identified that result in positive net NED benefits and significant positive regional economic effects. To date, there has been strong interest at the local, regional, State, and Federal levels in a potential project to address the identified planning objectives and opportunities. Much support has been expressed by CVP Friant Division contractors, and other statewide water supply and political interests.

The next major steps in the Investigation will be to refine and evaluate alternative plans for further consideration in the Draft and Final Feasibility Report and EIS/EIR. The following sections describe various uncertainties associated with the Investigation, and likely refinements to alternative plans.

Uncertainties

Further definition and resolution of concerns and uncertainties will be a substantial effort in upcoming studies for the Investigation. Certain assumptions were made for aspects of this report based on engineering and scientific judgment. Various uncertainties associated with the Investigation are discussed below. Uncertainties will be addressed further in the feasibility phase of the Investigation, to the extent practicable, as evaluations are refined.

Hydrology and Climate Change

The potential for climate change poses a major hydrologic uncertainty, which could possibly produce conditions that are different from those for which current water management operations were designed. The potential for, and magnitude of, climate change is widely debated. Climate change could cause warmer winters with less snow and more rain, resulting in more late winter and early spring runoff but less late spring and early summer runoff. This change in precipitation timing, frequency, and magnitude may require changes in reservoir operation and evacuation of storage to maintain the flood storage space. Less summer moisture available for crops would increase the need for more irrigation water during the growing season, and additional water deliveries may be required to support agriculture. Climate change is also expected to raise sea levels, which would increase Bay-Delta vulnerability to sea water intrusion, impact water quality and deliveries, and increase levee failure and flooding risk.

The State is investing substantial resources in studying how global climate changes could affect the way California receives and stores water. Results indicate that climate changes in the State could affect hydrology, water temperatures for fish, and future operations for both flood damage reduction and water supply deliveries. The effects of climate change on the Investigation will be considered in the feasibility phase as data sets for climate change sensitivity analyses become available.

System Operations

Water operations modeling performed for this PFR was completed assuming that current system facilities and operational constraints would not change for the without-project conditions. Federal planning guidance was used to make assumptions about which future projects and plans may or may not be implemented; and correspondingly included or excluded from these models and evaluations. Assumptions made for the PFR evaluations may change during feasibility evaluations, and may affect the findings. The most up-to-date information and assumptions is used for the operations modeling at each phase of the Investigation.

Some key areas of uncertainty potentially affecting operational analyses for the Investigation include implementation of the SJRRP on the operations of Friant Dam and the San Joaquin River, and changes in Delta export regulations or policies resulting from the pending OCAP biological opinions, new ESA listings, or recommendations from various planning processes for the Delta, including the Delta Vision and the BDCP.

As uncertainties regarding some of these plans and policies are resolved, operational assumptions will be refined, which may change the basis of comparison for or magnitude of the accomplishments of the alternative plans. The timing for potential resolution of any of these uncertainties relative to the Investigation schedule is unknown. It is expected that OCAP consultations will be completed by spring 2009. For the SJRRP, Congressional action is required to authorize Federal participation in the Settlement and to appropriate funds to support implementation goals. According to the schedule provided in the Settlement, full Restoration Flows will begin in 2014, and river facility construction will be completed by 2016. A program of Interim Flows will commence no later than October 1, 2009, and continue until full Restoration Flows begin. Details regarding the Water Management Goal are being developed and are not available at this time. The Investigation will make refinements to relevant planning assumptions as new information becomes available during the feasibility phase.

Cost Estimates

Cost estimates developed for alternative plans included in this report are based on September 2006 price levels. Varying uncertainties are associated with the material and unit costs used to develop the estimates, including the price of construction materials, the proximity of materials to the project site, and labor costs. Trends from the past few years were used to try to reliably estimate the cost of materials, but outside factors could further influence price changes. Cost estimates will be reevaluated and updated in the feasibility phase.

Alternatives Refinements

Plan formulation is an iterative process with the intent to lead to identification of a recommended plan for Federal and/or State consideration. As mentioned, the alternative plans described in this report are likely to evolve as the Investigation progresses toward completion. In addition to some of the other areas of uncertainty described herein, potential adjustments in the alternatives could result from assumptions and estimates concerning project scope, magnitude of accomplishments and benefits, environmental impacts, types and extent of potential mitigation, necessary physical features, and external projects and programs. This iterative process is important in refining alternatives to ensure that the plan ultimately chosen as the recommended plan best addresses the planning objectives and Federal and/or State criteria.

Future Actions

As described above, further refinement and evaluation of the alternative plans addressed in this PFR will be completed during the feasibility phase of the Investigation and documented in the Draft and Final Feasibility Report and EIS/EIR. As the Investigation progresses, Temperance Flat RM 274 Reservoir (1,260 TAF) alternative plans will likely evolve as technical studies are refined and additional information related to potential benefits, impacts, and estimated costs is obtained, developed, and evaluated. Further, additional environmental analyses will be completed, which will inform the nature of potential mitigation and/or enhancement measures included in this grouping of alternative plans. Additional comparisons will be conducted for the alternative plans during the feasibility study and included in the Draft and Final Feasibility Report and accompanying EIS/EIR. The comparisons in the next phase of the Investigation will provide the basis for selection of a recommended plan. At that time, implementation responsibilities and an allocation of estimated costs will be developed and identified for the Recommended Plan.

All of the alternative plans would require some portion of their estimated costs to be reimbursed by the non-Federal sponsor(s). The magnitude of estimated cost assigned to each potential project purpose would vary depending on the plan ultimately chosen for implementation. Accordingly, an important focus in upcoming studies would not only be placed on defining a recommended plan, but also on refining project participation, including reimbursement requirements.

Many of these issues or concerns will become better defined and more appropriate for resolution once the alternative plans, and later the recommended plan, are defined. Additional and important related future actions include the following:

- Completing environmental studies, including a detailed comparison of the environmental impacts of the alternative plans with the No-Action/No-Project Alternative for NEPA and CEQA, process documentation, agency coordination, and consultation.

- Completing identification of potential effects (adverse and beneficial) and mitigation features of the alternative plans.

- Developing detailed designs, cost estimates, potential benefits, and cost allocation, and defining the rationale for, and selection of, a Recommended Plan.

- Identifying a non-Federal cost share partner.

- Determining financial feasibility through ability-to-pay analyses of Federal and non-Federal project partners.

- Preparing and completing a Federal decision document that will incorporate the NEPA and CEQA compliance documentation by reference.

Schedule and Status of the Feasibility Study

Table 8-1 summarizes major activities that either have occurred, or are planned to occur, as a part of the feasibility study. A Draft Feasibility Report and EIS/EIR are currently scheduled for release to the public for review in late 2009. A schedule of major actions to complete the feasibility study and future milestones leading to project implementation are shown in Figure 8-1. The Final Feasibility Report and EIS/EIR are scheduled for Washington-level review through Reclamation in 2010.

Table 8-1. Time Line and Status of Feasibility Study

Activity	Description	Date
Federal authorization	Federal authorization for the Investigation was initially provided in Public Law 108-7, Division D, Title II, Section 215, the omnibus appropriations legislation for fiscal year 2003, enacted in February 2003. This act authorized the Secretary of the Interior to conduct feasibility studies for several storage projects identified in the CALFED ROD (2000a), including the Investigation. Subsequent authorization for the Investigation was provided in Public Law 108 361, Title I, Section 103, Subsection (d)(1)(A)(ii), the Water Supply, Reliability, and Environmental Improvement Act, signed October 25, 2004.	Authorization February 2003, subsequent authorization October 2004
Phase I Investigation	Evaluated 17 possible reservoir sites in the eastern San Joaquin Valley and selected 6 for continued study, as documented in the Phase I report.	Report issued October 2003
Formal initiation of environmental compliance processes (NOI/NOP)	Formal initiation of environmental compliance processes began with the NOI/NOP, consistent with Federal and State regulations.	February 2004
Public Scoping	Results of the public scoping process were documented in the Scoping Report. This document reports the results of a series of public scoping meetings held throughout California for the Investigation.	Report issued December 2004
Initial Alternatives Information Report	The six reservoir sites retained from Phase 1 were evaluated, and other reservoir storage sites added in response to comments received during public scoping, and identified potential groundwater storage measures, as documented in the Initial Alternatives Information Report (IAIR).	Report issued June 2005
Plan Formulation Report	This report outlines the formulation, comparison, and evaluation of comprehensive alternative plans that address Investigation planning objectives and opportunities.	Report issued October 2008
Draft Feasibility Report	The Draft Feasibility Report will be a Federal decision document that describes the study process, major results, potential recommended plan, Federal/non-Federal responsibilities and sponsorship, and future actions.	Scheduled for 2009
Draft EIS/EIR	The Draft EIS/EIR will provide environmental compliance documentation consistent with NEPA and CEQA for the alternatives presented in the Draft Feasibility Report, which will be incorporated by reference.	Scheduled for 2009
Final Feasibility Report	Following agency review, the Final Feasibility Report will incorporate revisions based on comments made on the draft report, and include a plan for recommended implementation.	Release for public review scheduled for mid-2010
Final EIS/EIR	Following public and agency review, the Final EIS/EIR will incorporate responses to comments made on the Draft EIS/EIR.	Release for public review scheduled for mid-2010
Washington D.C.-level review	Following additional public review, the Final Feasibility Report and accompanying EIS/EIR will be released by Reclamation staff in Washington, D.C., for State and agency review and processing.	Scheduled for mid-2010
Record of Decision	Following responses to comments from public review, Reclamation staff will issue a ROD for the Investigation and release to Congress for action.	Scheduled for late 2010
Congressional Authorization	Congress will review, and vote on whether to authorize, the project. Authorization would be included in a Conference Report, which would be sent to the President for final approval.	After project recommendation and ROD

Key:
CALFED = CALFED Bay-Delta Program
CEQA = California Environmental Quality Act
EIR = Environmental Impact Report
EIS = Environmental Impact Statement
Investigation = Upper San Joaquin River Basin Storage Investigation
NEPA = National Environmental Policy Act
NOI/NOP = Notice of Intent/Notice of Preparation
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
ROD = Record of Decision
State = State of California

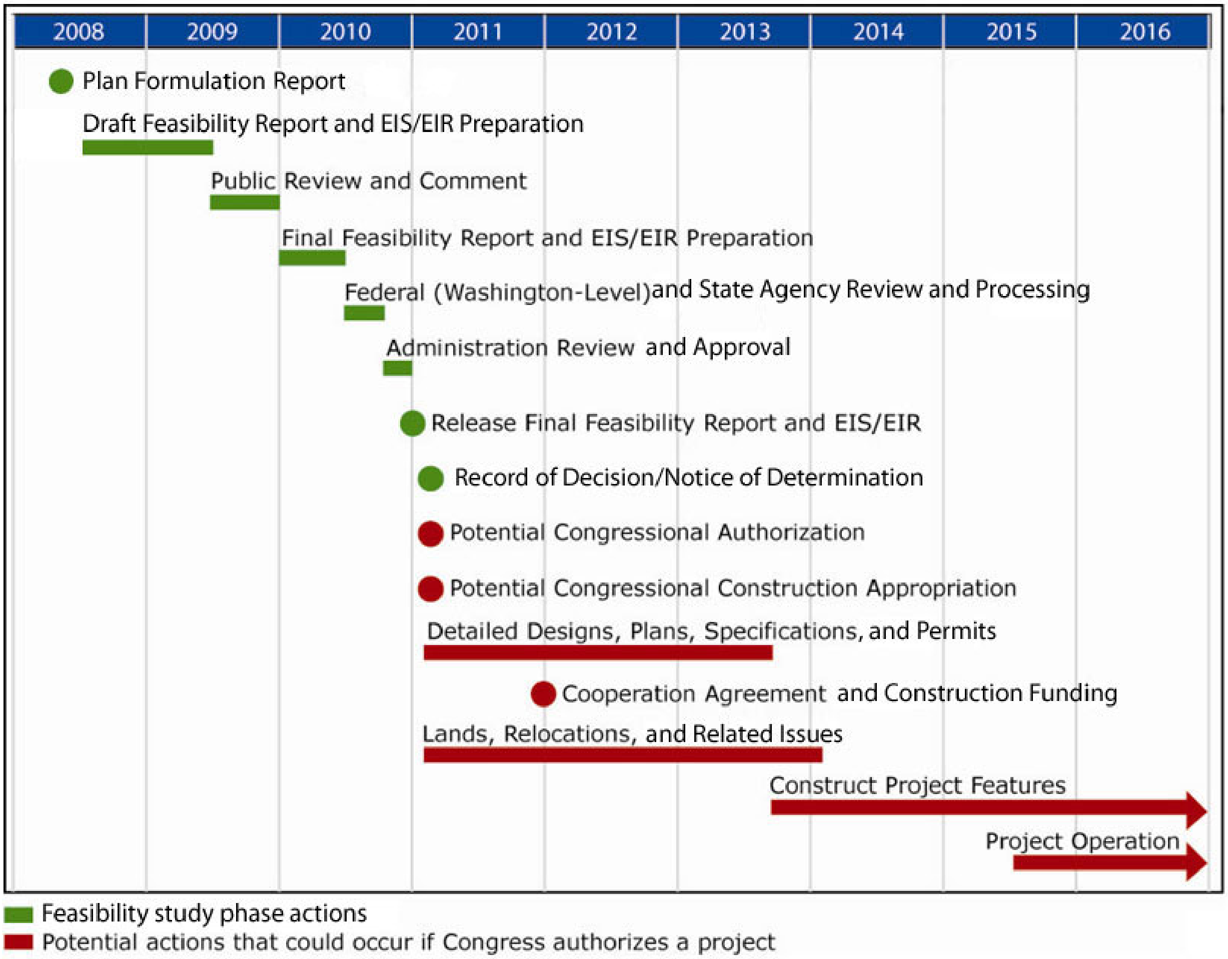

Figure 8-1. Upper San Joaquin River Basin Storage Investigation Schedule

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Chapter 9
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