Chapter 4 Upper San Joaquin River Basin Storage Investigation

This section describes the initial phases of the feasibility study of potential storage projects in the upper San Joaquin River watershed to expand water storage capacity; improve water supply reliability and operational 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. This section also summarizes new information for the Upper San Joaquin River Basin Storage Investigation (USJRBSI) (See Box 4-1 for a list of acronyms and abbreviations used in this section) reflecting recent water management changes including the 2008 US Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) Biological Opinions (BO) and how new surface storage in the upper San Joaquin River watershed could be coordinated with other water resource management activities (e.g., new project baselines and new conveyance in the Sacramento-San Joaquin Delta [Delta]).

Study Area

The primary study area (Figure 4-1) 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 activities, including the footprint of reservoir alternatives and related facilities upstream from Friant Dam. Friant Dam and Millerton Lake are on the San Joaquin River about 20 miles northeast of Fresno. Millerton Lake has a total storage capacity of approximately 520 thousand acre-feet (TAF), an active storage capacity of approximately 390 TAF, and an average annual inflow of approximately 1.8 million acre-feet (MAF). Friant Dam diverts much of the water from the San Joaquin River to the eastern portions of the San Joaquin and Tulare Lake hydrologic regions, from Chowchilla in the north to Bakersfield in the south.

The extended study area 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 Delta, lands with San Joaquin River water rights, and water service areas in the Friant Division and south-of-Delta (SOD) Central Valley Project (CVP) and State Water Project (SWP).

Project Objectives

Major water and related resources problems and needs for the USJRBSI pertain to water supply reliability and the San Joaquin River ecosystem. Opportunities also have been identified during the investigation, as described below. The problems, needs, and opportunities in the primary and extended study areas served as the basis for the planning objectives. This section briefly summarizes the problems, needs, and opportunities for the USJRBSI and presents planning objectives.

Water Supply Reliability

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.

Box 4-1. Chapter 4 Acronym and Abbreviation List

BO	Biological Opinion
CALFED	Bay-Delta Program
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
DWR	Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
IAIR	Initial Alternatives Information Report
M&I	municipal and industrial
MAF	million acre-feet
msl	mean sea level
MW	megawatt
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRDC	Natural Resources Defense Council
PFR	Plan Formulation Report
Reclamation	United States Bureau of Reclamation
RM	River Mile
Settlement	Stipulation of Settlement
SJRRP	San Joaquin River Restoration Program
SLIS	selective level intake structure
SOD	south-of-Delta
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
USFWS	United States Fish and Wildlife Service
USJRBSI	Upper San Joaquin River Basin Storage Investigation
WRC	Water Resources Council

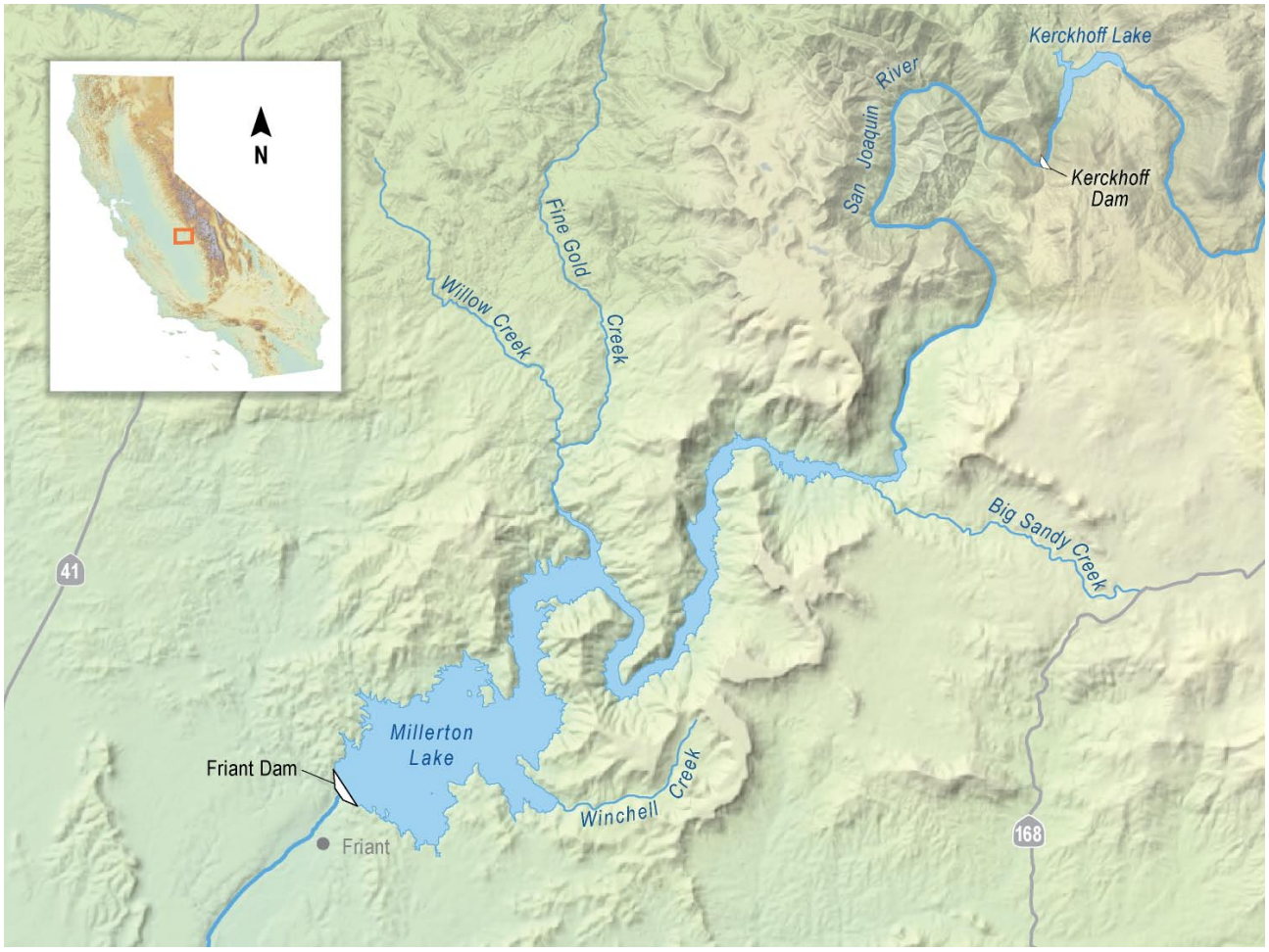

Figure 4-1. USJRBSI Primary Study Area

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 approximately 200 TAF per year, or approximately 15% to 19% of deliveries under pre-Settlement conditions. The Water Management Goal of the Settlement is to reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim and Restoration flows provided for in the Settlement. USJRBSI storage alternatives are not associated with the Water Management Goal.

In the 1990s, protective actions, including the Central Valley Project Improvement Act and the *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (SWRCB, 1995), reduced the ability of the SWP and CVP to contribute to statewide water supply reliability. The

CALFED Bay-Delta Program (CALFED) estimated that these two protective actions reduced water contract deliveries by more than 1 MAF annually during dry periods. More recently, the 2008/2009 BOs for delta smelt and salmon further reduced the annual delivery capability of the SWP and CVP.

San Joaquin River Ecosystem

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 USJRBSI. 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/flexible 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 Record of Decision, the following planning objectives for the USJRBSI were developed:

Primary Planning Objectives

- 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)

Secondary Planning Objectives

- Improve management of flood flows at Friant Dam
- Provide flexible generation allowing for the integration of renewable generation into the electric grid, preservation of energy generation, and improved energy management
- 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

Project Formulation and Initial Alternatives

The first interim planning document, the Phase 1 Investigation Report, completed in October 2003 (Reclamation and DWR, 2003), identified and addressed 17 possible reservoir sites in the eastern San

Joaquin Valley and selected 6 for continued study. Nearly all six retained sites are located in the upper San Joaquin River basin. In February 2004, formal initiation of environmental compliance processes began, in accordance with federal and 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, 2005a). 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 three reservoir sites as well as enlargement of Millerton Lake in combination with one of the three reservoir sites that, when combined with various reservoir sizes, facilities, and sets of operating rules and environmental measures, constitute initial alternatives.

The Plan Formulation Report (PFR) provided detailed evaluation of the initial alternatives retained from the IAIR (Reclamation, 2008b). For each initial alternative plan, 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. Surface storage locations and reservoir sizes were evaluated in a two-step process. The first step evaluation was based on technical evaluations performed during initial plan formulation for incremental cost effectiveness at a range of potential sizes. The second step evaluation was based on the relative ability of the surface water storage alternatives to meet each of the four criteria, effectiveness, efficiency, acceptability, and completeness, from the federal planning guide *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC, 1983).

Based on this two step analysis, a 1,260 TAF reservoir at Temperance Flat at River Mile (RM) 274 and a 690 TAF reservoir at Temperance Flat at RM 279 were retained for further evaluation in the PFR. Additionally, measures to increase transvalley conveyance capacity were added to some of the alternative plans.

Four action alternative plans, in addition to the No-Action/No-Project Alternative, were addressed in detail in the PFR, including the two reservoir sites for Temperance Flat Reservoir (RM 274 and RM 279) and potential transvalley conveyance to facilitate exchanges between the Friant Division and the South-of-Delta CVP and SWP system:

- **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, and would provide about 1,260 TAF of additional storage.
- **Temperance Flat RM 274 Reservoir and Increased Transvalley Conveyance Capacity –** This grouping of alternative plans included Temperance Flat RM 274 Reservoir with an increased transvalley conveyance capacity through construction of additional conveyance facilities.

- **Temperance Flat RM 279 Reservoir –** Temperance Flat RM 279 Reservoir would be formed by a dam in the upstream portion of Millerton Lake at RM 279, and would provide about 690 TAF of additional storage.
- **Temperance Flat RM 279 Reservoir and Increased Transvalley Conveyance Capacity –** This grouping of alternative plans included Temperance Flat RM 279 Reservoir with an increased transvalley conveyance capacity through construction of additional conveyance facilities.

All action alternative plans included water temperature management measures on the main dam and temperature control devices on Friant Dam. The alternative plans also included features to mitigate the loss of generation from the Kerckhoff Project powerhouses. The action alternative plans were evaluated under several distinct operations scenarios, which varied according to the extent of operations integration, available existing transvalley conveyance, and reservoir balancing. The primary operational focus was increasing water supply reliability and enhancing water temperature conditions in the San Joaquin River.

The No Action/No Project Alternative and the four alternatives plans, including various operational strategies, were evaluated to determine their accomplishment of project objectives, project benefits, and project costs. Estimates for benefits and costs used in the PFR were preliminary and subject to further refinement, but were considered sufficient to compare projects and alternative plans. Based on the analysis of accomplishments, benefits, and costs and comparison of alternative plans using the four federal evaluation criteria, the Temperance Flat RM 274 grouping of alternative plans was selected for further evaluation in the Feasibility Report and Environmental Impact Statement (EIS)/Environmental Impact Report (EIR).

As with all the surface storage studies, alternative analysis and evaluation is an iterative process and as conditions change and new information becomes available previously screened or new measures and alternative plans may be developed and evaluated during the remainder of the feasibility investigation.

Example Temperance Flat RM 274 Reservoir Project Formulation Features and Costs

This section summarizes potential project features and costs for an example Temperance Flat RM 274 reservoir project formulation. The example project formulation is most similar to the Temperance Flat RM 274 alternative plan selected in the PFR for further study in the feasibility report and EIS/EIR. Facilities and costs are generally the same. However, operations have been modified to account for new regulations in the Delta.

Example Temperance Flat RM 274 Reservoir Project Formulation Project Features

Temperance Flat RM 274 Reservoir would be created through constructing a dam in the upstream portion of Millerton Lake at RM 274 (Figure 4-2). The Temperance Flat RM 274 Dam site is approximately 6.8 miles upstream from Friant Dam. Permanent features would include a main dam with an uncontrolled spillway to pass flood flows (no saddle das are required), 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 4-2. Temperance Flat RM 274 Reservoir Project Location

Annual unimpaired runoff at Friant Dam from the upper San Joaquin River basin ranges from about 360 TAF to 4,600 TAF, with an average of 1,800 TAF (water years 1901-2007). Millerton Lake, at approximately 520 TAF in volume, is often undersized to adequately manage annual inflows, underscoring the need for additional storage. For example, between 1975 and 2007 flood control releases from Friant Dam total approximately 14 MAF, and flood releases were made in about two-thirds of the years.

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. 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.

Additional potential project features include:

- **Measures for water temperature management –** Potential water temperature management measures include a selective level intake structure (SLIS) on the main dam. A multiple-port SLIS could be constructed 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.
- **Measures to increase or maintain hydropower generation –** Temperance Flat RM 274 Reservoir would inundate the Pacific Gas and Electric Kerckhoff and Kerckhoff No. 2 powerhouses. 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. These power features are subject to change as the feasibility study progresses. Although not included in the example project formulation, flexible generation attributes of the Temperance Flat RM274 Reservoir facilities will be studied, which could be more valuable than the energy lost (especially any nighttime generation) at the Kerckhoff Project powerhouses.

Major project features of this example project formulation are illustrated in Figure 4-3 and listed below in Table 4-1.

Example Temperance Flat RM 274 Reservoir Project Formulation Potential Project Costs

As formulated in the PFR, the estimated capital cost for a new surface storage project at Temperance Flat RM 274 is approximately $3.36 billion dollars (presented in 2006 dollars) (Reclamation, 2008b). The investment cost includes construction costs ($2.9 billion) and interest during construction ($0.46 billion). Project costs are an appraisal-level cost estimate and are subject to change as the feasibility study progresses.

Example Temperance Flat RM 274 Reservoir Project Formulation Operations

As described in the PFR, a Temperance Flat RM 274 Reservoir could be operated under a variety of scenarios that could provide potential benefits for different purposes. Several operational scenarios were formulated and evaluated to assess the sensitivity of accomplishments for Temperance Flat RM 274 Reservoir to varying operational strategies and assumptions.

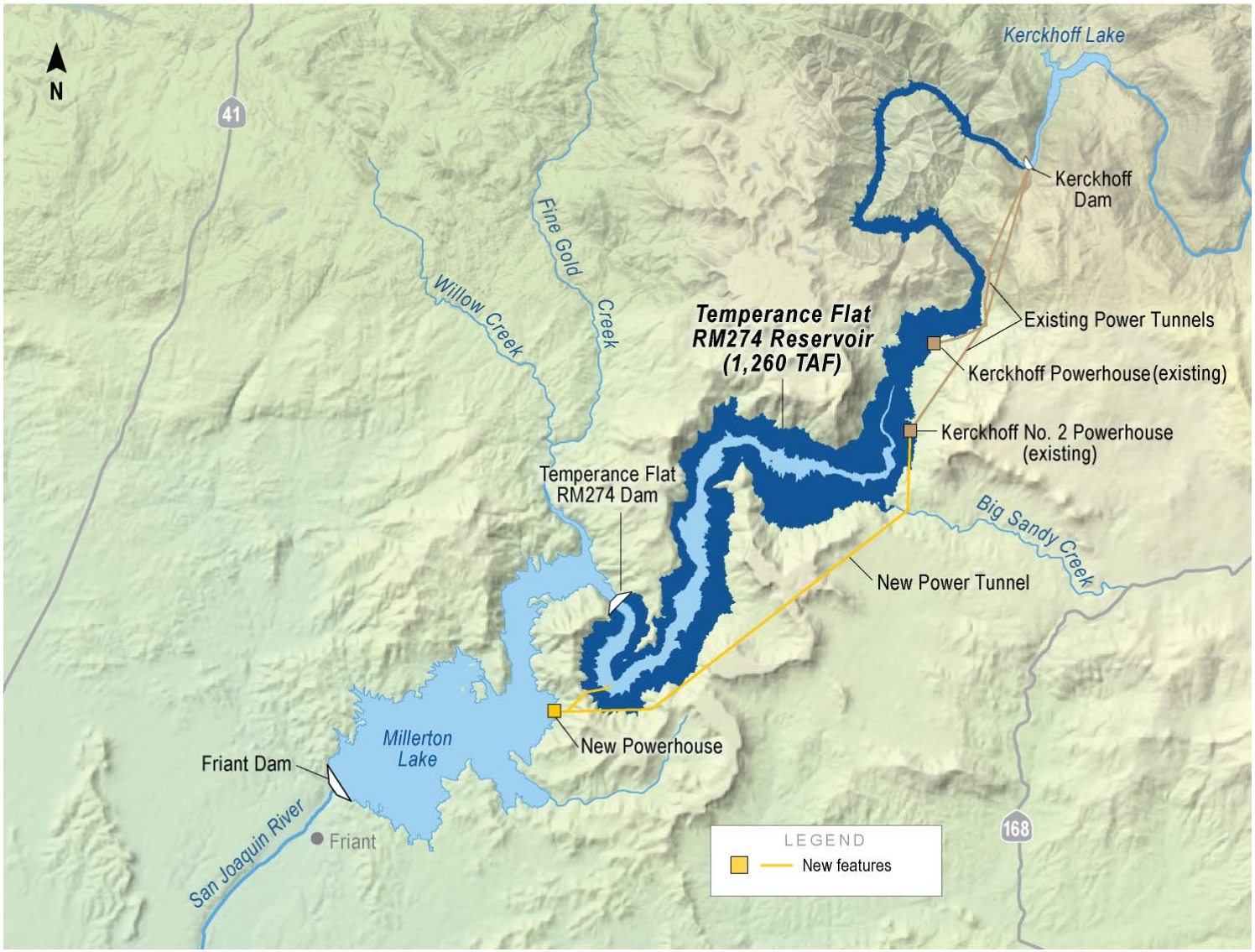

Figure 4-3. Temperance Flat RM 274 Reservoir Inundation Area and Major Project Features

Table 4-1. Summary of the Example Temperance Flat RM 274 Reservoir Project Features

Temperance Flat Reservoir	Gross Capacity - 1,330 TAF Net Capacity (Gross Capacity – Millerton Lake Overlap) - 1,260 TAF Maximum Elevation at Top of Active Storage – 985 feet msl Minimum Operating Elevation – 570 feet msl Surface Area at Top of Active Storage – 5,700 acres
Temperance Flat Dam	Location – San Joaquin River Mile 274 Straight Roller-Compacted Concrete Gravity Dam Maximum Height – 665 feet Crest Length – 2,560 feet Volume – 5.1 Million Cubic Yards
Spillway	Location – Center Section of Temperance Flat Dam Type – Uncontrolled Ogee Width – 665 feet Capacity – 129,182 cfs
Selective Level Intake Structure	Location – Left Bank, 7,200 feet Upstream From Dam Dimensions – Inclined 800 foot long reinforced concrete structure Normal Operating Range - up to 10,000 cfs Maximum Intake Capacity - 20,000 cfs Number of Ports – 4
Outlet Works	Feature Items and Location – Diversion Tunnel Converted to Outlet Tunnel; Valvehouse Located at Downstream End of Tunnel Downstream from Temperance Flat Reservoir along Millerton Lake Tunnel Dimensions – 3,050 feet in length; 30 feet in diameter Maximum Outlet Capacity – 20,000 cfs (4 valves)
Hydroelectric and Related Facilities	Feature Items and Location – Kerckhoff No. 2 Tunnel Extension; Powerhouse Located at Downstream End of Tunnel Downstream from Temperance Flat Reservoir along Millerton Lake Generating Capacity - 160 MW Kerckhoff No. 2 Tunnel Extension Length – 37,720 feet
Utility Relocations	Facility Decommissioning – Kerckhoff Hydropower Project Powerhouses and Kerckhoff Tunnel/Intake Relocations – Two High Voltage Power Lines, Minor Low Voltage Power Lines
Recreation Facilities	Additional Recreation Facilities – Could be Developed as Feasible Facility Relocations – San Joaquin River Trail, Several Campgrounds, and Bureau of Land Management Facilities
Roads	Additional Roads – 5 Miles of Permanent Access Roads; 10 Miles of Temporary Access Roads Road Re-alignments – None Required

Cfs = cubic feet per second msl = mean sea level
MW = megawatt TAF = thousand acre feet

Operations assumptions for the example Temperance Flat RM 274 Reservoir project formulation presented in this report include:

- **Full integration with operations of the SWP and CVP** – Operations integration with the SWP and CVP would include coordinated management of water supplies in Millerton Lake and Temperance Flat RM 274 Reservoir with operations of SWP and other CVP facilities (See Figure 4-4). This would involve delivery of water supplies to the Friant Division in combination with water exchanges between the Friant Division and SWP and other CVP service areas. Some SWP or CVP water supplies from the Delta that are diverted to San Luis Reservoir would instead be delivered to water users in the Friant Division of the CVP, 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 could allow capture of additional supplies from the Delta. Accumulated San Joaquin River water supplies would be provided through exchange to SWP and CVP SOD water users when Delta supplies are less than demand. Thus, Temperance Flat RM 274 Reservoir would not only be operated as an enlargement of Millerton Lake for managing flood or high flows on the San Joaquin River (functioning as a reservoir upstream of the Delta), but would also be operated as an expansion of SOD offstream storage like a San Luis Reservoir on the east side of the San Joaquin Valley to capture additional Delta supplies through exchange (functioning as a reservoir downstream of the Delta).

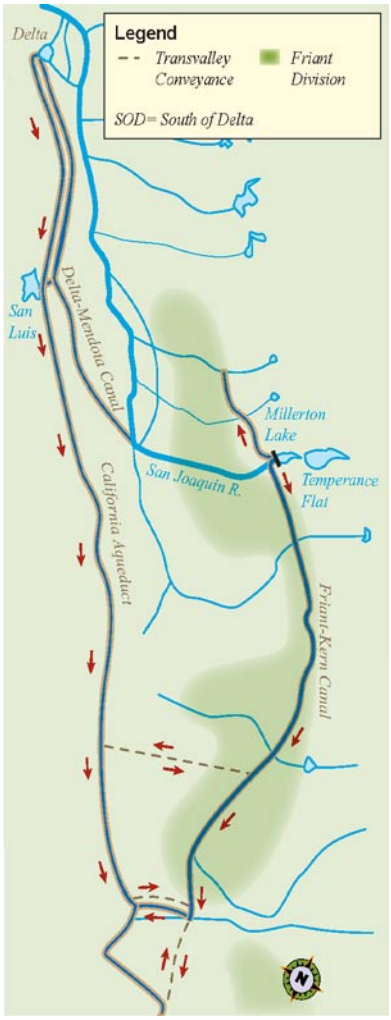

Figure 4-4. Integrated Operations of South-of-Delta Facilities

- **Transvalley conveyance via Shafter-Wasco Pipeline, Cross Valley Canal, and Arvin-Edison Canal** – To facilitate operations integration of Millerton Lake and Temperance Flat RM 274 Reservoir with the SWP and CVP systems, transvalley water exchanges (east to west or west to east) would be accomplished using assumed available capacity in the Shafter-Wasco Pipeline, Cross Valley Canal, and Arvin-Edison Canal. The Friant-Kern Canal and California Aqueduct would also be necessary conveyance components for water exchanges. Water stored in Temperance Flat RM 274 Reservoir could also be released from Friant Dam to Mendota Pool and then delivered to CVP or SWP users through exchanges.

- **Reservoir balancing** –When both reservoirs are not full, the storage levels in Temperance Flat Reservoir and Millerton Lake would be operated in a coordinated manner to balance effects on recreation, hydropower, and temperature. The amount of total storage available would dictate the water supply that could be developed for multiple purposes.

For the purposes of this report, water operations modeling was performed to determine potential changes in water supply deliveries to agricultural and M&I water contractors and Level 4 water supplies for California's wildlife refuges, water quality improvements, and ecosystem restoration. The modeling summarized in this report was performed using a combination of CALSIM for the operations of San Joaquin River supplies and the Friant Division of the CVP and a spreadsheet-based model for integrating the operations of Temperance Flat RM 274 Reservoir with the broader CVP and SWP systems through exchange. The spreadsheet model is a conservative, simplified approach that typically underestimates the magnitude of potential benefits of operations integration with the CVP and SWP.

Example Temperance Flat RM 274 Reservoir Project Formulation Benefits

This section describes the results of modeling conducted for the example formulation of Temperance Flat RM 274 Reservoir that includes new operating criteria recommended by the 2008/2009 BOs for delta smelt and salmon and summarizes potential project benefits. This section describes how the example formulation of a Temperance Flat RM 274 Reservoir project would meet primary objectives and achieve project benefits, including public benefits. This presentation distinguishes between public and non-public benefits based on guidance from the 2009 Comprehensive Water Package. According to the 2009 Comprehensive Water Package, public benefits may include ecosystem improvements, water quality improvements, flood control benefits, emergency response, and recreation. Water supply reliability and water quality benefits for M&I and agricultural users and hydropower generation are assumed to be non-public benefits and would need to be paid for by the beneficiaries.

The information presented in this section is for informational purposes only. The example project components and operations were formulated to fulfill a wide variety of project benefits and may not represent the most technically and/or economically feasible alternative considered in past and/or future feasibility study reports and environmental impact documents, and should not be considered as a preferred alternative.

With Temperance Flat RM 274 Reservoir in place and a representation of operational conditions described in the PFR (i.e., 2004/2005 Operations Criteria and Plan), a long-term annual average water supply of approximately 180 TAF would be developed, with 70 TAF attributed to operations integration. For the purposes of this report, a representation of operational conditions described in the 2008/2009 BOs results in a long-term annual average water supply (for period October 1922 to September 2003) of approximately 140 TAF, which could be developed for multiple purposes. The dry year average (combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992) would be about 86 TAF. The need for the available storage space in Temperance Flat RM 274 Reservoir to be used for exchanges is closely tied to the frequency of filling San Luis Reservoir. About 30 TAF of the approximately 140 TAF long-term average water supply developed would be attributed to operations integration. Water supplies developed with an example formulation of Temperance Flat RM 274 Reservoir could be used for a variety of purposes to provide a wide range of public benefits and other benefits, as described below. The water stored in Temperance Flat RM 274 Reservoir (San Joaquin River supplies and CVP/SWP exchange supplies) and the proportion of water supply that could be dedicated for each purpose has not yet been determined. These benefits and their distribution will be further evaluated in the Draft Feasibility Report. For modeling convenience in quantifying the amount of water that could be developed with an example formulation of Temperance Flat RM 274 Reservoir in this report, the operation of the reservoir was analyzed with a water supply focus.

Potential benefits are illustrated on Figure 4-5.

Figure 4-5. Summary of Potential Benefits of the Example Temperance Flat RM 274 Project

Public Benefits

The example formulation of Temperance Flat RM 274 Reservoir could provide public benefits, including ecosystem improvements, water quality improvements, flood control benefits, emergency response benefits, and recreational benefits, as described in the following sections.

Ecosystem Improvements

A Temperance Flat RM 274 Reservoir has potential to improve habitat conditions in the San Joaquin River by managing temperature of flow releases and by facilitating release of additional flows to the San Joaquin River in critically dry years. Temperance Flat RM 274 Reservoir would also provide cold water management flexibility through increased volumes of cold water that would be available for management and release to the San Joaquin River. The average end of September storage in Millerton Lake and Temperance Flat RM 274 Reservoir for this future condition is about 720 TAF compared to 220 TAF in Millerton Lake in the without project condition. The increase in early fall cold water volume would enhance conditions for anadromous fish downstream from Friant Dam (assuming implementation of the San Joaquin River Restoration Program [SJRRP]) during the spawning and incubation period occurring in the fall.

Ecosystem improvements could also be provided through operational integration of Millerton Lake and Temperance Flat RM 274 Reservoir with the SWP and CVP systems, which would improve management of Delta exports and allow for shifting of SWP and CVP pumping operations to times less damaging to sensitive Delta fish species. The ability to store additional San Joaquin River water in Temperance Flat RM 274 Reservoir could also result in additional Class 2 deliveries in the Friant Division which are used for conjunctive management and would reduce reliance on groundwater pumping in the overdrafted San Joaquin Valley aquifers. Water released from Friant Dam for exchange at Mendota Pool through operations integration actions could also enhance water temperature and flow conditions to improve aquatic habitat in the San Joaquin River. Water from Temperance Flat RM 274 Reservoir could also be dedicated to the San Joaquin River and Delta for ecosystem purposes, or to preserve and enhance other river system public trust resources.

Water Quality Improvements

No new modeling on San Joaquin River water quality opportunities was conducted for this report. For a potential Temperance Flat RM 274 Reservoir, this opportunity would be considered to the extent it can be implemented in conjunction with actions to achieve the primary objectives. 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 water quality improvement programs and activities. Water quality in the San Joaquin River could also be improved if water is released from Friant Dam for exchanges at Mendota Pool through operations integration actions. These exchanges could improve the water quality of agricultural return flows to the San Joaquin River downstream from Mendota Pool. The extent of water quality improvements is difficult to anticipate until water quality monitoring and analyses are completed for these actions.

Flood Control Benefits/Flood Protection

No new modeling on flood risk management opportunities was conducted for this report, though previous study results show that Temperance Flat RM 274 Reservoir would provide significant incidental flood control space that would improve the management of flood flows at Friant Dam. A series of evaluations in previous stages of the feasibility study estimated potential flood protection

benefits that would result from dedicating a range of additional floods storage space at or upstream from Millerton Lake. These evaluations found that potential flood protection 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. For a potential Temperance Flat RM 274 Reservoir, this opportunity would be considered to the extent it can be implemented in conjunction with actions to achieve the primary objectives.

Emergency Response/Storage

Temperance Flat RM 274 Reservoir's strategic location south of the Delta and its large storage capacity would provide both long-term and emergency water supply benefits for much of the state. A Temperance Flat RM 274 Reservoir could provide a source of short-term emergency water supplies to SOD water users in the event of a disruption in Delta water supplies caused by levee failure during a seismic event. Such an event in the Delta would disrupt the ability to pump water from the Delta and deliver to SOD SWP and CVP water users. In addition to natural events, future environmental constraints may periodically limit the amount of water that can be delivered through Delta SWP and CVP pumping facilities. Water from Temperance Flat RM 274 Reservoir could be immediately available to SOD water users (either directly or through exchange), since the water would already be stored south-of-the-Delta.

Recreational Purposes

No new modeling or analysis on recreation opportunities was conducted for this report. Opportunities for recreation development vary depending on operations integration and Millerton Lake reservoir balancing options. In the PFR, simulation results indicate improved recreation opportunities in the primary study area when Temperance Flat RM 274 Reservoir is balanced to maintain Millerton Lake water levels at baseline average monthly storage levels or higher. Higher pool elevations would provide a minor potential benefit to boaters, while maintaining good shoreline use conditions. Boating and waterskiing activities provided by the new reservoir would provide the greatest recreational value.

Water Supply Reliability Benefits

A Temperance Flat RM 274 Reservoir would capture flows from the upper San Joaquin River basin that could be delivered to water users. The additional storage space in the new reservoir would provide opportunities for water exchanges with other SOD water users by integrating storage operations with SWP and other CVP facilities. Municipal, industrial, and agricultural water users would benefit from additional surface water deliveries, which could increase SOD agricultural and M&I water supply reliability, reduce reliance on groundwater supplies, and reduce aquifer drawdown.

Water stored in Temperance Flat RM 274 Reservoir could also be delivered as Level 4 refuge supplies to Tulare Basin and San Joaquin Valley wildlife refuges. Level 4 refuge water supply reliability improvements could be considered a public benefit.

M&I Water Quality Benefits

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. Integrating operations of Friant Dam and Temperance Flat RM 274 Reservoir with operations of the 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. Operations integration of Friant Dam and Temperance Flat RM 274 Reservoir with the SWP and CVP would also facilitate water quality exchanges to make high quality upper San Joaquin River water available to urban interests receiving water from the Delta. Improvements in raw water quality can benefit urban water users through a reduction in treatment costs required to attain a given level of finished water quality.

Hydropower/Flexible Generation

No new modeling or analysis on hydropower generation opportunities was conducted for this report. Previous PFR studies show most hydropower for a potential Temperance Flat RM 274 Reservoir would be generated by diverting flow into an extended Kerckhoff No. 2 Powerhouse tunnel at Kerckhoff Lake and discharging flow through a new powerhouse located just downstream from Temperance Flat RM 274 Dam into Millerton Lake (See Figure 4-3). This would take advantage of the relatively constant water level in Kerckhoff Lake. Releases from Temperance Flat RM 274 Reservoir would also be used for power generation. Per analysis done for the PFR, power generation for this hydropower configuration would generate enough energy to replace more than 95 percent of the energy lost through inundation of the Kerckhoff Project powerhouses, on an average annual basis. Other hydropower configurations that vary reservoir water level balancing and the percent of flow routed through Temperance Flat RM 274 Reservoir would generate between 65 and 95 percent of the energy lost. Future gains in hydropower benefits may be realized by utilizing the additional storage of Temperance Flat RM 274 Reservoir to carry over water supplies later in the year for power generation, whereas the existing Kerckhoff project has very limited storage. Additional opportunities may also be realized by adding a pumped storage component to a hydropower configuration, which would take advantage of California's rising renewable energy market and its dependence on hydropower and other flexible generation/storage resources for power regulation (i.e., shaping wind/solar generation on a second-by-second basis to meet electrical demand and allow for reliable operation of the electric grid).

Example Temperance Flat RM 274 Reservoir Project Formulation Benefits Under an Uncertain Future

As stated previously in this report, future conditions are uncertain at this time and considered projects must be able to fulfill project objectives and provide benefits under variable future conditions. This section describes modeling conducted for an example formulation of Temperance Flat RM 274 Reservoir coordinated with potential new Delta conveyance and presents qualitative analysis on the potential for climate change to impact the ability of a Temperance Flat RM 274 Reservoir to achieve intended benefits. The information presented in this section is for informational purposes only.

Potential Effect of New Delta Conveyance on Project Benefits

This section presents how an example formulation of Temperance Flat RM 274 Reservoir could accomplish project objectives and provide benefits under future operation scenarios that include potential new Delta conveyance, as being studied by the Bay-Delta Conservation Plan and Delta Habitat Conservation and Conveyance Program. This section focuses on quantitative and qualitative analyses conducted for public benefits, including ecosystem improvements, water quality improvement, emergency response and recreational purposes; and water supply reliability, M&I water quality, and hydropower generation. Other benefit categories discussed in previous sections, such as flood

protection, are not expected to change significantly with new Delta conveyance; however, further analysis will be conducted as the feasibility study progresses. The same modeling tools (CALSIM and simplified spreadsheet model, as discussed above) were used; therefore, the results are impacted by the same limitations. These limitations are only exacerbated by the uncertainty associated with potential new Delta conveyance.

With Temperance Flat RM 274 Reservoir in place and a representation of operations including new Delta conveyance and the BOs, a long-term annual average of approximately 230 TAF of water could be developed for multiple purposes. The dry year average would be about 149 TAF. The frequency of filling San Luis Reservoir is much greater under future operation scenarios that include potential new Delta conveyance than those without new Delta conveyance. New Delta conveyance increases the utilization of the available storage space in Temperance Flat for exchanges and the corresponding water supply that could be developed for multiple purposes. About half of the approximately 230 TAF long-term average water developed would be attributed to operations integration.

As with the future scenario without new Delta conveyance, the operations of the reservoir was analyzed with a water supply focus for modeling convenience in quantifying the amount of water that could be developed, but the water stored in Temperance Flat RM 274 Reservoir (San Joaquin River supplies and CVP/SWP exchange supplies) could be dedicated to provide a wide range of public benefits and other benefits, as described below.

Ecosystem Improvements

New Delta conveyance would increase the volume of water supply stored in Temperance Flat RM 274 Reservoir through exchange and would increase the cold water pool. The average end of September storage in Millerton Lake and Temperance Flat RM 274 Reservoir for a future condition with new Delta conveyance is about 850 TAF, compared to 720 TAF in the future condition without new Delta conveyance (an increase of 130 TAF). The increase in early fall cold water volume would further enhance conditions for anadromous fish downstream from Friant Dam (assuming implementation of the SJRRP) during the spawning and incubation period occurring in the fall.

With new Delta conveyance, storage in Temperance Flat RM 274 Reservoir and Millerton Lake could be better balanced and coordinated with reservoirs throughout the CVP and SWP system, such as San Luis Reservoir, Folsom Lake, Lake Oroville, Shasta Lake, and New Melones Reservoir. This coordination of reservoirs could be used to enhance Delta and river ecosystems under a variety of ecological and regulatory needs and constraints. For example, through timing of operations integration flow, Temperance Flat RM 274 could have storage available in drier conditions. This water could be released during these conditions to satisfy Delta flow needs, reducing the need for releases from Sacramento River Basin reservoirs. This could improve cold water pool conditions in Sacramento River Basin reservoirs, for later anadromous fish releases, without sacrificing ecosystem conditions in the Delta. Water could then be replenished in Temperance Flat RM 274 Reservoir during wetter conditions or when Sacramento River Basin reservoirs release additional stored water as environmental conditions allow. This example of ecosystem improvement would be made possible and would use less water than alternative scenarios without new Delta conveyance or a Temperance Flat RM 274 Reservoir.

Water Quality Improvements

As mentioned, no new modeling on San Joaquin River water quality opportunities was conducted for this report, though benefit opportunities in water quality will be explored in future feasibility study efforts. An example formulation of Temperance Flat RM 274 Reservoir coordinated with potential new Delta conveyance could benefit river water quality in a similar manner to the Sacramento River Basin reservoirs integration and timing of flows discussed in the "Ecosystem Improvements" section. Water stored in Temperance Flat RM 274 Reservoir through operations integration could be released to improve San Joaquin River water quality. This water could then be exported from the southern Delta and returned to the water users, resulting in minimal water cost. During the time water is being released down the San Joaquin River, a reduction in Sacramento River inflows may be possible, as well as, decreases in releases from San Joaquin River tributaries. Water quality improvements in the San Joaquin River could also be achieved if water is released from Friant Dam for exchanges at Mendota Pool through operations integration actions resulting in improved water quality of agricultural return flows to the San Joaquin River downstream from Mendota Pool.

Emergency Response/Storage

Temperance Flat RM 274 Reservoir storage would likely be significantly higher in a future condition with new Delta conveyance than in a future condition without improved Delta conveyance. This increased storage would result in an increase in time a high quality emergency water supply would be available. Although the probability of a Delta outage is less under a future condition with new Delta conveyance, this supply is located south of the Delta and could be available if the California Aqueduct is damaged.

Recreational Purposes

There is a potential that as additional water is stored in Temperance Flat RM 274 Reservoir through exchanges enhanced by new Delta conveyance, conditions for recreation would be improved. This improvement could occur via more flexibility in balancing the water levels in the two reservoirs that would benefit recreational purposes.

Water Supply Reliability Benefits

New Delta conveyance could significantly enhance the magnitude of M&I, agricultural, and Level 4 Refuge (public benefit) water supply accomplishments of Temperance Flat RM 274 Reservoir, as discussed in the previous water supply reliability section without new Delta conveyance. New Delta conveyance could increase the ability to move water supply south of the Delta in wet years, resulting in improved flexibility for exchange operations integrating Temperance Flat RM 274 Reservoir with the CVP and SWP systems. With new Delta conveyance, there could also be opportunities for direct delivery of Delta water supplies to the Friant Division (bypassing storage in San Luis Reservoir).

M&I Water Quality Benefits

Operations integration of Friant Dam and Temperance Flat RM 274 Reservoir with the SWP and CVP, under new Delta conveyance conditions, could facilitate water quality exchanges to make high quality upper San Joaquin River water available to urban interests. North-of-Delta water quality delivered to SOD M&I water users, however, would be improved with new Delta conveyance, and the incremental water quality improvement with Temperance Flat RM 274 Reservoir would be small. Improvements in raw water quality can benefit urban water users through a reduction in treatment costs required to attain a given level of finished water quality.

Hydropower/Flexible Generation

Operations integration has typically resulted in minor changes in hydropower benefits. There is a potential that as additional water is stored in Temperance Flat RM 274 Reservoir through exchanges enhanced by new Delta conveyance, conditions for hydropower would be improved with higher water levels. The increase in benefits would be dependent on the coordination of Temperance Flat RM 274 Reservoir and Millerton Lake water levels, and releases for the multiple purposes of water supply, release temperatures, and reservoir recreation.

Potential Effect of Climate Change on Project Benefits

Potential effects from climate change underscore the need for additional storage. For the San Joaquin River basin, climate change could affect surface water supplies provided from snowpack in the high mountain headwaters. Climate change resulting in future warming could lead to more rain and less snow, more rainfall-runoff during winter and early spring and less snowmelt volume during late spring and summer, and increased crop water needs.

Future warming could cause a greater fraction of annual runoff to occur during winter and early spring and the fraction of annual runoff during late spring and summer could decrease. This could result in impacts to existing water supplies as additional flood control releases would need to be made and less water would be stored later in the season and flood control rules are relaxed. To the extent that climate change would cause a greater fraction of annual runoff in the upper San Joaquin River basin to occur during winter and early spring, the need for additional storage would be further underscored. Temperance Flat RM 274 Reservoir would provide additional incidental flood control space.

Further, sea level rise from global climate change could affect Delta conditions that constrain SWP and CVP operations in the Delta, and also lead to changes in upstream operations in the San Joaquin River basin.

Temperance Flat RM 274 Reservoir Potential Environmental Effects

Primary potential effects for aquatic biological resources, terrestrial biological resources, recreation resources, and cultural resources affected by the Temperance Flat RM 274 Reservoir alternative plans are described in the PFR. Examples of potential adverse effects described in the PFR include inundation of terrestrial habitats and associated species, including special status species, affected usable habitat for riverine fish species, inundation of historic or prehistoric cultural resources sites of concern, and affected recreation resources. Potential beneficial effects, such as improved water temperature conditions in the San Joaquin River below Friant Dam, increases in shallow-water habitat for lake species, and improved recreation opportunities, are also described in the PFR.

Additional environmental analyses will be completed during the feasibility study that will inform the nature of potential mitigation and/or enhancement measures included in the Temperance Flat RM 274 Reservoir alternative plans, and included in the Draft and Final Feasibility Report and accompanying EIS/EIR. 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. The Bureau of Reclamation (Reclamation) is the lead agency for National Environmental Policy Act (NEPA) compliance, and the Department of Water Resources (DWR) is the lead agency for California Environmental Quality Act (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.

A draft EIS/EIR disclosing environmental impacts resulting from the USJRBSI is scheduled for release in 2011. Environmental studies and evaluations are currently being conducted to determine the type and extent of potential environmental impacts. It is anticipated that some of the adverse effects would be temporary, construction related effects and other adverse effects would be permanent, such as effects on botanical and wildlife resources within the newly inundated areas. As part of the project planning and environmental assessment process, DWR and Reclamation will incorporate environmental commitments and best management practices to avoid or minimize potential effects. DWR and Reclamation have also committed to coordinate with applicable resource agencies and tribal groups during planning, engineering, design, construction, operation, and maintenance phases of the project.