# Chapter 2
# Alternatives

This chapter documents compliance with NEPA and CEQA requirements for the development, analysis, and documentation of alternatives, and describes the five action alternatives and the No Action Alternative evaluated in detail in this Draft EIS. This chapter includes the following sections:

- **Summary Description of Alternatives**, providing a brief overview of the action alternatives and No Action Alternative

- **Alternatives Development Process**, describing the overall plan formulation process and phases for the Investigation, project objectives, planning constraints and considerations, management measures, and development and refinement of alternatives

- **No Action Alternative**, describing the No Action Alternative, a scenario in which a project is not implemented

- **Action Alternatives**, describing each action alternative evaluated in this Draft EIS, including features and operations of the action alternatives, environmental commitments, and construction activities and schedule

- **Summary of Potential Accomplishments of Action Alternatives**, summarizing the major potential accomplishments of the action alternatives related to water supply reliability, system operational flexibility, water temperature and flow conditions, flood damage reduction, hydropower, recreation, and water quality

- **Preferred Alternative and Rationale for Selection**, describing the basis for selecting a plan for recommendation, including the criteria and considerations used in selecting a recommended course of action by the Federal Government; the preferred alternative will be identified in the Final EIS

The purpose of including action alternatives in an EIS is to offer a clear basis for choice by decision makers and the public about whether to proceed with a proposed action or project. NEPA requires consideration of a range of alternatives. This range must include all reasonable alternatives, which must be rigorously explored and objectively evaluated, as well as other alternatives eliminated from detailed study. A brief discussion of the reasons for eliminating alternatives must be included (Section 1502.14). CEQA requires that an EIR describe a reasonable range of alternatives that could feasibly avoid or lessen any significant environmental impacts while substantially attaining the basic objectives of the proposed action or project. A No Action Alternative (which also constitutes the No Project Alternative under CEQA) is also analyzed, as required by NEPA and CEQA.

## Summary Description of Alternatives

This chapter summarizes the alternatives considered in detail in this Draft EIS, which include a No Action Alternative and five action alternatives:

- **No Action Alternative –** Under the No Action Alternative, the project would not be implemented. The No Action Alternative reflects projected conditions under a 2030 level of development if the project is not implemented.

- **Alternative Plan 1 –** Alternative Plan 1 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern and Madera Canals, and to SWP SOD M&I contractors via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes a low-level intake structure (LLIS) and a 200 TAF minimum carryover storage target (water that is kept in the reservoir as a minimum storage reserve for cold water pool, hydropower generation, recreation, and emergency response, rather than delivered) in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 340 TAF minimum carryover storage target, with a preference to store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above the target.

- **Alternative Plan 2 –**Alternative Plan 2 would construct a dam in the upstream portion of Millerton Lake at RM

274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern Canal and Madera Canals, and to both SWP SOD M&I contractors and CVP SOD contractors, including refuges, via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes an LLIS and a 200 TAF minimum carryover storage target in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 340 TAF minimum carryover storage target, with a preference to store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above the target.

- **Alternative Plan 3 –** Alternative Plan 3 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to: the Friant Division of the CVP via the Friant-Kern and Madera Canals; SWP SOD M&I contractors via existing cross-valley conveyance and the California Aqueduct; and CVP SOD contractors via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes an LLIS and a 200 TAF minimum carryover storage target in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 340 TAF minimum carryover storage target, with a preference to store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above the target.

- **Alternative Plan 4 –** Alternative Plan 4 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern and Madera Canals; and SWP SOD M&I contractors and CVP SOD contractors via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes a selective-level intake structure (SLIS) and a 325 TAF minimum carryover storage target in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 340 TAF minimum carryover storage target, with a preference to store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above the target.

- **Alternative Plan 5** – Alternative Plan 5 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern and Madera Canals, and to CVP SOD contractors via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes a LLIS and a 100 TAF minimum carryover storage target in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 130 TAF minimum carryover storage target, with preferences to store water in Millerton Lake up to 340 TAF and store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above 340 TAF. Alternative Plan 5 also includes modification of the water supply allocation operational rules to increase drier year water supply reliability with minimal impact to long term average annual water supply reliability.

NEPA requires that agencies devote substantial treatment to each alternative such that reviewers may evaluate their comparative merits. In addition, the CEQ Regulations for implementing NEPA require a range of reasonable alternatives to be rigorously and objectively evaluated in an EIS (40 CFR 1502.14). Alternatives that cannot reasonably meet the project purpose and needs do not require detailed analysis and can, with explanation, be eliminated from further consideration.

CEQA requires that the lead agency consider alternatives that would avoid or reduce one or more of the significant impacts identified in an EIR. The State CEQA Guidelines state that an EIR needs to describe and evaluate only those alternatives necessary to permit a reasonable choice and to foster informed decision making and informed public participation (Section 15126.6(f)). Consideration of alternatives focuses on those that can either eliminate significant adverse environmental impacts or reduce them to less-than-significant levels; alternatives considered in this context may include those that are more costly, and those that could impede, to some degree, the attainment of all the project objectives (Section 15126.6(b)).

## Alternatives Development Process

This section describes the alternatives development process for the Investigation. A more detailed description of this process is included in the Plan Formulation Appendix. Action alternatives considered in the Draft Feasibility Report and Draft EIS fundamentally consist of constructing new surface water storage facilities and operating them to address the primary planning objectives of increasing water supply reliability and enhancing temperature and flow conditions in the San Joaquin River.

### Tiering from the CALFED Program EIS and ROD

The CALFED Program was initiated to help reduce the gap between water supplies and projected demands. Expanding water storage capacity is critical to successfully implementing all aspects of the program. Water supply reliability depends on capturing peak flows during wet years. New storage must be strategically located to provide the needed flexibility in the current water system to improve water quality, support fish restoration goals, and meet the needs of a growing population.

The CALFED agencies conducted an initial screening of 52 potential surface water storage sites to reduce the number of sites to 12, a more manageable number for more detailed evaluation during project-specific studies (CALFED 2000a). CALFED eliminated sites providing less than 200 TAF storage and those that conflicted with CALFED solution principles, objectives, or policies. Further, based on information existing at that time, CALFED identified some potential surface water storage sites that were more promising in contributing to CALFED goals and objectives and more implementable due to relative costs and stakeholder support. The CALFED ROD recommended detailed evaluation of the five most highly rated sites and acknowledged that other sites in the list of 12 could serve as alternatives. Surface water storage sites recommended by CALFED for subsequent evaluation focused on those with the greatest potential for helping meet CALFED goals and objectives: Shasta Lake Enlargement, Los Vaqueros Reservoir Enlargement, Sites Reservoir, In-Delta Storage, and development of storage in the upper San Joaquin River Basin (CALFED 2000b). Only the In-Delta Storage project was excluded from the Calfed Bay-Delta Authorization Act (P.L. 108-361) that authorized the Federal feasibility study. Table 2-1 summarizes the CALFED surface water storage site evaluations leading up to the Investigation, as well as the subsequent site evaluations in the interim planning documents developed for the Investigation to date, which are described further below.

**Table 2-1. CALFED and Upper San Joaquin River Basin Storage Investigation Surface Water Storage Site Evaluations**

| Year | Activity, Authorization, or Document | Number of Alternative Sites / Notes |
|---|---|---|
| 1997 | CALFED Bay-Delta Program Storage and Conveyance Component Inventories | 52 sites identified through an initial inventory of surface storage sites with potential to contribute to improving water management for beneficial uses of the Bay-Delta system |
| 2000 | CALFED Initial Surface Water Storage Screening | 12 of the 52 sites evaluated for CALFED;<br>5 of the 12 sites retained for continued evaluation;<br>The balance of the 12 sites were deferred |
| 2000 | CALFED Final PEIS/R (CALFED 2000a) and ROD (CALFED 2000b) | 3 of the 5 sites recommended for site-specific study;<br>The remaining 2 sites, including the upper San Joaquin River Basin, recommended for additional consideration |
| 2003 | Public Law 108-7, Division D, Title II, Section 215 | Authorized Federal feasibility studies for storage in the upper San Joaquin River Basin |
| 2003 | Phase 1 Upper San Joaquin River Basin Investigation Report (Reclamation and DWR 2003) | 17 sites considered that could develop upper San Joaquin River water supplies; 6 were retained for further analysis |
| 2004 | Public Law 108-361: Water Supply, Reliability, and Environmental Improvement Act | Confirmed authorization of planning and feasibility studies for the Upper San Joaquin River storage in Fresno and Madera Counties |
| *2004* | Public Scoping for the Upper San Joaquin River Basin Storage Investigation | 5 additional surface water storage sites recommended for consideration during scoping |
| 2005 | Initial Alternatives Information Report (Reclamation and DWR 2005) | 11 surface water storage sites considered;<br>4 sites retained for further analysis |
| 2008 | Plan Formulation Report (Reclamation and DWR 2008) | 1 of the 4 sites identified as potentially feasible |
| 2014 | Draft Feasibility Report (Reclamation 2014) and Draft EIS | 1 feasible reservoir site and up to 5 operational and physical alternatives evaluated |

Key:
CALFED = CALFED Bay-Delta Program
EIS = Environmental Impact Statement
PEIS/R = Programmatic Environmental Impact Statement/Environmental Impact Report
ROD = Record of Decision

## Feasibility Study Process

In 2004, Congress passed Public Law 108-362, authorizing the Secretary of the Interior to conduct formal feasibility studies of four of the surface storage projects identified in the CALFED ROD (2000b). Those projects are Shasta Lake Enlargement, Los Vaqueros Reservoir Enlargement, Sites Reservoir, and storage in the upper San Joaquin River Basin.

Formal feasibility studies are guided by the P&G (WRC 1983), and Reclamation policy requires the agency to comply with NEPA as part of the entire feasibility study process.

During the site-specific planning process for the Investigation, alternative storage locations and methods for water storage were evaluated for their ability to meet the site-specific objectives, environmental impacts, water right availability, constructability, and cost. Table 2-1 summarizes the chronology of the alternatives development process that led to the current range of alternatives for the Investigation. The number of alternative reservoir sites was reduced through a phased evaluation process considering the ability to achieve site-specific project objectives and/or the purpose and need. As alternative sites were eliminated from further detailed consideration, evaluation of the remaining alternative sites was conducted in progressively greater levels of detail. The complete plan formulation approach and feasibility study process for the Investigation is illustrated in Figure 2-1 and described in the Plan Formulation Appendix to this Draft EIS. As shown in Figure 2-1, the process includes public and stakeholder outreach.

Progress and results of the Investigation are documented in a series of interim reports produced in five phases and will culminate in a Final EIS and Feasibility Report, as follows:

- **Phase 1** – During this phase, 17 possible reservoir sites in the upper San Joaquin Valley were identified and evaluated, and 6 were selected for continued study, including a raise of Friant Dam/enlargement of Millerton Lake. Formal initiation of NEPA and CEQA processes also began in this phase, through the Notice of Intent/Notice of Preparation and public scoping activities.

- **Initial Alternatives Phase** – During this phase, 24 reservoir measures were evaluated (based on location and size), many with multiple alternative hydropower generation options. In addition, several initial water operations scenarios addressing various planning objectives were identified and evaluated. Enlarging Millerton Lake and developing new reservoirs at three sites (Temperance Flat RM 274 Reservoir, Temperance Flat RM 279 Reservoir, and Fine Gold Reservoir) were selected for continued study.

- **Plan Formulation Phase** – Analyses conducted during this phase refined initial alternatives into four groupings of alternatives, based on two dam site locations and inclusion/exclusion of a new Trans Valley Canal. The four groupings of alternatives were then evaluated based on P&G planning criteria, the ability to address planning objectives, purpose and need, and meet planning constraints and considerations. The Temperance Flat RM 274 Reservoir grouping of alternatives (without the Trans Valley Canal) was retained for detailed feasibility design and evaluation.

- **Draft Feasibility and Plan Refinement Phase –** This phase focused on further physical features and operations refinement of the action alternatives to identify a plan suitable to be recommended for implementation. This phase includes preparing and circulating this Draft EIS and a Draft Feasibility Report.

- **Final Feasibility and Recommended Plan Phase –** The next phase of the Investigation will focus on responding to comments, identifying a recommended plan, and confirming Federal and non-Federal responsibilities. This phase will conclude with responding to comments on the Draft EIS and preparing and publishing a Final EIS and a Final Feasibility Report to support a Federal recommendation and a Congressional decision.

Development of alternatives evaluated in this Draft EIS was guided by the purpose and need, planning objectives, constraints, and other considerations developed during the Draft Feasibility and Plan Refinement Phase. These considerations are presented in the following sections.

### Purpose and Need

As summarized in Chapter 1, “Introduction,” the project purpose is to increase storage of water from the upper San Joaquin River watershed to improve water supply reliability and operational flexibility in CVP San Joaquin Valley areas and other regions of California; and to enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish. Alternatives were evaluated for their ability to meet the project purpose and need during each phase of alternatives development and screening, as described in the Plan Formulation Appendix to this Draft EIS. Temperance Flat RM 274 Reservoir is the site that best meets the purpose and need.

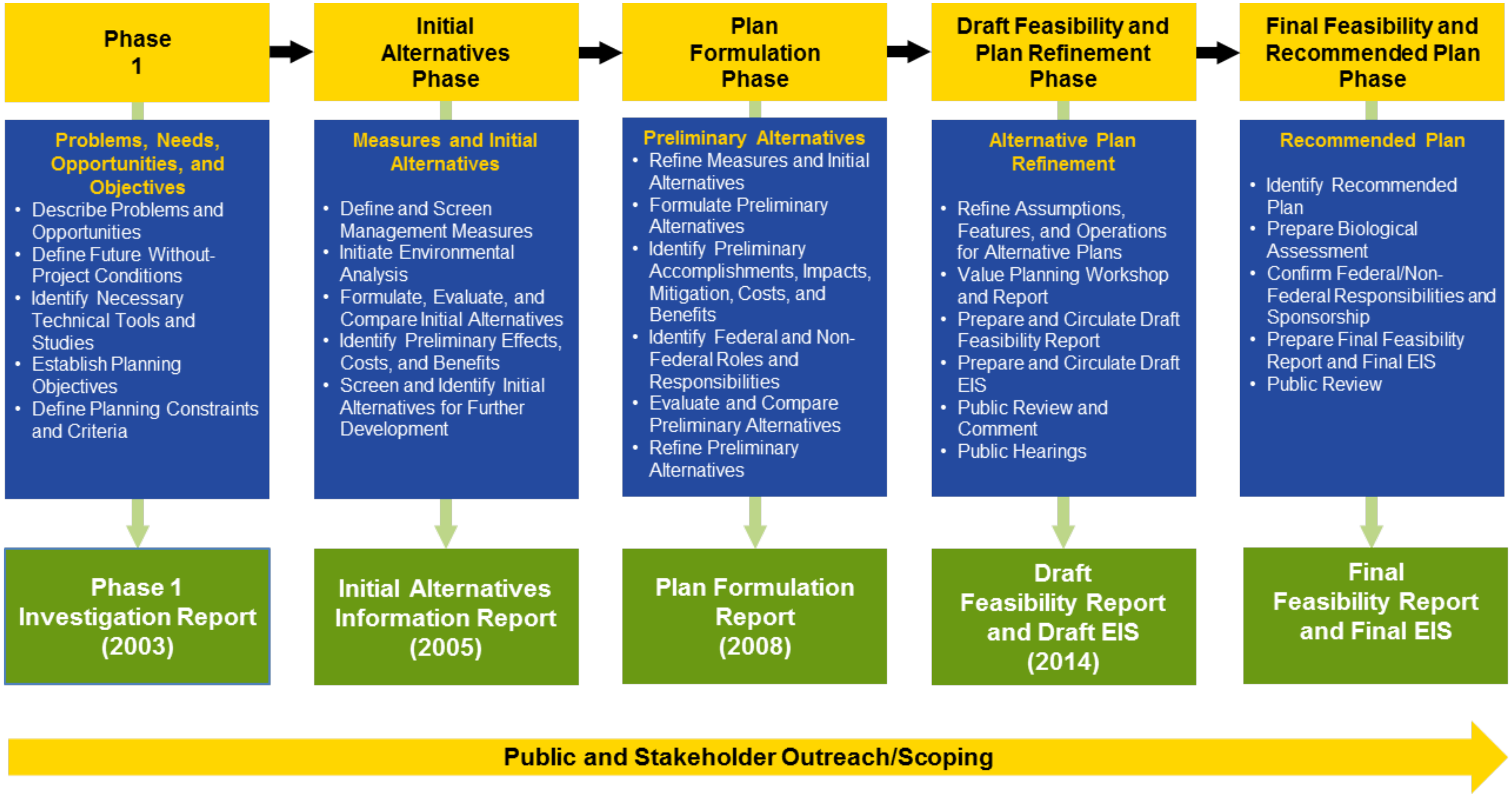


**Figure 2-1. Plan Formulation Process**

## Planning Objectives

This section documents the Federal and State planning objectives and Investigation-specific objectives, constraints, considerations, and criteria.

The CALFED ROD (2000b) provides a programmatic framework for participating Federal and State agencies to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. Findings in the CALFED ROD established the initial basis for potential Federal interest in the Investigation; hence, the objectives identified in the CALFED ROD represent important context for the Investigation-specific planning objectives (2000b).

### *Federal and State Objectives*

The Federal objectives are guided by the P&G (WRC 1983), which focuses on national economic development, and encourages projects that maximize public benefits, both monetary and non-monetary.

The Federal objective for water resources planning is defined in the P&G:

> *The Federal objective of water and related resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.*

Contributions to national economic development (NED) are further defined as "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).

DWR requires that economic analyses of programs and projects be conducted fundamentally in accordance with the Federal planning principles defined in the P&G (WRC 1983); however, innovative methods and tools can also be incorporated when appropriate, such as mentioned in California's comprehensive water legislation, Senate Bill 1, enacted in 2009.

### *Investigation-Specific Planning Objectives*

As a result of changing conditions, and using the CALFED ROD as a general framework, primary and secondary planning objectives were developed based on the problems, needs, and opportunities identified during Phase 1 of the plan formulation process, study authorities, and other pertinent direction, including information contained in the August 2000 CALFED ROD (2000b) and supporting documents. Primary objectives are those for which specific alternatives are formulated to address. The primary planning objectives are considered to have equal priority, with each pursued to the maximum practicable extent without adversely affecting the other. Secondary objectives are actions, operations, or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary objectives.

- Primary Planning Objectives:
    - Increase water supply reliability and system operational flexibility for agricultural, M&I, and environmental purposes in the Friant Division of the CVP, other San Joaquin Valley areas, and other regions of California
    - Enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish
- Secondary Planning Objectives:
    - Reduce flood damages downstream from Friant Dam
    - Maintain the value of hydropower attributes in the study area
    - Maintain and increase recreational opportunities in the study area
    - Improve San Joaquin River water quality downstream from Friant Dam
    - Improve 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 help guide the feasibility study. Some planning constraints are more rigid than others. Examples of more rigid constraints include congressional direction in study authorizations; other 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 key constraints identified for the Investigation are as follows.

**Study Authorizations** 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). This act authorized the Secretary of the Interior to conduct feasibility studies for several storage projects identified in the CALFED ROD (2000b), including the Investigation. Additional authorization was given in the October 2004 Water Supply, Reliability, and Environmental Improvement Act (Public Law 108-361). Based on California Water Code (CWC) Section 227, 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** CALFED was established to "develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system." The 2000 CALFED ROD (CALFED 2000b) includes program goals, objectives, and projects primarily to benefit the Bay-Delta system. The objectives for the Investigation are consistent with the CALFED ROD (CALFED 2000b), as follows:

> *…250-700 TAF of additional storage in the upper San Joaquin River watershed. It 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.*

The ROD has been adopted by various Federal and State agencies as a framework for further consideration, including the Department of the Interior. The CALFED ROD also includes numerous other projects to help improve the ecosystem functions of the Bay-Delta system and states that developed plans should address the goals, objectives, and programs of the CALFED ROD (2000b).

Table 2-2 provides a summary of the CALFED ROD guidance and the site-specific objectives for the Investigation. Interpretation of the CALFED ROD objectives for the Investigation has been refined over time to reflect current and projected future conditions. Further details are included in the Plan Formulation Appendix.

**Table 2-2. Summary of CALFED ROD Guidance and Investigation Specific Objectives**

| CALFED ROD Storage Program Guidance | Investigation Specific Objectives |
|---|---|
| Expand storage to meet needs of a growing population | Increase water supply reliability and system operational flexibility |
| Improve system flexibility | |
| Capture water during peak flows and wet years | |
| Facilitate conjunctive management | |
| Support fish restoration | Enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish. |
| Contribute to restoration of the San Joaquin River | |
| Improve San Joaquin River water quality | Improve water quality in the San Joaquin River downstream from Friant Dam |
| Improve water quality delivered to communities | Improve quality of water supplies delivered to urban areas |

Key:
CALFED ROD = CALFED Bay-Delta Program Record of Decision

**Laws, Regulations, and Policies** Numerous laws, regulations, executive orders, and policies need to be considered by either the Federal or state lead agencies, among them: the P&G, NEPA, Fish and Wildlife Coordination Act, Clean Air Act (CAA), Federal Clean Water Act (CWA), National Historic Preservation Act, California PRC, Federal Endangered Species Act (ESA) and California Endangered Species Act (CESA), CEQA, the CVPIA, and the San Joaquin River Restoration Settlement Act. Important laws and regulations are discussed in Chapter 28.

### *Statewide Water Operation Considerations*

Reclamation developed a version of the California Water Resources Simulation Model (CalSim) II model, the March 2012 CalSim II Benchmark, based on a set of assumptions for facilities and operation of the CVP and SWP systems. This version of the CalSim model, and the associated facilities and assumptions were adopted as the basis for evaluation of the No Action Alternative and action alternatives in this analysis. This version of the model is referred to throughout this Draft EIS as the Reclamation March 2012 CalSim II Benchmark model.

### *Other Planning Considerations*

Planning considerations relate to economic justification, environmental compliance, technical standards, etc., and may result from local policies, practices, and conditions. Planning considerations are used in the Investigation for formulating, evaluating, and comparing initial plans, and later, formulating detailed action alternatives. Examples of these planning considerations include the following:

- A direct and significant geographical, operational, and/or physical dependency must exist between major components of action alternatives.
- Action alternatives should meet the project purpose and need.
- Action alternatives should address, at a minimum, all of the identified primary planning objectives, and, to the greatest extent possible, the secondary planning objectives.
- Measures to address identified secondary planning objectives should be either directly or indirectly related to the primary planning objectives (i.e., plan features should not be independent increments).
- Action alternatives should account for offsetting affected hydropower generation value.
- Action alternatives should consider issues raised in coordination with other Federal and State agencies.
- Action alternatives should avoid any increases in flood damages or other substantial hydraulic effects to areas downstream on the San Joaquin River.

- Action alternatives should either avoid potential adverse effects to environmental, cultural, and historical resources or include features to mitigate significant impacts, when feasible.

- Action alternatives should not result in a substantial adverse effect on existing and future water supplies, or related water resources conditions.

- Action alternatives should either avoid potential adverse effects on recreational resources or include features to mitigate significant impacts, when feasible.

- Action alternatives should be formulated and evaluated based on a 100-year period of analysis.

- Construction costs for action 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).

- Action alternatives should have a high certainty for achieving intended benefits and not depend on long-term actions unrelated to the Investigation (past the initial construction period) for success.

### Management Measures

Once water resources problems, needs, and opportunities have been identified, and planning objectives, constraints, considerations, and criteria have been developed, the next major plan formulation process element is identifying management measures. A management measure is any structural or nonstructural project action or feature that could address the planning objectives and satisfy the other applicable planning constraints, considerations, and criteria. Numerous potential measures to address the planning objectives were identified based on information from previous studies, environmental scoping, and stakeholder outreach to address the planning objectives and satisfy the applicable planning constraints, considerations, and criteria. Measures were reviewed and refined through Investigation team meetings, field inspections, and coordination with stakeholders.

### *Measures Considered*

Measures addressing primary planning objectives were grouped into broad categories associated with reservoir operations and water management, increasing surface water and groundwater storage and conveyance, reducing demand, performing water transfers and purchases, enhancing Delta exports, and constructing water temperature management devices. Measures addressing secondary planning objectives, which could be implemented in coordination with primary planning objective measures, were grouped according to specific secondary objectives.

Of the measures identified, several were selected for development into action alternatives investigated in the Draft Feasibility Report and Draft EIS. Other measures were eliminated from consideration during Phase 1, the Initial Alternatives Phase, the Plan Formulation Phase, and the Draft Feasibility and Plan Refinement Phase of the Investigation. Four measures identified to address only water supply reliability and system operations flexibility were retained for subsequent investigations (Table 2-3). Two measures identified to enhance water temperature and flow conditions in the San Joaquin River were retained for subsequent investigations. Three measures identified to address secondary planning objectives were retained for subsequent investigations.

Further detail on the management measures considered, deleted from consideration, and retained, is included in the Plan Formulation Appendix.

## Table 2-3. Management Measures Addressing Planning Objectives

| Planning Objective(s) | Measure Category | Measure | Status | Rationale |
|---|---|---|---|---|
| Both Primary Planning Objectives | Perform Reservoir Operations and Water Management | 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. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |
| Both Primary Planning Objectives | Increase Surface Water Storage in the Upper San Joaquin River Basin | Construct Temperance Flat RM 274 Reservoir | Retained | Reservoir sizes up to elevation 1,100 feet msl (2,110 TAF additional storage) at this site were considered. A maximum reservoir size at elevation 985 feet msl (1,260 TAF new storage capacity) was retained in the IAIR because larger, costlier reservoirs at the site were not justified due to substantial additional effects on environmental resources and hydropower generation. Temperance Flat RM 274 Reservoir also had greater benefits, greater net benefits, and a higher benefit-cost ratio than other reservoir sites considered. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |
| Both Primary Planning Objectives | Increase Groundwater Storage | Increase conjunctive management of water in Friant Division of the CVP | Retained | Conjunctive management in the Friant Division of the CVP occurs by increasing incidental groundwater storage and/or recharge with additional Class 2 deliveries or the development of local surface water supplies, such as increasing surface water storage in the upper San Joaquin River Basin. Groundwater banks operated as allocable water supplies in the Friant Division of the CVP could increase water supply reliability and provide water for river releases. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |

### Table 2-3. Management Measures Addressing Planning Objectives (contd.)

| Planning Objective(s) | Measure Category | Measure | Status | Rationale |
|---|---|---|---|---|
| Primary Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility | Perform Reservoir Operations and Water Management | Modify diversion to Madera and Friant-Kern canals | Retained | 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. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |
| Primary Planning Objective of Enhancing 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 | Retained | Balancing water storage levels between multiple reservoirs could improve water temperature management and affect hydropower generation and recreation. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |
| Primary Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River | Construct Water Temperature Management Devices | Construct selective-level intake structures on new upstream dams | Retained | Selective withdrawal of cold or warm water for releases to Millerton Lake from new upstream reservoirs could help manage cold water in Millerton Lake and provides flexibility in managing cold water in potential reservoirs upstream from Millerton Lake. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |
| Secondary Planning Objective of Reduce Flood Damages Downstream from Friant Dam | N/A | Increase flood storage space in or upstream from Millerton Lake | Retained | Available incidental flood storage space created through increasing surface water storage in the upper San Joaquin River Basin. Compatible with planning objectives and would not conflict with other opportunities or planning constraints/criteria. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |

### Table 2-3. Management Measures Addressing Planning Objectives (contd.)

| Planning Objective(s) | Measure Category | Measure | Status | Rationale |
|---|---|---|---|---|
| Secondary Planning Objective of Maintain Value of Hydropower Attributes | N/A | Construct new hydropower generation facilities on new surface water storage measures | Retained | Would increase the capability to recover lost generation capacity at each retained Temperance Flat Reservoir site. Would not conflict with other opportunities or planning constraints/criteria. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |
| Secondary Planning Objective of Maintain and Increase Recreation Opportunities in the Study Area | N/A | Replace or upgrade recreational 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 recreational uses at Millerton Lake State Recreation Area. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation. |

Key:
CALFED = CALFED Bay-Delta Program
CVP = Central Valley Project
IAIR = Initial Alternatives Information Report (Reclamation and DWR 2005)
msl = above mean sea level
N/A = not applicable
RM = river mile
SWP = State Water Project
TAF = thousand acre-feet

In the discussion of Investigation management measures, the term "enhancement" specifically refers to actions that improve environmental conditions above the future without-project conditions. Correspondingly, the term "mitigation" refers to actions that compensate or offset project impacts, returning conditions back to a similar level as the future without-project conditions. The relationship between enhancement and mitigation is illustrated in Figure 2-2.

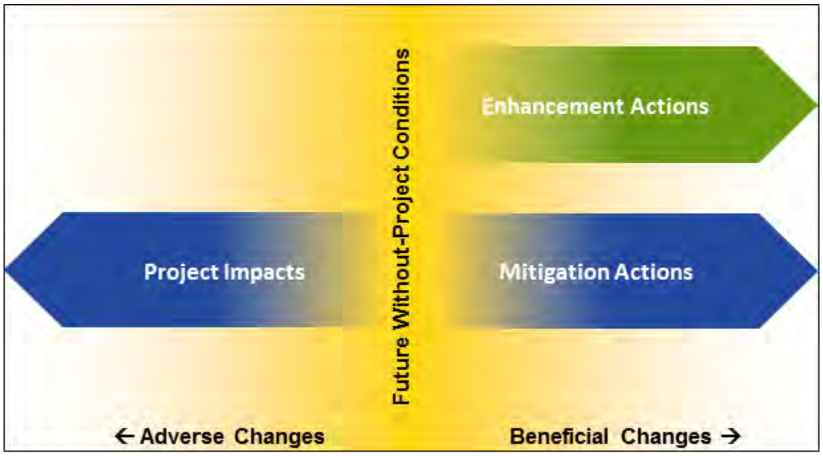


**Figure 2-2. Conceptual Schematic of Enhancement Actions Versus Mitigation Actions**

Measures that were eliminated from consideration and further development as action alternative components may be incorporated into action alternatives as mitigation measures. This is primarily because some measures may be found potentially effective in mitigating adverse impacts.

### Measures Addressing Both Primary Planning Objectives

Measures retained that address both primary planning objectives of the Investigation include those that fall under the categories of Perform Reservoir Operations and Water Management, and Increase Surface Water Storage in the upper San Joaquin River Basin, as summarized in Table 2-3.

### Modify Storage and Release Operations at Friant Dam

This measure would include modifications to storage and release operations at Friant Dam. These operational modifications would be intended to optimize the existing system of reservoirs. In addition, this measure 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.

*Temperance Flat RM 274 Reservoir* During previous phases of the Investigation, several potential surface water storage sites in the upper San Joaquin River Basin were identified and evaluated for potential inclusion in action alternatives (Reclamation and DWR 2003, 2005, and 2008). Multiple sizes and configurations were considered at several sites. Evaluations considered water supply operations, general environmental consequences, construction costs, and energy generation and use. Locations of each of the 22 surface water storage measures considered are shown in Figure 2-3.

A detailed plan formulation and screening process considering 22 storage sites in addition to those evaluated by CALFED led to selection of the Temperance Flat RM 274 Reservoir as the preferred surface water storage measure for further development and inclusion in action alternatives in the Draft Feasibility and Plan Refinement Phase (Figure 2-4). Temperance Flat RM 274 Reservoir would include 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.

With a top-of-active-storage capacity at elevation 985 feet above mean sea level (msl), Temperance Flat RM 274 Reservoir 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. Reservoir sizes up to elevation 1,100 feet msl at this site were considered in previous phases of the Investigation. Reservoir sizes corresponding to elevations higher than elevation 985 feet msl were not retained because the incremental new water supply provided did not appear justified in light of substantial additional effects to environmental resources and hydropower generation, and higher construction costs (Reclamation and DWR 2005).

**Historical Dam Site Selection**

Almost 84 years ago, Hyde Forbes, an engineering geologist, issued a geological report on three potential dam sites on the San Joaquin River for the State of California. The report evaluated geologic conditions at the Friant, Fort Miller, and Temperance Flat (RM 274) sites. The geologic study contributed to planning efforts that led to construction of Friant Dam (Forbes 1930).

From a water storage perspective, the RM 274 site was considered superior to the two other sites, but the Friant location was selected because constructing a dam at RM 274 would have required extending canals around or through the current Millerton Lake area, or constructing a second dam at Friant for diverting water to the canals (Reclamation and DWR 2003).

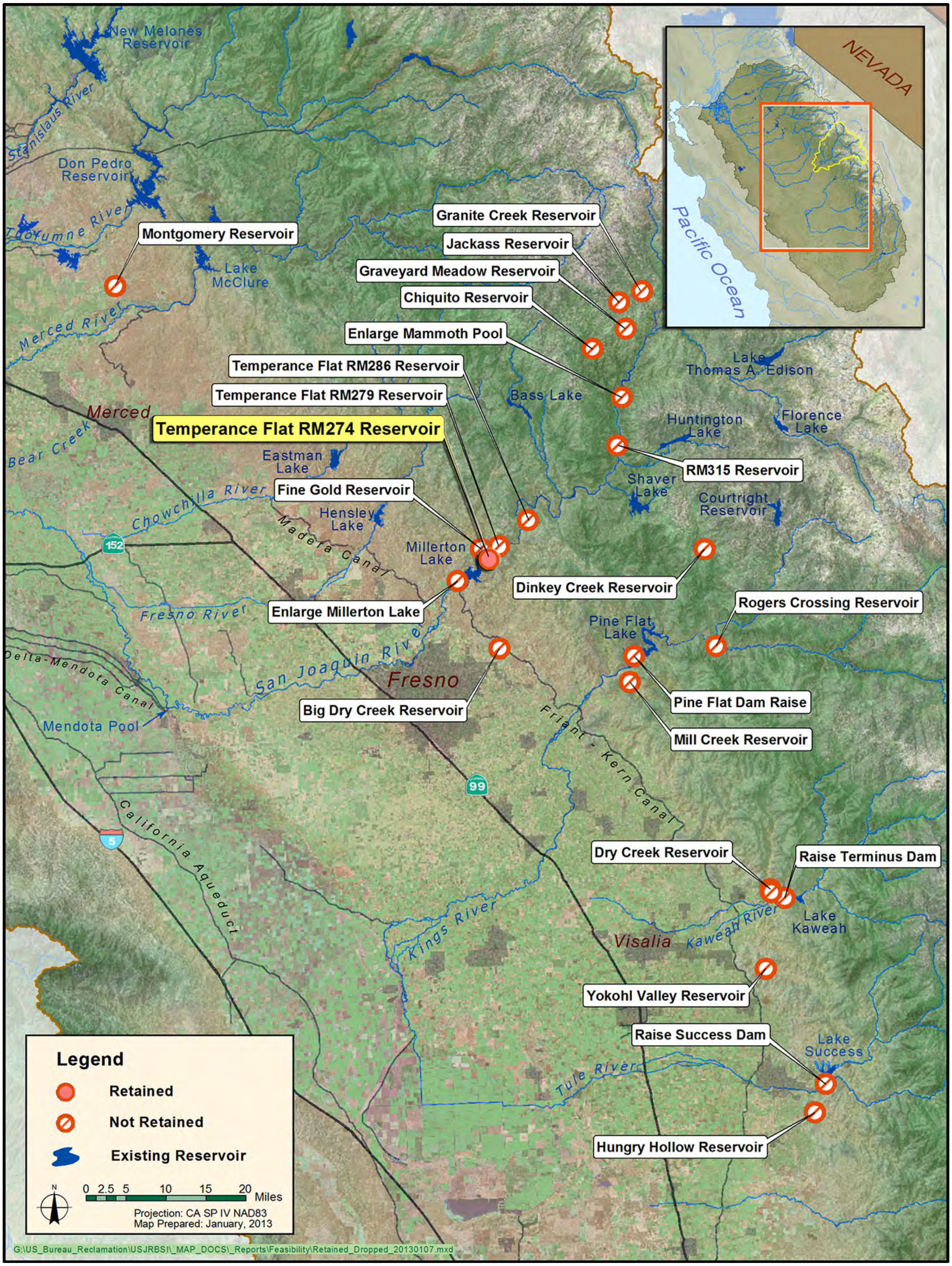


**Figure 2-3. Surface Water Storage Measures Considered**

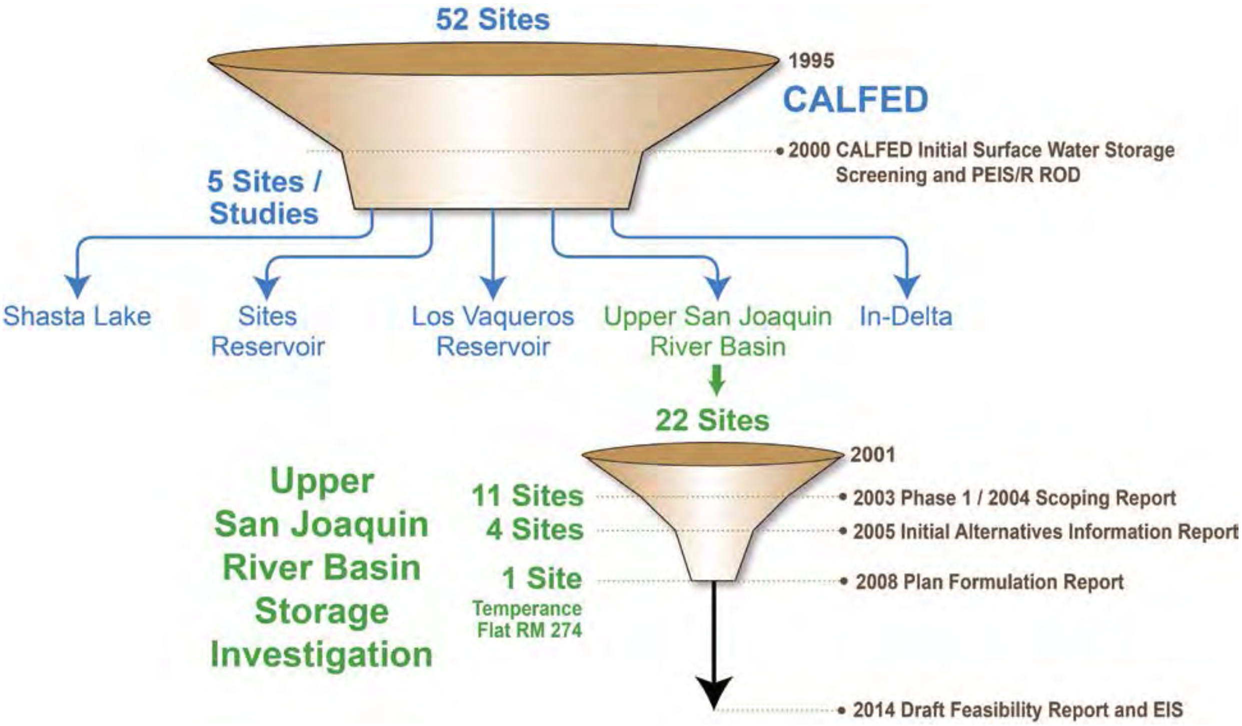


**Figure 2-4. CALFED and Investigation Process Leading to Selection of Temperance Flat RM 274 Reservoir Site**

*Increase Conjunctive Management of Water in the Friant Division of the CVP* The Friant Division of the CVP is already operated as a regional conjunctive management project. Currently, 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, such as increasing surface water storage in the upper San Joaquin River Basin, or direct delivery in lieu of groundwater pumping, would also 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. 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 per year of additional groundwater recharge could be possible on an average annual basis. 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 (2000b).

**Measures Specifically Addressing Increasing Water Supply Reliability and System Operational Flexibility** Measures retained that specifically address the primary planning objective of increasing water supply reliability and system operational flexibility include those that affect reservoir operations and water management.

*Modify Diversion to Madera and Friant-Kern Canals* This measure would involve modifying the timing and quantity of water diverted to Madera and Friant-Kern canals, which would increase water supply reliability to Friant Division contractors and may provide opportunities for groundwater banking.

**Measures Specifically Addressing Enhancing Water Temperature and Flow Conditions** Measures retained that specifically address the primary planning objective of enhancing water temperature and flow conditions include those that perform reservoir operations and water management, and construct water temperature management devices.

*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 supply, water temperature management, hydropower generation, and recreation. Reservoir-balancing scenarios were developed for surface water storage measures in the upper San Joaquin River Basin during the Plan Formulation Phase, and these reservoir-balancing scenarios were refined in the Draft Feasibility and Plan Refinement Phase of the Investigation.

*Construct Selective-Level Intake Structures on New Upstream Dams* SLISs could be constructed on the intakes for dams associated with measures to increase surface water storage in the upper San Joaquin River Basin. The SLISs would allow selective withdrawal of cold or warm water from these upper reservoirs for temperature management, thereby enhancing temperature conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish during sensitive life stages.

**Measures Addressing Secondary Planning Objectives**
Measures retained that address secondary planning measures include those that improve management of flood flows at Friant Dam, maintain and increase energy generation and improve energy generation management, maintain and increase recreational opportunities in the Study Area, and improve quality of water supplies delivered to urban areas. Descriptions of measures that also apply to primary planning objectives are not repeated in this section.

*Increase Flood Storage Space in or Upstream from Millerton Lake* Development of additional storage for water supply would provide 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 and DWR 2005), but subsequent evaluations in the Plan Formulation and Draft Feasibility and Plan Refinement phases of the Investigation led to inclusion of incidental flood space with the additional storage.

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

*Replace or Upgrade Recreational Facilities* Implementation of surface water storage and reservoir operations measures would affect existing recreational facilities in the primary study area. 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 action alternatives.

### *Measures Retained for Inclusion in Action Alternative*

Measures retained through the Draft Feasibility and Plan Refinement Phase for further consideration in action alternatives in this Draft EIS are summarized below and in Table 2-4.

**Table 2-4. Management Measures Retained for Action Alternatives in Draft Feasibility Report and this Draft Environmental Impact Statement**

| Objective Level | Planning Objective | Resources Management Measure Feature/Activity | Resources Management Measure Description |
|---|---|---|---|
| Primary | Increase Water Supply Reliability and Operational Flexibility; Enhance Water Temperature and Flow Conditions | Construct Temperance Flat River Mile 274 Reservoir | Increase surface water storage capacity by constructing dam in upstream portion of Millerton Lake at River Mile 274 |
| Primary | Increase Water Supply Reliability and Operational Flexibility; Enhance Water Temperature and Flow Conditions | Modify storage and release operations at Friant Dam | Optimize existing system of reservoirs by modifying Friant Dam operations |
| Primary | Increase Water Supply Reliability and Operational Flexibility; Enhance Water Temperature and Flow Conditions | Increase conjunctive management of water in Friant Division of the Central Valley Project | Increase incidental groundwater storage and/or recharge with additional Class 2 deliveries by constructing a dam in the upper San Joaquin River Basin |
| Primary | Increase Water Supply Reliability and Operational Flexibility | Modify diversion to Madera and Friant-Kern canals | Increase water supply reliability by modifying the timing and quantity of water diverted to Madera and Friant-Kern canals |
| Primary | Enhance Water Temperature and Flow Conditions | Balance water storage in Millerton Lake and new upstream reservoirs | Improve water temperature management through balancing water storage levels between multiple reservoirs |
| Primary | Enhance Water Temperature and Flow Conditions | Construct selective-level intake structures on new upstream dams | Provide flexibility in managing cold water in potential reservoirs upstream from Millerton Lake through selective withdrawal of cold or warm water |
| Secondary | Reduce Flood Damages Downstream from Friant Dam | Increase flood storage space in or upstream from Millerton Lake | Increase incidental flood storage space by constructing a dam in upstream portion of Millerton Lake at River Mile 274 |
| Secondary | Maintain Value of Hydropower Attributes | Construct new hydropower facilities on retained new surface water storage measures | Generate hydropower with new powerhouse using releases from new reservoir |
| Secondary | Maintain/Increase Recreational Opportunities | Replace or upgrade recreational facilities | Develop replacement facilities to provide similar or greater recreational opportunities at Millerton Lake and new reservoir |

## Draft Feasibility and Plan Refinement Phase

This section provides additional detail and context regarding the measures selected for inclusion in the Draft EIS action alternatives for Temperance Flat RM 274 Reservoir and rationale for some of the measures and options considered and deleted during plan refinement.

### *Physical Features Development Process for Action Alternatives*

Several engineering studies have been performed for the Draft Feasibility and Plan Refinement Phase of the Investigation to support development of Temperance Flat RM 274 Reservoir action alternatives. This section summarizes development of the main physical features of the action alternatives: Temperance Flat RM 274 Dam and appurtenant structures, diversion and outlet works, hydropower generation features, and temperature management features. Further details on site engineering and features are included in the Draft Feasibility Report Engineering Summary Appendix (Reclamation 2014).

**Dam and Appurtenant Structures** The PFR included action alternatives with an embankment dam type (Reclamation and DWR 2008); however, Reclamation reevaluated both embankment and roller-compacted concrete (RCC) dam types and recommended the RCC dam type for development of feasibility-level designs at the Temperance Flat RM 274 Dam site (Reclamation 2009a). A value planning study was conducted in 2011 to identify potential means and methods to reduce costs on all engineering features while meeting planning objectives (Reclamation 2011). Proposals specific to the dam included assessment of a thinner straight RCC dam, a curved RCC dam, and a new spillway configuration. Considering the construction method for RCC, a single center arch dam layout was determined to be most appropriate for the Temperance Flat RM 274 Dam site (Reclamation 2013).

**Diversion and Outlet Works** After the PFR (Reclamation and DWR 2008), updated flood routings prompted a refinement of the diversion-during-construction concept to use two rockfill cofferdams, two RCC cofferdams, a diversion notch in the left abutment of the RCC dam, and a 30-foot-diameter tunnel in the Big Bend area (the tunnel would be used for diversion and river outlet works permanent releases) (Reclamation 2009b, 2010). The value planning study concluded that the 30-foot diversion tunnel and rockfill cofferdams built to elevation 580 feet msl would be sufficient for a 10-year return period flood. The cofferdams were also designed to withstand larger floods and overtopping in the event that becomes necessary during construction, eliminating the need for the diversion notch and RCC cofferdams (Reclamation 2013).

**Hydropower Generation** Initial appraisal-level designs documented in the PFR for hydropower generation included an extended Kerckhoff No. 2 Powerhouse tunnel to supply water from Kerckhoff Dam to the proposed powerhouse (Reclamation and DWR 2008). Further assessment of the powerhouse design in the Draft Feasibility and Plan Refinement Phase included two power options: Power Option 1, consisting of two turbines for hydropower generation using water released from Temperance Flat RM 274 Reservoir; and Power Option 2, consisting of one turbine and an extended Kerckhoff No. 2 Powerhouse tunnel for hydropower generation using water released from Kerckhoff Lake, and one turbine for hydropower generation using water released from Temperance Flat RM 274 Reservoir. This assessment incorporated additional appraisal-level design data, refining layouts and design concepts, and establishing a cost range for power reimbursement planning purposes within constraints of water supply operations.

The value planning study had proposals specific to hydropower generation, including evaluating viability of onsite power facilities, and consolidating the powerhouse to the downstream toe of the dam. Hydroelectric pumped-storage facilities were considered during the value planning study; however, were rejected because it was found to be uneconomical given the variability in operations and head range (Reclamation 2011). Relocation of the powerhouse to the toe of the dam was also rejected because it would create congestion and schedule limitations at the construction site (Reclamation 2013). Additional economic evaluations were performed in the Draft Feasibility and Plan Refinement Phase to reinforce the viability of onsite power facilities.

Reclamation selected Power Option 1 as the preferred onsite hydropower option for feasibility-level designs (see Draft Feasibility Report Engineering Summary Appendix, Reclamation 2014). Power Option 2 was eliminated from further consideration in the Investigation because it was found to be less cost effective than Power Option 1 in meeting project requirements. In addition to Power Option 1, action alternatives include additional power reimbursement costs to fully offset the Kerckhoff Hydroelectric Project value.

**Intake Structure and Temperature Management** The PFR included consideration of temperature control devices (TCD) on Friant Dam and an SLIS at Temperance Flat RM 274 Reservoir (Reclamation and DWR 2008). Additional study during the Draft Feasibility and Plan Refinement Phase showed that an SLIS at Temperance Flat Reservoir would be more effective for cold-water pool management than a TCD at Friant Dam. The value planning study also proposed assessing the need for temperature management (Reclamation 2011). The incremental benefits and costs of an SLIS were evaluated using field costs and an economic benefit analysis for temperature improvements. Operations considered included a range of minimum carryover storage targets, and it was determined that the SLIS would be the most effective under action alternatives with higher Temperance Flat RM 274 Reservoir minimum carryover storage targets. For lower minimum carryover action alternatives, the SLIS cost was not as cost effective, and an LLIS was included in the design (Reclamation 2013).

### *Operations Development Process for Action Alternatives*

Operations were refined after the Plan Formulation Phase during the Draft Feasibility and Plan Refinement Phase, which included evaluation of several potential operation assumptions. A range of values for each assumption was explored to assess how well they accomplished planning objectives and criteria. The major categories of operation assumptions included:

- Minimum carryover storage targets in Millerton Lake and Temperance Flat RM 274 Reservoir
- Hydropower generation options
- Temperature management options
- Water supply beneficiaries (Friant Division contractors, CVP SOD contractors, CVP wildlife refuges, SWP SOD M&I contractors)

Operation assumptions were combined into a number of preliminary action alternatives, which were then evaluated to better understand the inter-relationships and impacts on planning objectives and criteria from various combinations of assumptions. The potential range of operation assumptions was limited to the following:

- Maintain Temperance Flat RM 274 Reservoir minimum carryover storage targets to less than 400 TAF to balance project objective achievements (water supply and emergency water supply, water temperature, hydropower, recreation).

- Operate Millerton Lake storage with a target of 340 TAF to balance project objective achievements (hydropower, recreation, water supply and emergency water supply, water temperature).
- Include multiple project beneficiaries to meet project objectives (economic and financial feasibility).
- Include an SLIS to improve reservoir cold-water pool management and release temperatures to the San Joaquin River.

Results from this evaluation also demonstrated that multiple water supply beneficiaries (Friant Division contractors, CVP SOD agricultural contractors, and SWP SOD M&I contractors) would likely be necessary for the project to be economically and financially feasible.

#### *Refinement of Operation Assumptions*

Building on findings developed in the previous evaluation, reservoir operation assumptions were refined and grouped into 10 scenarios, with varying priorities placed on the primary planning objectives. Analyses included varying the volume of new water supplies delivered to beneficiaries, and routing new supplies via the Friant-Kern and Madera canals as well as the San Joaquin River and Mendota Pool (to be conveyed to CVP SOD contractors or wildlife refuges or exchanged for SWP deliveries via the California Aqueduct).

Consideration was given to Level 2 refuge diversification and providing Incremental Level 4 refuge supplies during this stage, but Incremental Level 4 deliveries were not included in the action alternatives formulated in subsequent stages of operations development. Annual acquisitions of Incremental Level 4 water will continue to vary from year to year, depending on annual hydrology, water availability, water market pricing, and funding. Each year, Reclamation strives to provide as much Incremental Level 4 water as possible. Section 3406 (d)(2) of the CVPIA specifies that Reclamation must acquire this Incremental Level 4 water "…through voluntary measures such as water conservation, conjunctive use, purchase, lease, donations, or similar activities, or a combination of such activities which do not require involuntary reallocations of project yield." Therefore, it would be speculative to predict or assume quantities and locations of annual Incremental Level 4 acquisitions from willing sellers. Without that information, it could not be incorporated into the CalSim II modeling assumptions or other analyses.

The scenarios in this evaluation also included three levels of Temperance Flat RM 274 Reservoir minimum carryover storage targets to better characterize potential water supply reliability and ecosystem benefits. An SLIS was incorporated in several scenarios to improve control over river temperatures, with varying operations and timing. During this evaluation the ecosystem benefits assessment was expanded from inferring salmon habitat improvements from river temperature improvements to explicit modeling of spring-run Chinook salmon habitat improvements due to flow and temperature changes.

#### *Range of Operation Assumptions Included in Action Alternatives*

There are a number of operations assumptions and variations in implementing each assumption that affect the performance of the action alternatives in meeting planning objectives and criteria. The action alternatives formulated through the operations refinement process represent a range of (1) planning objective achievements and opportunities, (2) reservoir-balancing and water management actions between Millerton Lake and Temperance RM 274 Flat Reservoir, and (3) potential new water supply beneficiaries (multiple).

This section contains details of operation assumptions in the action alternative and how they could affect project accomplishments. These major operations variables relate to Millerton Lake/Friant Dam operations, Temperance Flat RM 274 Reservoir and Dam operations, new water supply beneficiaries, and new water supply routing. Operational rules for management of storage levels between Millerton Lake and Temperance Flat RM 274 Reservoir could significantly affect all project accomplishments. As described in this section, water supply reliability and flood damage reduction would be influenced by total carryover storage in the two reservoirs; and river release temperature, hydropower management, and recreation would be strongly influenced not only by total carryover storage, but by the balancing of storage between the two reservoirs.

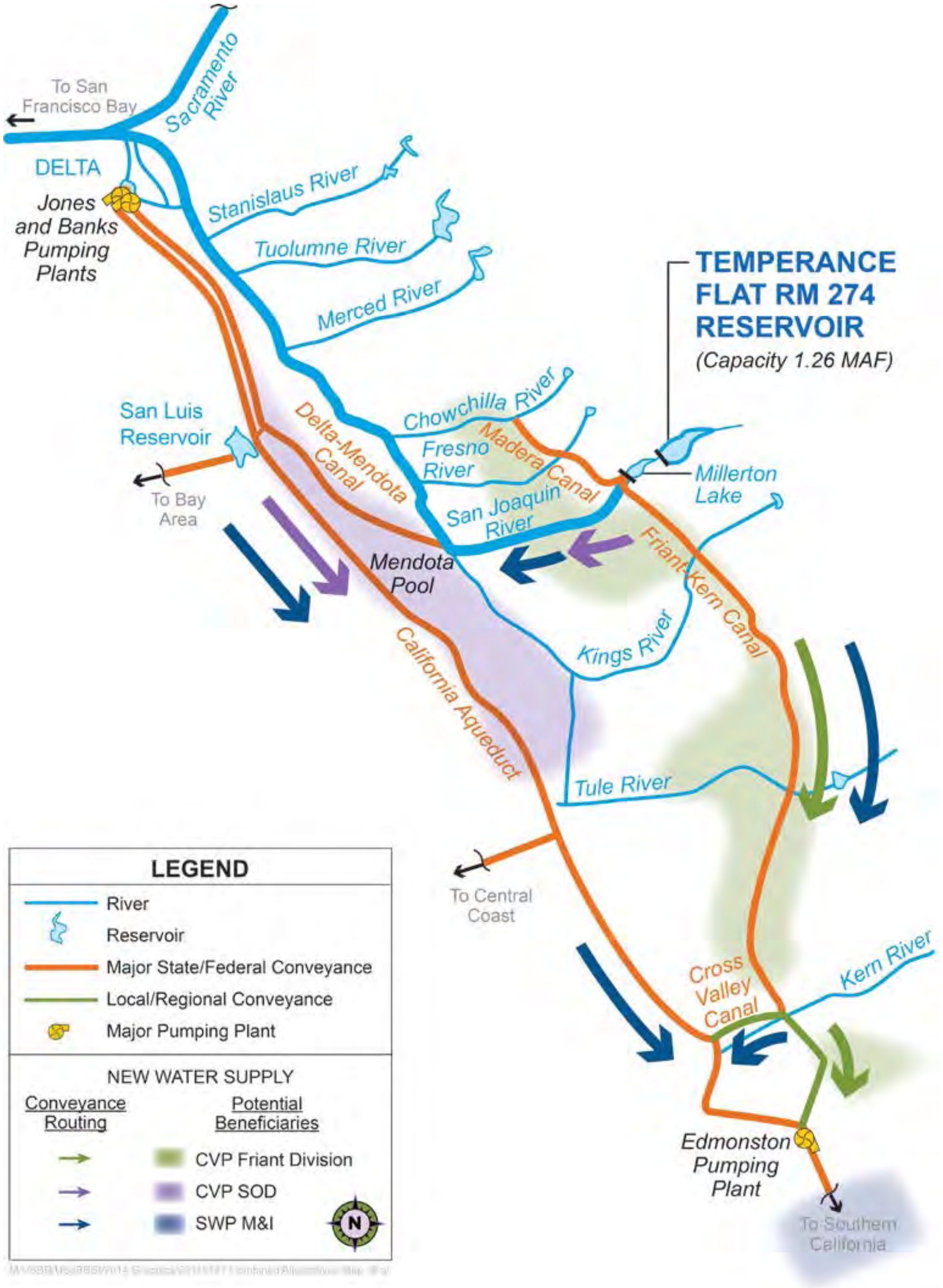
**Millerton Lake/Friant Dam Operations** Millerton Lake has historically been operated as an annual reservoir, with annual fluctuations of up to 110 feet between the Friant-Kern Canal outlet near elevation 470 feet msl (approximately 130 TAF) and the top of active storage at elevation 580 feet msl (approximately 520 TAF, or 450 TAF with Temperance Flat RM 274 Dam in place), depending on timing of inflow and demands. Evaluation of operations studies demonstrated that operations with stable Millerton Lake levels would result in multiple benefits, including cold water pool management, increased hydropower production at Friant Dam, and enhanced recreation opportunities, while only slightly decreasing water supply reliability. Alternative Plans 1, 2, 3, and 4 consider one Millerton Lake fixed carryover storage target at elevation 550 feet msl (340 TAF target storage), and Alternative Plan 5 considers a preference for keeping Millerton Lake storage at 340 TAF, but allows for Millerton Lake to be drawn down to 130 TAF when needed for water supply delivery.

**Temperance Flat RM 274 Reservoir Operations**
Constructing Temperance Flat RM 274 Dam and Reservoir would create a storage capacity of 1,331 TAF, reduce the storage capacity of Millerton Lake by about 75 TAF, and create additional net storage capacity of about 1,260 TAF. The top of active storage in Temperance Flat RM 274 Reservoir would be at elevation 985 feet msl. A range of minimum carryover storage target volumes from 100 TAF to 325 TAF (elevation 606 to 731 feet msl) is represented in the action alternatives. The action alternatives with greater than 100 TAF carryover in Temperance Flat RM 274 Reservoir support a minimum pool for cold water management, emergency water supply, recreation opportunities, and hydropower generation. Water levels in Temperance Flat RM 274 Reservoir would fluctuate significantly above the minimum carryover target level, depending on the time of year and water year type (see Modeling Appendix).

**New Water Supply Beneficiaries** Temperance Flat RM 274 Reservoir could influence SOD water management by increasing water supply deliveries through various conveyance options, including the Friant-Kern Canal and the Cross Valley Canal to the Friant Division of the CVP, and SWP contractors and the San Joaquin River to Mendota Pool. Potential beneficiaries of the Temperance Flat RM 274 Reservoir new water supply include the Friant Division of the CVP, CVP SOD agricultural contractors, and SWP SOD M&I contractors. San Joaquin Valley CVP wildlife refuges could also benefit by diversifying or increasing the number of sources of Level 2 refuge water supplies, thereby delivering higher quality San Joaquin River water supplies.

General options for routing water supply to different beneficiaries are shown in Figure 2-5. Delivery of new supplies to the Friant Division of the CVP considered long-term contract rules, conveyance capacities, delivery patterns, and changes due to the Settlement. The Friant Division of the CVP would experience improved water supply reliability due to shifting Section 215 water to Class 2 supplies. Delivery of new supplies to CVP SOD contractors was limited to current CVP SOD contract allocation limits, and to contractors with access to Mendota Pool, the Delta-Mendota Canal (DMC), or the California Aqueduct. Delivery to SWP SOD M&I contractors was based on the assumption that they would have demand for any amount of water supply delivered from Temperance Flat RM 274 Reservoir, within existing conveyance constraints.

**New Water Supply Routing** New water supply to the Friant Division of the CVP would be delivered via the Friant-Kern and Madera canals. Supply to the CVP SOD contractors and to wildlife refuges could be delivered via the San Joaquin River to Mendota Pool for delivery or exchange to contractors with access to Mendota Pool, the DMC, or the California Aqueduct. SWP SOD M&I water supply could be directly delivered via the Friant-Kern Canal, cross-valley conveyance, and the California Aqueduct. SWP SOD M&I supply could also be delivered via the San Joaquin River and Mendota Pool, exchanged with Level 2 refuge supplies or exchanged with CVP SOD deliveries, and then via the California Aqueduct. Delivery of Temperance Flat RM 274 Reservoir water supplies to SWP SOD M&I contractors could require modifications to the CVP consolidated place of use. Alternatively, Temperance Flat RM 274 Reservoir could be developed jointly between the CVP and another partner.



Key:
CVP = Central Valley Project
M&I = municipal and industrial
SOD = South-of-Delta
SWP = State Water Project

**Figure 2-5. Potential Temperance Flat RM 274 Reservoir Water Supply Beneficiaries and Routing Options**

**Carryover Storage** Action alternatives were formulated to balance traditional water supply reliability accomplishments (dependent on active storage capacity) with accomplishments tied to ecosystem and other public benefits (many of which are influenced by minimum carryover storage). This approach also is intended to maximize net benefits consistent with the P&G, maximize potential public benefits consistent with the Safe, Clean and Reliable Drinking Water Supply Act of 2010 (Senate Bill X7-2), and incorporate the various planning objectives for the Investigation.

Long-term average water supply reliability would increase with greater active storage and smaller volumes of minimum carryover storage, which would capture more San Joaquin River flood flows for delivery. Table 2-5 summarizes analyses performed to illustrate the sensitivity of Temperance Flat RM 274 Reservoir new water supply to changes in minimum carryover storage.

**Table 2-5. Long-Term Average Annual Change in Deliveries for Temperance Flat RM 274 Reservoir with Varying Minimum Carryover Storage Target**

| **Minimum Carryover Storage in Millerton Lake and Temperance Flat RM 274 Reservoir (TAF)[1]** | **230** | **320** | **440** | **540** | **665** |
|---|---|---|---|---|---|
| Active Storage Capacity in Millerton Lake and Temperance Flat RM 274 Reservoir (TAF)[2] | 1,550 | 1,460 | 1,340 | 1,240 | 1,115 |
| Average Annual Change in Deliveries (TAF)[3,4,5,6] | 98 | 91 | 85 | 70 – 76[7] | 61[8] |

Notes:

[1] Combined total storage capacity = 520 TAF Millerton (existing) + 1,260 TAF Temperance Flat (net additional) = 1,780 TAF.

[2] Active storage capacity = total storage capacity minus minimum carryover storage.

[3] Does not include deliveries pursuant to Paragraph 16(b) of the Stipulation of Settlement in in *NRDC, et al., v. Kirk Rodgers, et al*.

[4] Alternatives compared to No Action Alternative.

[5] All estimates of new water supply/change in deliveries based on CVP and SWP operating conditions with the 2008 USFWS and 2009 NMFS BOs (USFWS 2008, NMFS 2009).

[6] The values represent the net change in CVP/SWP systemwide deliveries, accounting for new deliveries from Temperance Flat RM 274 Reservoir and decreases in Delta exports due to the decrease in San Joaquin River flood flows. These sensitivity scenarios are based on storage of San Joaquin River supplies only and do not include operations integration with the broader CVP and SWP.

[7] Values represent the range of new water supply for Alternative Plans 1, 2, and 3, which include the same minimum carryover.

[8] Value for new water supply represents Alternative Plan 4.

Key:
BO = Biological Opinion
CVP = Central Valley Project
NMFS = U.S. Department of Commerce, National Marine Fisheries Service
RM = river mile
SWP = State Water Project
TAF = thousand acre-feet
USFWS = U.S. Department of the Interior, Fish and Wildlife Service

For ecosystem enhancements, greater active storage would correlate to more new water supply and therefore more potential flow-related improvements, while greater carryover storage could support more temperature-related improvements. San Joaquin River ecosystem enhancement for anadromous fish would also be related to water supply routing when using the river as a conveyance route to Mendota Pool.

**CVP and SWP Operating Conditions and Conveyance** The magnitude of new water supply that could be developed by Temperance Flat RM 274 Reservoir would be strongly influenced by CVP and SWP operating conditions and conveyance. Analysis of Temperance Flat RM 274 Reservoir in the draft feasibility phase with operating conditions under the 2008 USFWS and 2009 NMFS Biological Opinions (BO) (USFWS 2008, NMFS 2009) focuses on developing new water supply by storing wet year water supplies from the San Joaquin River that would otherwise be released from Friant Dam as flood flows. Operations conditions may be sensitive to uncertain future conditions related to integration with the broader CVP and SWP SOD export and storage system and/or increased flexibility for CVP and SWP SOD export operations.

## No Action Alternative

The No Action Alternative is the basis for comparison with the action alternatives, consistent with NEPA and CEQA guidelines and the Federal P&G (WRC 1983) and *Principles and Requirements for Federal Investments in Water Resources* (CEQ 2013). The No Action Alternative constitutes the No Project Alternative under CEQA, which represents “what would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services” (State CEQA Guidelines Section 15126.6(e)(2)). The existing conditions are also a basis of comparison for determining potential effects of the action alternatives on the affected environment, consistent with State CEQA Guidelines (Section 15126.6(e)(2)). For Federal feasibility studies of potential water resources projects, the No Action Alternative is intended to account for existing facilities, conditions, land uses, and reasonably foreseeable actions in the Study Area. Reasonably foreseeable actions include actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete.

If the action alternatives are not determined to be feasible, the project would not be implemented. The No Action Alternative reflects projected conditions in 2030 if the project is not implemented (2030 is the future level of development for which water resources are simulated in the Reclamation March 2012 California Water Resources Simulation Model [CalSim II] Benchmark). Plan formulation efforts and analysis of the action alternatives and the No Action Alternative described in this Draft EIS are based on CVP and SWP operational conditions described in the 2008 USFWS and 2009 NMFS BOs (USFWS 2008, NMFS 2009).

The sections below describe reasonably foreseeable SJRRP actions included in the No Action Alternative, and the potential consequences of implementing the No Action Alternative, as they relate to the objectives of the Investigation. The Modeling Appendix further describes the No Action Alternative, showing which actions and projects are assumed to be part of the future condition in the Reclamation March 2012 CalSim II Benchmark model for feasibility study operations modeling efforts.

### San Joaquin River Restoration Program Reasonably Foreseeable Actions Included in No Action Alternative

SJRRP actions implemented as of January 2014 are considered part of the existing conditions evaluated in this Draft EIS, as shown in Table 2-6. These actions include the management and release of Restoration Flows pursuant to Paragraph 13 of the San Joaquin River Stipulation of Settlement (Settlement), recapture of Restoration Flows at existing facilities on the San Joaquin River, and recirculation of those flows to the Friant Division of the CVP, pursuant to Paragraph 16 of the Settlement (NRDC et al. 2006).

## Table 2-6. SJRRP Actions Included in Existing and Future Conditions

| Settlement Paragraph | Action | Existing Conditions | Future Conditions |
|---|---|---|---|
| 11a | Construct Mendota Pool Bypass and modify Reach 2B to convey at least 4,500 cfs | No | Yes |
| 11a | Modify Reach 4B1 to convey at least 475 cfs | No | Yes[1] |
| 11a | Modify San Joaquin River Headgate Structure to enable fish passage and flow routing | No | Yes |
| 11a | Modify Sand Slough Control Structure to enable fish passage | No | Yes |
| 11a | Screen Arroyo Canal and provide fish passage at Sack Dam | No | Yes |
| 11a | Modify Eastside and Mariposa Bypasses for fish passage | No | Yes |
| 11a | Enable deployment of seasonal barriers at Mud and Salt sloughs | No | Yes |
| 11b | Modify Chowchilla Bypass Bifurcation Structure | No | Yes |
| 11b | Fill or isolate gravel pits | No | Yes |
| 11b | Modify Reach 4B1 to convey at least 4,500 cfs | No | No[1] |
| 12 | Enhance spawning gravel | No | Yes |
| 12 | Reduce potential for redd superimposition and/or hybridization | No | Yes |
| 12 | Supplement the salmon population | No | Yes |
| 12 | Modify floodplain and side-channel habitat | No | Yes |
| 12 | Enhance in-channel habitat | No | Yes |
| 12 | Reduce potential for aquatic predation of juvenile salmonids | No | Yes |
| 12 | Reduce potential for fish entrainment | No | Yes |
| 12 | Enable fish passage | No | Yes |
| 12 | Modify flood flow control structures | No | Yes |
| 12 | Apply various conservation measures to actions above | No | Yes |
| 13a | Release of Restoration Flows (Base Flows, Buffer Flows, and application of provisions to flexibly manage releases for the best achievement of the Restoration Goal pursuant to Exhibit B) | Yes | Yes |
| 13b | Riparian releases, downstream diversions, seepage losses | Yes | Yes |
| 13c | Acquire and release additional water supplies to address seepage losses | Yes | Yes |
| 13d | Minimize increases in flood risk in the Restoration Area as a result of Restoration flows | Yes | Yes |
| 13e | Changes in releases for maintenance of CVP facilities | Yes | Yes |
| 13f | Steps to prevent/address unexpected diversions or seepage | Yes | Yes |
| 13g | Measurement of flows within Restoration Area | Yes | Yes |
| 13h | Protection of water rights | Yes | Yes |
| 13i | Manage unreleased Restoration Flows | Yes | No |
| 13j | Establish Restoration Flow Guidelines | Yes | Yes |
| 14 | Reintroduce salmon | No | Yes |
| 16a | Recapture Restoration Flows in Restoration Area at Mendota Pool and wildlife refuges | Yes | No[2] |
| 16a | Recapture Restoration Flows in Delta at existing CVP/SWP facilities | No[2] | Yes |
| 16a | Recapture Restoration Flows at existing facilities on San Joaquin River with potential in-district modifications to existing facilities | No[2] | Yes |
| 16a | Recirculate recaptured Restoration Flows | Yes | Yes |
| 16b | Establish a Recovered Water Account and manage Friant Dam to make water supplies available to Friant Division long-term contractors at a preestablished rate | Yes | Yes |

**Table 2-6. SJRRP Actions Included in Existing and Future Conditions (contd.)**

| Settlement Paragraph | Action | Existing Conditions | Future Conditions |
|---|---|---|---|
| 20 | Changes to the Restoration Flows after December 31, 2025 | No | No |
| SA | Implement capacity restoration for the Friant-Kern and Madera canals | No | Yes[3] |
| SA | Construct permanent reverse flow pump-back facilities on the Friant-Kern Canal | No | Yes[3] |
| SA | Develop groundwater banking projects in the Friant Division of the CVP | No | Yes[3] |

Notes:
[1] As described in the Selected Alternative in the SJRRP PEIS/R ROD.
[2] Channel constraints temporarily limit conveyance of Restoration Flows
[3] Included in the Settlement Act: Part III – Friant Division Improvements(Public Law 111-11); addressed qualitatively in No Action and all action alternatives
Key:
cfs = cubic feet per second
CVP = Central Valley Project
Settlement = San Joaquin River Stipulation of Settlement
SJRRP = San Joaquin River Restoration Program
SWP = State Water Project

Actions from the SJRRP PEIS/R ROD Preferred Alternative are included in the future conditions evaluated in this Draft EIS. All actions included under the existing conditions are also included in the future conditions. Additional SJRRP actions anticipated to be implemented in the future are reasonably foreseeable under the No Action Alternative, and are included in the future conditions as shown in Table 2-6. These actions include physical modifications to the San Joaquin River pursuant to Paragraphs 11 and 12 of the Settlement; reintroduction of salmonids to the San Joaquin River, pursuant to Paragraph 14 of the Settlement; additional actions to recapture Restoration Flows at existing, modified, or new facilities on the San Joaquin River, pursuant to Paragraph 16; and improvements in the Friant Division of the CVP pursuant to Part III of Public Law 111-11.

Where relevant and quantifiable, SJRRP actions shown in Table 2-6 are included in the existing condition and/or future condition of the Reclamation March 2012 CalSim II Benchmark model. The No Action Alternative does not include any changes to Restoration Flows pursuant to Paragraph 13 or Paragraph 20 of the Settlement.

### Water Temperature and Flow Conditions

The No Action Alternative includes release of full Restoration Flows from Friant Dam to the San Joaquin River as provided in the Settlement. No actions other than SJRRP actions listed in Table 2-6 would be taken to enhance water temperature and flow conditions in the San Joaquin River under the No Action Alternative.

### Water Supply Reliability and System Operational Flexibility

Demands for water in the Central Valley and throughout California exceed available supplies, and the need for additional supplies is expected to grow. The population of California and the Central Valley is expected to increase by approximately 19 percent and 35 percent, respectively, by 2030 (California Department of Finance 2013). As this occurs, along with the need to maintain a healthy and vibrant industrial and agricultural economy, the demand for adequate and reliable water supplies will become more acute. Competition for available water supplies will intensify as water demands increase to support M&I, and associated urban growth relative to agricultural uses. Delivering water supplies SOD for agricultural and M&I users has also become increasingly constrained and complex. Increases in population, land-use changes, regulatory requirements, and limitations on storage and conveyance facilities will further strain available water supplies and infrastructure to meet water demands.

Water conservation and reuse efforts are increasing and mandatory conservation resulting from increasing shortages will continue. In the past, during drought years, many water conservation measures were implemented to reduce the effects of the drought. In the future, as more water conservation measures become necessary to help meet even average year demands, the impacts of droughts will be much more severe. Besides mandatory conservation, without developing cost-efficient new sources, more reliance will be placed on shifting uses from such areas as agricultural production to urban uses. It is likely that with continued and deepening shortages in available water supplies, increasing adverse economic impacts will occur over time in the Central Valley and elsewhere in California. One possible impact is an increase in water costs, resulting in a further shift in agricultural production to areas outside California and/or outside the United States or the conversion to higher value permanent crops.

Under the No Action Alternative, Friant Dam would continue operating similarly to existing conditions (with implementation of the Settlement, including Restoration Flows). The No Action Alternative would continue to meet water supply demands at levels similar to existing conditions.

### Flood Management, Hydropower Attributes, Recreation, San Joaquin River Water Quality, Urban Water Quality

Flood system improvements along the San Joaquin River downstream from Friant Dam are currently underway or will be initiated in the future by the USACE, DWR, and local/regional flood management districts. Additionally, modifications to San Joaquin River flow conveyance features downstream from Friant Dam will be initiated in the future by Reclamation under the SJRRP.

California’s demand for electricity is expected to substantially increase in the future. Under the No Action Alternative, PG&E is assumed to relicense the existing Kerckhoff Hydroelectric Project under the FERC in 2022. PG&E will have decommissioned the No. 2 unit in the Kerckhoff Powerhouse (PG&E 2012), which would decrease the powerhouse capacity below the 30-megawatt (MW) Renewable Portfolio Standard limit.

As California’s population continues to grow, demands for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley would grow significantly. Regional population growth in the vicinity of Millerton Lake is expected to result in increased demand for recreation and increased visitation at Millerton Lake (Reclamation and State Parks 2010).

Several activities to improve San Joaquin River water quality conditions through reducing pollutant concentrations and/or reducing pollutant loading to the river are underway, including continued implementation of the Westside Regional Drainage Plan and the Grassland Bypass Project.

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 2000b). Under the No Action Alternative, there would be no actions to increase storage in the upper San Joaquin River Basin that could enhance CVP and/or SWP operational flexibility to meet water quality goals in the Delta or facilitate water quality exchanges and similar programs to improve urban water quality.

## Action Alternatives

The action alternatives are described in the following sections. Features common to all action alternatives are described in detail, including environmental commitments. Detailed discussions of potential effects and proposed mitigation measures for each action alternative are included in Chapters 4 through 7 and 9 through 26 of this Draft EIS. If any action alternative is authorized by Congress, Reclamation would implement the features, operations, environmental commitments, mitigation measures, and permit and approval conditions, as described throughout this Draft EIS, Final EIS, ROD, and in permits or approvals issued for implementation.

### Description of Action Alternatives

#### *Alternative Plan 1*

Alternative Plan 1 would provide new water supplies to Friant Division and SWP SOD M&I contractors. New supplies to SWP SOD M&I contractors would be delivered via the San Joaquin River and exchanged for Delta supplies at Mendota Pool, where an equivalent amount of Delta water could be delivered to SWP SOD M&I contractors via the California Aqueduct. Alternative Plan 1 would include minimum carryover storage targets of 340 TAF in Millerton Lake and 200 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 540 TAF.

Alternative Plan 1 would include a fixed LLIS on Temperance Flat RM 274 Reservoir. The LLIS would be an inclined reinforced-concrete structure, located approximately 7,200 feet upstream from the dam and adjacent to and upstream from the outlet works entrance. The LLIS would consist of two, low-level fixed-wheel gates sized in combination to pass 20,000 cfs during high-flow conditions. Water through each gate would flow directly into the outlet works tunnel. Because the lower gates would also function to release higher flood flows, both would be necessary but only one gate would be opened, as needed, for normal releases.

#### *Alternative Plan 2*

Alternative Plan 2 would provide new water supplies to Friant Division contractors, SWP SOD M&I contractors, and CVP SOD contractors. New supplies to SWP SOD M&I contractors would be delivered via the San Joaquin River and exchanged for Delta supplies at Mendota Pool, where an equivalent amount of Delta water could be delivered to SWP SOD M&I contractors via the California Aqueduct.

New water supplies to CVP SOD contractors would be developed by delivering CVPIA Level 2 refuge water from Temperance Flat RM 274 Reservoir. The water would be released to the San Joaquin River for refuge deliveries from Mendota Pool, which would make Delta supplies available at Mendota Pool for direct access or exchange with Delta supplies for delivery to CVP SOD contractors.

Similar to Alternative Plan 1, Alternative Plan 2 would have minimum carryover storage targets of 340 TAF in Millerton Lake and 200 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 540 TAF. Alternative Plan 2 would include a fixed LLIS on Temperance Flat RM 274 Reservoir, as described for Alternative Plan 1.

#### *Alternative Plan 3*

Alternative Plan 3 would provide new water supplies to Friant Division contractors, SWP SOD M&I contractors, and CVP SOD contractors. New supplies to SWP SOD M&I contractors would be delivered via the Friant-Kern Canal, cross-valley conveyance, and the California Aqueduct. New water supplies to CVP SOD contractors would be delivered via the San Joaquin River to Mendota Pool for direct access or exchange with Delta supplies.

Similar to Alternative Plans 1 and 2, Alternative Plan 3 would have minimum carryover storage targets 340 TAF in Millerton Lake and 200 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 540 TAF. Alternative Plan 3 would include a fixed LLIS on Temperance Flat RM 274 Reservoir, as described for Alternative Plan 1.

#### *Alternative Plan 4*

Alternative Plan 4 would provide new water supplies to Friant Division contractors, SWP SOD M&I contractors, and CVP SOD contractors. New supplies to SWP SOD M&I contractors and CVP SOD contractors would be delivered via the San Joaquin River and exchanged for Delta supplies at Mendota Pool, where an equivalent amount of Delta water could be delivered to SWP SOD M&I contractors via the California Aqueduct. New water supplies to CVP SOD contractors would be delivered via the San Joaquin River to Mendota Pool, for direct access or exchange with Delta supplies. Alternative Plan 4 would have minimum carryover storage targets of 340 TAF in Millerton Lake and 325 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 625 TAF.

Alternative Plan 4 would include an SLIS on Temperance Flat RM 274 Reservoir. The SLIS would be an inclined reinforced-concrete structure, located approximately 7,200 feet upstream from the dam and adjacent to and upstream from the outlet works entrance. The SLIS would consist of two low-level fixed-wheel gates sized in combination to pass 20,000 cfs during high-flow conditions, and three 6,000 cfs upper-level fixed-wheel gates to allow withdrawal from different temperature zones in the reservoir. Water through each lower gate would flow directly into the outlet works tunnel. Because the lower gates would also function to release higher flood flows, both would be necessary but only one gate would be opened, when needed, for low-elevation releases to meet water temperature objectives.

#### *Alternative Plan 5*

Alternative Plan 5 would provide new water supplies to Friant Division and CVP SOD contractors. New water supplies to CVP SOD contractors would be delivered via the San Joaquin River to Mendota Pool for direct access or exchange with Delta supplies.

Alternative Plan 5 would have minimum carryover storage targets of 130 TAF in Millerton Lake and 100 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 230 TAF. Alternative Plan 5 considers an operational preference for keeping Millerton Lake storage at 340 TAF, but allows for Millerton Lake to be drawn down to 130 TAF when needed for water supply delivery, and to fill completely (to 450 TAF) after Temperance Flat RM 274 Reservoir fills. This action alternative also considers additional dry year carryover, where some new water supply that could be delivered in wetter years is held over for delivery in subsequent drier years. This operation slightly decreases the magnitude of long-term average new water supply, but increases deliveries in drier years. Alternative Plan 5 would include a fixed LLIS on Temperance Flat RM 274 Reservoir, as described for Alternative Plan 1.

### Features Common to All Action Alternatives

The following features are common to all action alternatives and are assumed for impact analyses in this Draft EIS. Physical features common to all action alternatives are shown in Figures

2-6 through 2-9. Variations in physical features, such as dam location, design and construction approach, hydropower features, and location of outlet works/diversion tunnels, were considered during the development of feasibility designs and cost estimates, but the preferred approaches were identified during feasibility design and are reflected consistently in the action alternatives.

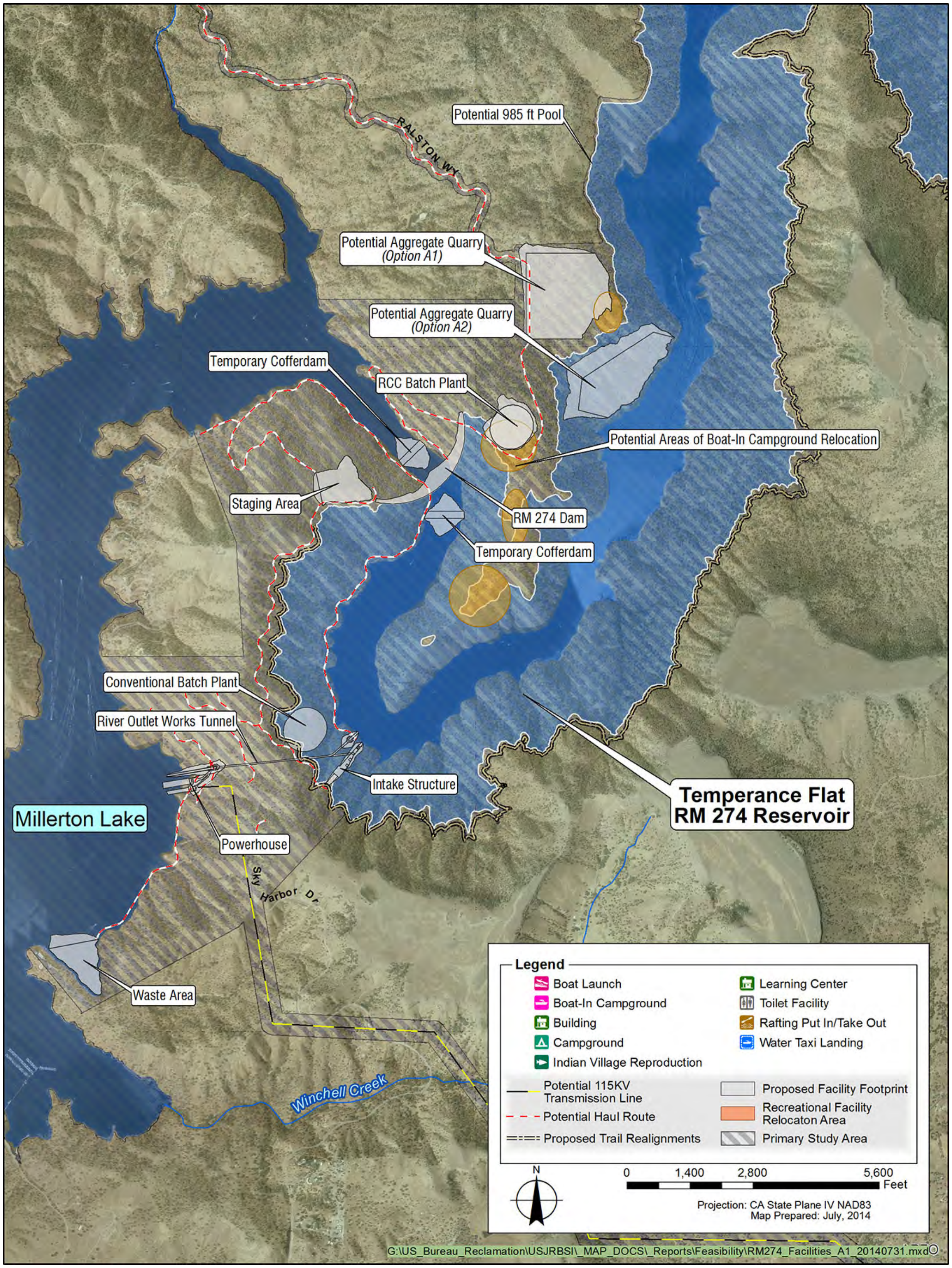


**Figure 2-6. Proposed Temperance Flat RM 274 Reservoir Project Features for Quarry, Batch Plant, and Haul Road Option A**

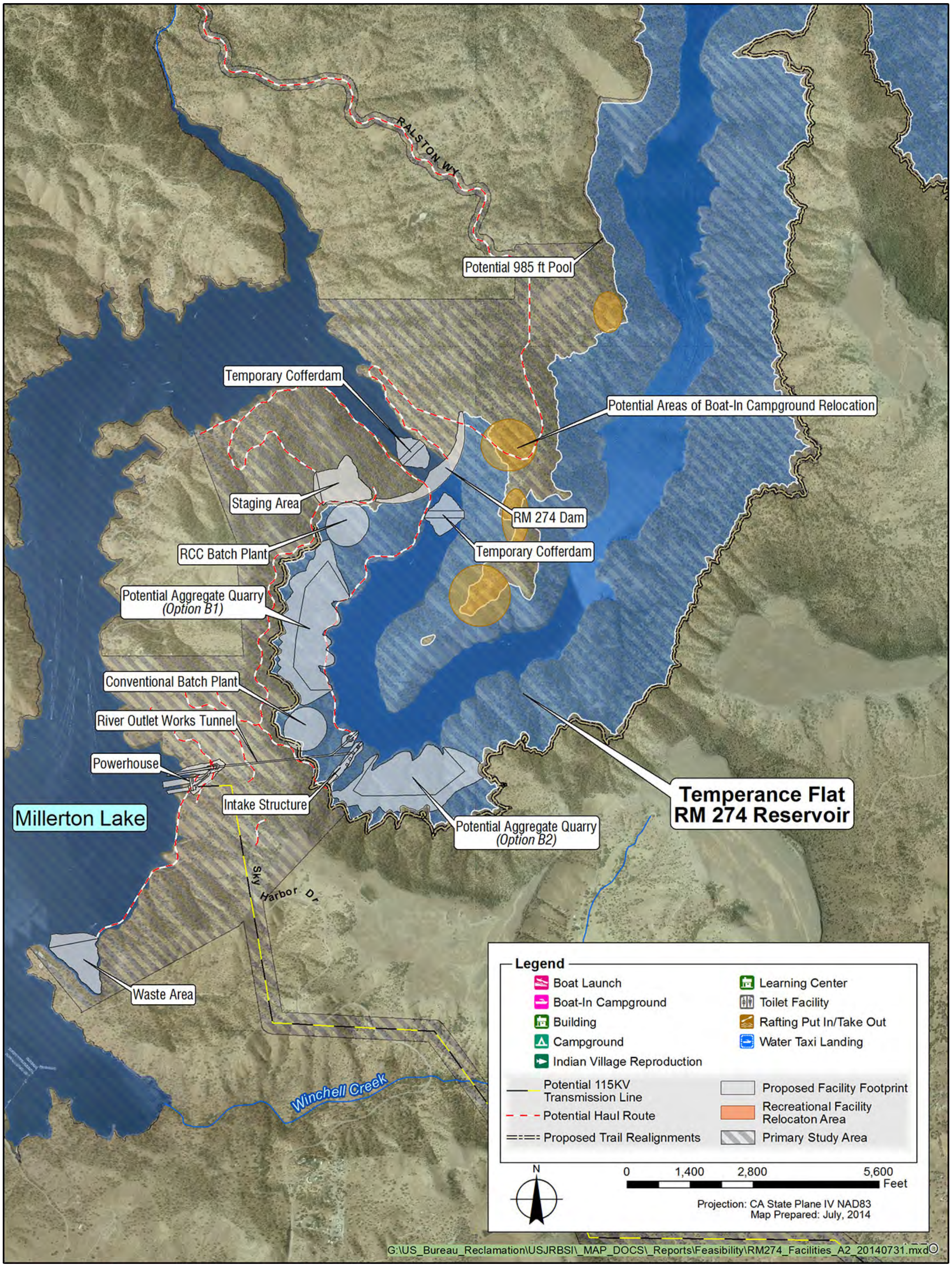


**Figure 2-7. Proposed Temperance Flat RM 274 Reservoir Project Features for Quarry, Batch Plant, and Haul Road Option B**

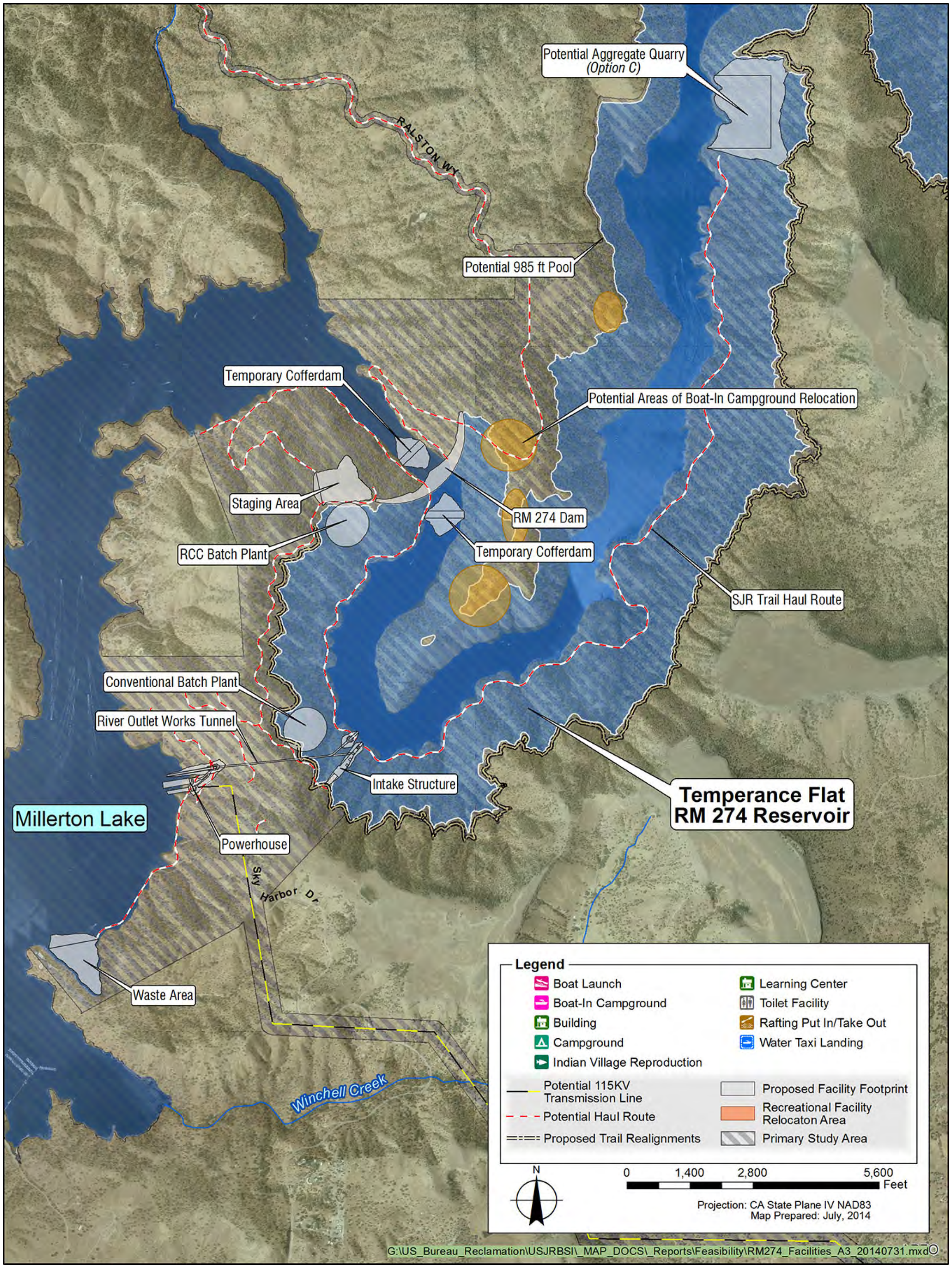


**Figure 2-8. Proposed Temperance Flat RM 274 Reservoir Project Features for Quarry, Batch Plant, and Haul Road Option C**

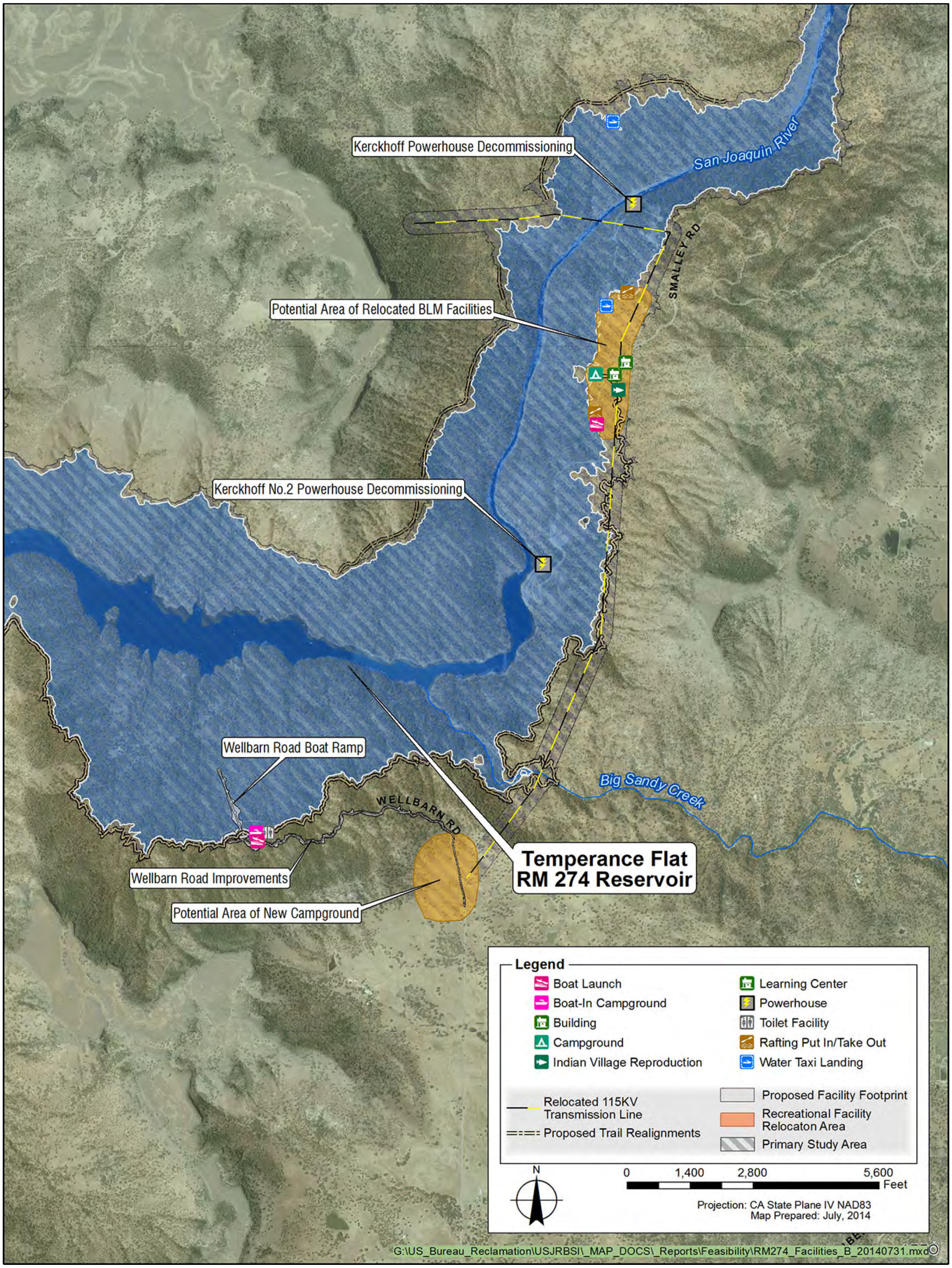


Figure 2-9. Proposed Temperance Flat RM 274 Reservoir Upstream Project Features

### *Dam and Reservoir*

The proposed dam at Temperance Flat RM 274 would be a RCC arch gravity dam. This dam site would be located 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. The dam would be approximately 665 feet high, from a base elevation of 340 feet msl in the bottom of Millerton Lake (San Joaquin River channel) at the upstream face to the dam crest at 1,005 feet msl. The width of the dam crest would be approximately 3,360 feet. The overflow section of Temperance Flat RM 274 Dam would consist of a 665-foot-wide uncontrolled ogee crest spillway at elevation 985 feet msl.

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

Temperance Flat RM 274 Reservoir would inundate varying areas of vegetated shoreline, riparian, and upland habitat. Vegetation would be cleared from about 3,580 acres within the inundation area to keep debris clear of dam operations, and for the safety of recreational users and habitat concerns.

Extensive alternatives analysis was performed as part of the plan formulation process for the Investigation since 2002, with 22 reservoir sites evaluated for their ability to meet basic project purposes and objectives, and in consideration of environmental effects, cost-effectiveness, and overall feasibility. Alternative dam and reservoir sites included options suggested during the scoping process. The number of alternative reservoir sites was reduced through a phased evaluation process considering the ability to achieve site-specific project objectives and/or the purpose and need. Other potential alternatives failed to meet the basic project purpose and need, and had substantial impacts on biological resources, hydropower, and other resources.

While the plan formulation process following the P&G and documented in the 2008 PFR considers NEPA, it is not the direct vehicle for NEPA compliance. A NEPA document must provide specific information related to the process to develop, screen and evaluate alternatives. All reasonable alternatives should be screened, and those that meet the basic project purposes should be carried through the analysis of the NEPA document. The CEQ Section 1502.14 states that agencies shall "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." Agencies have discretion in determining the range of reasonable alternatives to include in the rigorous analysis of a NEPA document.

In *Northern Alaska Environmental Center v. Kempthorne*, U.S. 9th Circuit 457 F.3d 969, 978 (9th Cir. 2006), NEPA requirements for a range of reasonable alternatives are summarized succinctly:

> *…an agency's consideration of alternatives is sufficient if it considers an appropriate range of alternatives, even if it does not consider every available alternative. Headwaters, Inc. v. Bureau of Land Mgmt., 914 F.2d 1174, 1181 (9th Cir.1990). An agency need not, therefore, discuss alternatives similar to alternatives actually considered, or alternatives which are "infeasible, ineffective, or inconsistent with the basic policy objectives for the management of the area." Id. at 1180-81 (citing California v. Block, 690 F.2d 753, 767 (9th Cir.1982)).*

Reclamation has thoroughly explained its process for developing the range of alternatives carried forward in the EIS and explained why alternatives and management measures were rejected from detailed discussion in the EIS, consistent with the alternatives development processes upheld in recent case law (see *Protect Our Communities Foundation v. Salazar*, 2013 U.S. Dist. LEXIS 159281 [S.D. Cal. 2013]; and *La Cuna De Aztlan Sacred Sites Protection Circle Advisory Committee v. Interior*, 2013 U.S. Dist. LEXIS 123331 [E.D. Cal. 2013]).

Reclamation is required to examine a range of reasonable alternatives, and provide a detailed analysis of the action alternatives and No Action Alternative, but is not obligated to undertake a detailed examination of every conceivable measure that could benefit water supply reliability and operational flexibility or enhancements to water temperature and flow conditions in the San Joaquin River downstream from Friant Dam. For these reasons, Temperance Flat RM 274 was retained as the preferred dam and reservoir location in this Draft EIS. Additional discussion of the plan formulation and screening processes is provided in the Plan Formulation Appendix.

### *Cofferdams*

Upstream and downstream cofferdams would be required to divert stream flows during construction and to prevent inundation of the site from Millerton Lake. Both cofferdams would require a minimum crest elevation of 580 feet msl and height of 240 feet to accommodate normal reservoir operation of Millerton Lake and to pass diversion flows. After completion of the RCC arch gravity dam, cofferdams would be removed to elevation 525 feet msl.

### *Diversion Tunnel*

A 30-foot-diameter and approximately 2,900-foot-long concrete-lined tunnel would be constructed through the left abutment, approximately 1.5 miles upstream from the main dam. The tunnel would later serve as the outlet works tunnel for the reservoir.

**Relation of the Outlet Tunnel and Intake Structures**

The diversion tunnel would be used to divert the San Joaquin River around the Temperance Flat RM 274 Dam site during dam construction. After the dam is completed, the diversion tunnel would serve as the outlet works tunnel for the reservoir. An intake structure on the outlet tunnel (either a Selective Level Intake Structure or a Low Level Intake Structure, depending on the action alternative) would direct water into the tunnel. Finally, water in the tunnel would be diverted through the powerhouse and/or valve house, depending on operations.

### *Intake Structure*

All action alternatives would include an inclined, reinforced-concrete intake structure located approximately 7,200 feet upstream from the dam and adjacent to and upstream from the outlet works entrance. The length, width, and slope of the intake structure, along with number, location, and operability of inlet gates, would vary among the action alternatives. Descriptions for the intake structure configurations specific to each action alternative are included in the alternative-specific sections later in this chapter.

### *Powerhouse and Transmission Facilities*

The Temperance Flat RM 274 Reservoir powerhouse would be located approximately 750 feet southwest from the diversion tunnel outlet portal and consist of an 85-foot-deep reinforced-concrete substructure and 64-foot-high steel superstructure. The powerhouse would contain two 80 MW turbines, which in combination are sized to pass a design flow of 6,000 cubic feet per second (cfs). After passing through the turbine units, water would then flow through an approximately 490-foot-long tailrace tunnel into an open channel to Millerton Lake, regulated by a concrete weir to maintain a minimum tailwater elevation of 550 feet msl. An aboveground switchyard would connect to a new Temperance Flat transmission line, which would traverse approximately 5 miles southeast to the existing Kerckhoff–Sanger transmission line.

### *Valve House*

The Temperance Flat RM 274 Reservoir valve house would be sized to pass up to 20,000 cfs. Water would be directed from the outlet works tunnel in a 30-foot-diameter penstock and then diverted through the valve house and/or powerhouse, depending on operations. The valve house would be an at-grade, reinforced-concrete structure connected to the powerhouse superstructure, located approximately 650 feet southwest from the diversion tunnel portal. External features would include a river outlet works chute, approximately 600 feet long, which would release into Millerton Lake.

### *Quarry, Batch Plant, and Haul Road Options*

The aggregate quarry would supply aggregate for the main dam and cofferdams. Because of uncertainties in the adequacy of rock for aggregate, three quarry options with varying locations are being considered within each action alterative. The main dam batch plant location and haul road, connecting the potential quarry site to the main dam batch plant, would also vary depending on quarry option. The specific locations of aggregate quarry sites, batch plants, and haul roads are subject to change based on further engineering and geotechnical analyses. Only one quarry site, batch plant, and haul road option, however, would be selected to support construction activities under any of the action alternatives.

Regardless of the quarry option selected, final quarry development would typically include benched or terraced rock faces in sound rock, with 40-foot vertical faces and 20-foot horizontal bench widths. The quarried area would be closed to the public and include access barriers. In addition, long-term slope inspection and maintenance would be required. Appropriate signage and restrictions for reservoir recreation would be required for quarry options within the reservoir. The three quarry, batch plant, and haul road options are described in the following sections.

#### Quarry, Batch Plant, and Haul Road Option A

*Aggregate Quarry* Quarry, batch plant, and haul road Option A includes two potential quarry sites. Potential quarry site A1 would be located approximately 2,500 feet northeast of the dam’s right abutment on the Madera County side of Millerton Lake, outside the proposed inundation area. Potential quarry site A2 would be located directly southwest of quarry site A1 within the inundation area, also on the Madera County side of Millerton Lake. Both quarry sites would be approximately 92 acres in size. Only one quarry site would ultimately be constructed. An estimated 10 million cubic yards of material would be excavated from the proposed quarry site, and excavated to approximately elevation 600 feet msl. The specific location, size, and geometry of the site would be subject to change based on further engineering and geotechnical analyses.

*Batch Plants* The main dam potential batch plant site would be located approximately 800 feet east of the dam’s right abutment. This batch plant site would be about 19 acres in size and most of the site would be outside the proposed inundation area. This dam batch plant site is the same for both quarry sites (A1 and A2) under Option A. The potential batch plant for the diversion tunnel, powerhouse, valve house, and intake structure would be located east of Sky Harbour Road between the powerhouse and intake structure sites (just east of the intersection of Access Road Nos. 1 and 2 within the inundation area). This second batch plant would be about 19 acres in size. Cement and pozzolan would likely be delivered by truck to both batch plants, most likely from railroad terminals near Fresno, California. The specific locations of the batch plants are subject to change based on further engineering and geotechnical analyses.

*Haul Roads* Five temporary haul roads would provide construction access to the aggregate quarry, batch plant, dam and cofferdams, staging area, intake structures, and diversion tunnel waste area. The total length of temporary haul roads would be approximately 10 miles with two lanes, with each lane width ranging from 12 to 20 feet. The specific locations of the haul roads are subject to change based on further engineering and geotechnical analyses.

### Quarry, Batch Plant, and Haul Road Option B

*Aggregate Quarry* Quarry, batch plant, and haul road Option B includes two potential quarry sites. Potential quarry site B1 would be located within the inundation area on the Fresno County side of Millerton Lake, between the main dam and intake structure. Potential quarry site B2 would be located southeast of potential quarry site B1, also within the inundation area, upstream from the intake structure. An estimated 10 million cubic yards of material would be excavated from either quarry site or a combination of both of the proposed quarry sites, and the quarry site(s) would be excavated to approximately elevation 600 feet msl. The specific location(s), size, and geometry of the site(s) would be subject to change based on further engineering and geotechnical analyses.

*Batch Plants* The main dam potential batch plant site would be located directly south of the staging area on the dam's left abutment. This batch plant site would be about 19 acres in size and would be inside the proposed inundation area. The potential batch plant for the diversion tunnel, powerhouse, valve house, and intake structure would be located east of Sky Harbour Road between the powerhouse and intake structure sites (just east of the intersection of Access Road Nos. 1 and 2 within the inundation area). This second batch plant would be about 19 acres in size. Cement and pozzolan would likely be delivered by truck to both batch plants, most likely from railroad terminals near Fresno, California. The specific locations of the batch plants are subject to change based on further engineering and geotechnical analyses.

*Haul Road* Four temporary haul roads would provide construction access to the aggregate quarry/quarries, batch plant, dam and cofferdams, staging area, intake structures, and diversion tunnel waste area. The total length of temporary haul roads would be approximately 7 miles with two lanes, with each lane width ranging from 12 to 20 feet. The haul road from potential quarry site B2 would approximately follow the existing San Joaquin River Trail. The specific locations of the haul roads are subject to change based on further engineering and geotechnical analyses.

### Quarry, Batch Plant, and Haul Road Option C

*Aggregate Quarry* The proposed quarry site under quarry, batch plant, and haul road Option C would be located within the inundation area on the Fresno County side of Millerton Lake at River Mile 279. The quarry site would be approximately 92 acres in size. An estimated 10 million cubic yards of material would be excavated from the proposed quarry site, and excavated to approximately elevation 600 feet msl. The specific location, size, and geometry of the site would be subject to change based on further engineering and geotechnical analyses.

*Batch Plants* Potential batch plants for quarry, batch plant, and haul road Option C would be the same as described under Option B. The specific locations of the batch plants are subject to change based on further engineering and geotechnical analyses.

*Haul Road* Five temporary haul roads would provide construction access to the aggregate quarry, batch plant, dam and cofferdams, staging area, intake structures, and diversion tunnel waste area. The total length of temporary haul roads would be approximately 14 miles with two lanes, with each lane width ranging from 12 to 20 feet. The haul road between Option C and the dam batch plant would approximately follow the existing San Joaquin River Trail. The specific locations of the haul roads are subject to change based on further engineering and geotechnical analyses.

#### ***Staging Area***

The dam staging area would be located directly above the dam’s left abutment, outside the proposed inundation area, and be approximately 21 acres in size. This area would be used for construction staging and aggregate stockpiling. Trucks would be used to transport stockpiled aggregate to the dam site.

A marine staging area for constructing the cofferdams would be located between the proposed haul roads and Millerton Lake shoreline downstream from the downstream cofferdam. Additional area, between the cofferdams and in the inundation area slightly upstream from the upstream cofferdam, would also be used to stage and construct the cofferdams. Excavated material from the marine staging area would be used in the cofferdams.

#### ***Access Roads***

Three permanent access roads would provide O&M staff with access to the dam, intake structures, and valve house/powerhouse. Permanent access roads would leave Sky Harbour Road near the valve house and have a total length of approximately 3.5 miles. These roads would consist of two 12-foot wide lanes.

#### ***Waste Area***

The waste area would be located approximately 3,200 feet southwest of the powerhouse within the existing inundation area of Millerton Lake and be approximately 21.5 acres in size. This area would be used for permanent disposal of remaining waste rock from diversion tunnel and powerhouse excavation.

#### ***Kerckhoff Hydroelectric Project Facilities***

Temperance Flat RM 274 Reservoir, with a top-of-active storage at elevation 985 feet msl, would inundate the existing Kerckhoff Project powerhouses, Kerckhoff Powerhouse and Kerckhoff No. 2 Powerhouse. Kerckhoff Powerhouse is an aboveground facility and would be removed and restored to near-natural conditions. Kerckhoff No. 2 Powerhouse is an underground facility and would be abandoned in place. The majority of mechanical and electrical equipment for both powerhouses would be removed and salvaged. Temperance Flat RM 274 Reservoir top-of-active storage would be just a few feet below the top of the Kerckhoff Dam spillway gates. The top of Kerckhoff Dam would be modified to accommodate higher tailwater elevations, including modifications to mechanical operators and gates to the existing deck. Inundated sections of the Kerckhoff–Le Grand and Kerckhoff–Sanger transmission lines (approximately 4 miles) would be reconstructed as the Le Grand–Sanger transmission line.

#### ***Recreational Facilities***

Temperance Flat RM 274 Reservoir would affect several recreational features found along the existing Millerton Lake shoreline. Recreational facilities upstream from RM 274 include the Temperance Flat Boat-In Campground within the Millerton Lake State Recreation Area (SRA), and the San Joaquin River Trail, which connects the SRA and the BLM San Joaquin River Gorge (SJRG) Special Recreation Management Area (SRMA). Within the SJRG SRMA are hiking, biking, and equestrian trails, including an extension of the San Joaquin River Trail; two footbridges; primitive campgrounds; and a cultural heritage learning center, which includes a reproduction of a Native American village, simulated archaeological dig, authentic bedrock mortars, and a nature trail. Reclamation would protect such facilities from inundation, modify existing facilities to replace affected areas (i.e., relocate facilities on site), or abandon existing facilities and replace them at other suitable sites to the extent feasible (i.e., relocate facilities off site and upslope). Reclamation would seek to maintain the quality of visitor experiences by replacing affected recreational facility capacity with facilities providing equivalent visual resource quality, amenities, and access to the Millerton Lake SRA and SJRG SRMA, as well as Temperance Flat RM 274 Reservoir (e.g., new Wellbarn Road and Smalley Road boat ramps and associated upgrades to access roads, and a San Joaquin River and Pa'san Ridge trails seasonal water taxi). Inundated recreational facilities and associated utilities would be relocated before demolition, with the exception of facilities identified for abandonment. Additional detail on recreational facilities can be found in the Draft Feasibility Report (Reclamation 2014).

### *Reservoir Area Utilities*

A majority of the infrastructure adjacent to Millerton Lake above RM 274 is located in the Temperance Flat area off Wellbarn Road, and PG&E and BLM facilities off Smalley Road. Utilities in the area include potable water, power distribution, telecommunications, and wastewater facilities. If utilities are impacted by inundation, they would be demolished and relocated (if associated facility is relocated or required to maintain distribution).

### *Coordination with San Joaquin River Restoration Program*

Temperance Flat RM 274 Reservoir would capture San Joaquin River flood flows that would be released from Friant Dam under the No Action Alternative. Reclamation’s ability to meet Restoration Flow targets would not change; flood flows that meet Restoration Flow targets in the No Action Alternative would be replaced with managed releases from Friant Dam to meet Restoration Flow targets. Additional managed releases of Restoration Flows from Friant Dam would increase opportunities for downstream recapture pursuant to paragraph 16(a) and reduce the availability of water supply pursuant to paragraph 16(b). All action alternatives include operations of Friant Dam for delivery of new water supplies via the San Joaquin River to Mendota Pool. Under all action alternatives, the following coordination actions with the SJRRP would be included:

- Revise Restoration Flow Guidelines, as necessary
- Revise the Recapture and Recirculation Plan, as necessary
- Revise accounting for Recovered Water Account (RWA) and delivery of water under Paragraph 16b, as necessary
- Coordinate scheduling of releases from Friant Dam for downstream delivery of additional water supply developed by Temperance Flat RM 274 Reservoir
- Coordinate with floodplain habitat planning efforts for Reach 2B and Reach 4B

### *Reservoir Flood Storage Operations*

The existing Flood Control Diagram at Friant Dam specifies that rain flood space increases from zero on October 1 to 170 TAF on November 1, and decreases from 170 TAF on

February 1 to zero on April 1 (USACE 1980). From November 1 to February 1, rain flood space in excess of 85 TAF may be replaced by an equal amount of space in Mammoth Pool. The required total available rain flood control storage and operation rules at Millerton Lake were used for the combined Temperance Flat RM 274 and Millerton Lake analysis to maintain the same level of regulatory rain flood control. The assumption was made that the available rain flood control storage could be in either reservoir, provided the required rain flood control storage space was always available between the two reservoirs. With Millerton Lake generally operated at elevation 550 feet msl (340 TAF) or lower in the action alternatives, the rain flood space requirement of 170 TAF would generally be maintained in Millerton Lake (operated in conjunction with Mammoth Pool). Temperance Flat RM 274 Reservoir could provide incidental additional rain flood storage space if space was available during a rain flood event.

#### *CVP and SWP Operations Criteria*

The operations modeling of the action alternatives was based on the Reclamation March 2012 CalSim II Benchmark, which represents operations of the CVP and SWP in accordance with the 2008 USFWS and 2009 NMFS BOs (USFWS 2008, NMFS 2009), and modified to include Temperance Flat RM 274 Reservoir and operations. The operations and requirements under the 2008 USFWS and 2009 NMFS BOs are described in Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences,” and in the Modeling Appendix.

#### *Conveyance Facilities Operations*

The action alternatives include modifying the timing and quantity of water diverted to Madera and Friant-Kern canals, which would increase water supply reliability to Friant Division contractors and provide opportunities for groundwater banking. Additionally, the action alternatives would improve conjunctive management in the Friant Division of the CVP by increasing incidental groundwater storage and/or recharge with additional Class 2 deliveries.

The action alternatives include existing and foreseeable available cross-valley conveyance capacity in the Cross Valley Canal, Shafter-Wasco/Semitropic Interconnection, and Arvin Edison South Canal. Total capacity is shown in the conveyance schematic in Figure 2-10.

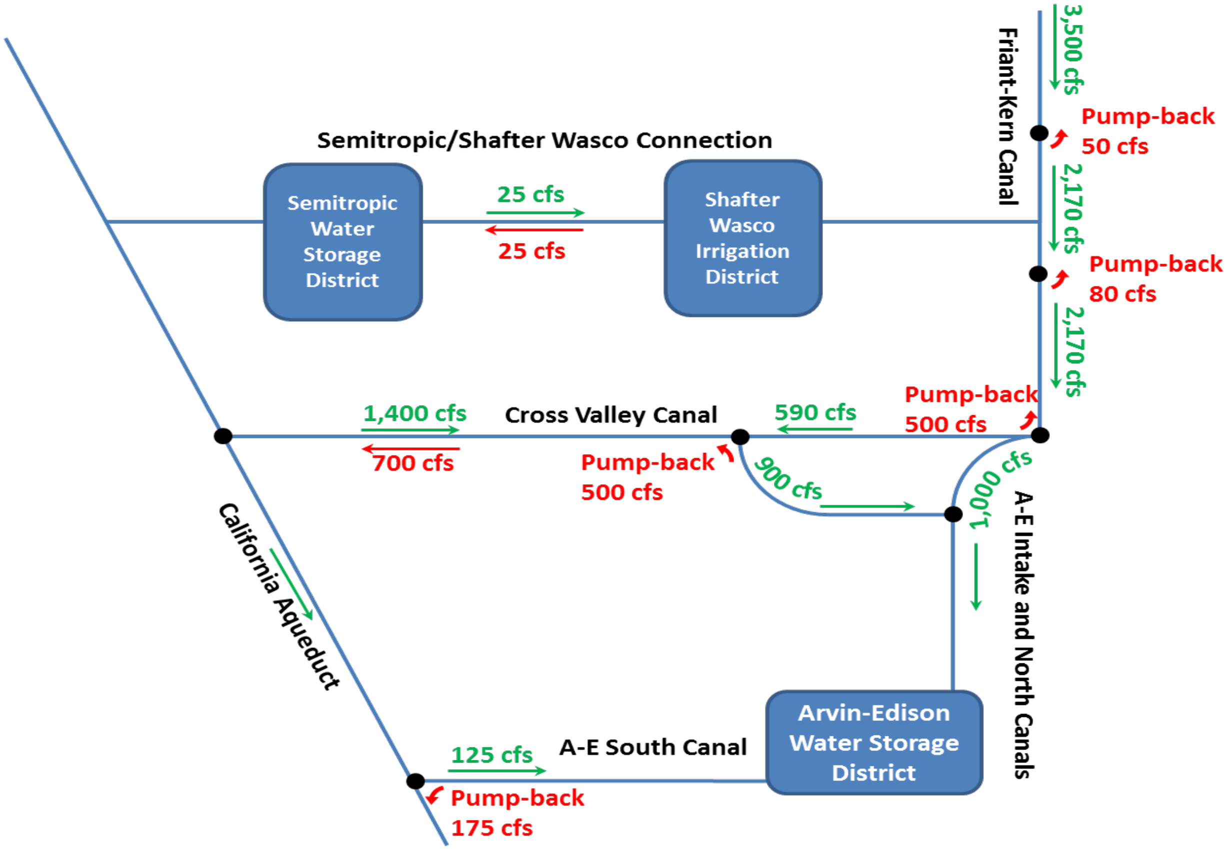
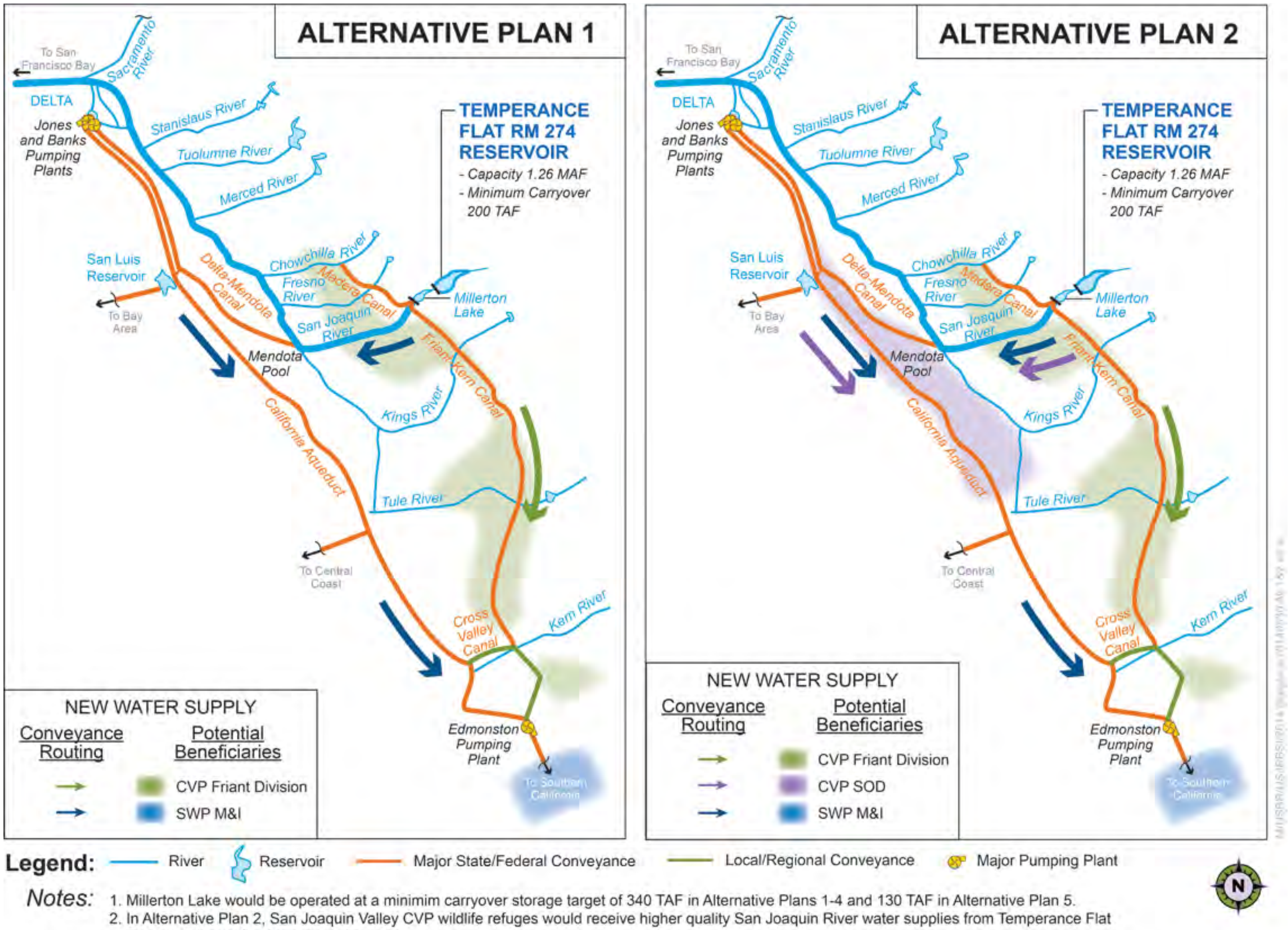


**Figure 2-10. Schematic of Major Cross-Valley Conveyance Capacities**

## Features and Operations Varying Between Action Alternatives

The action alternatives mainly differ in five ways: carryover storage target for Millerton Lake, carryover storage target for Temperance Flat RM 274 Reservoir, beneficiaries of new water supply, routing of new water supply, and type of intake structure. Operations for the action alternatives are summarized in Figures 2-11 through 2-13, and Table 2-7.

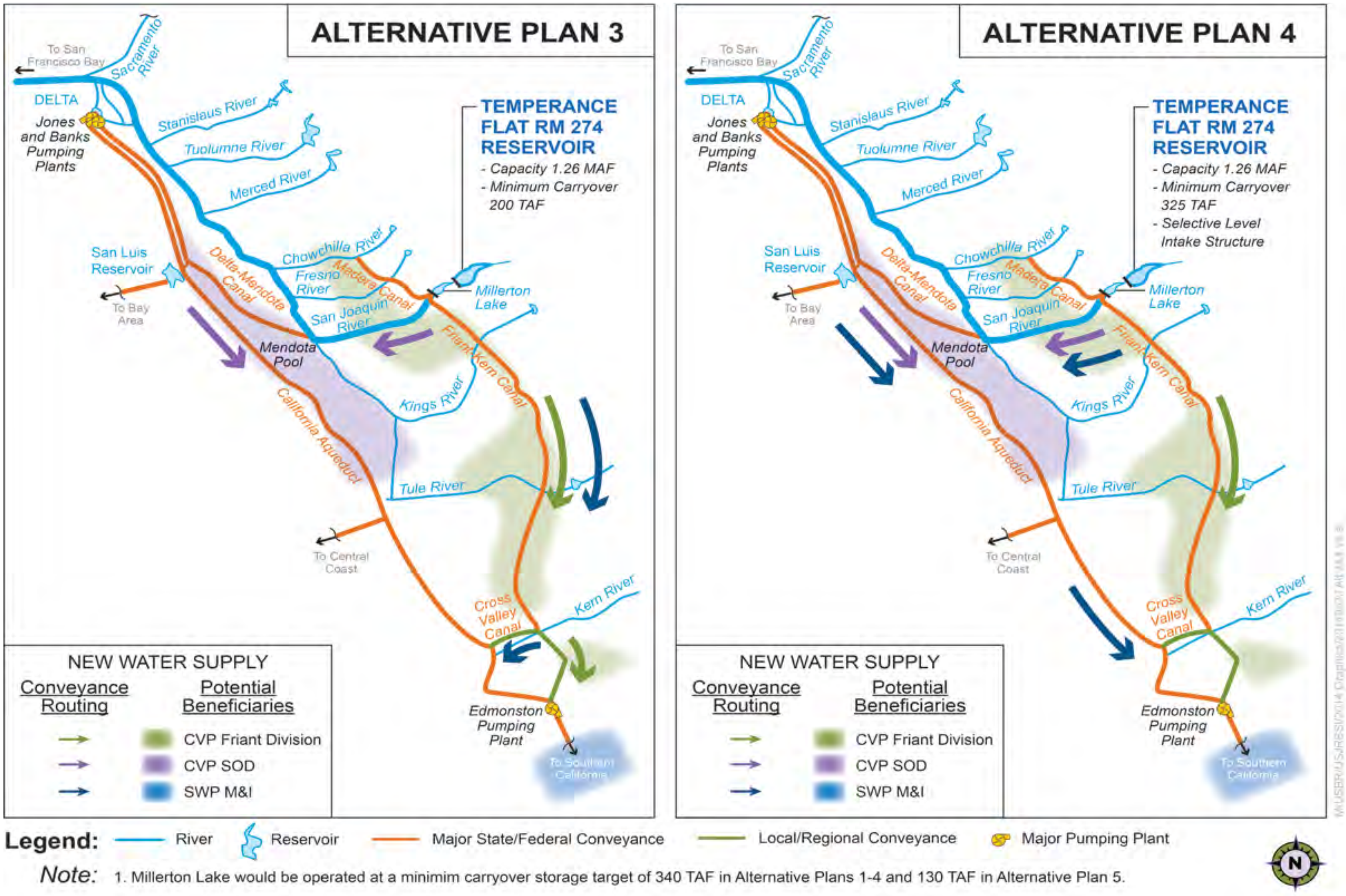


Notes: 1. Millerton Lake would be operated at a minimim carryover storage target of 340 TAF in Alternative Plans 1-4 and 130 TAF in Alternative Plan 5.
2. In Alternative Plan 2, San Joaquin Valley CVP wildlife refuges would receive higher quality San Joaquin River water supplies from Temperance Flat Reservoir (Level 2 refuge diversification).

Key:

| | | |
|---|---|---|
| Banks Pumping Plant = Harvey O. Banks Pumping Plant | Jones Pumping Plant = C.W. “Bill” Jones Pumping Plant | SOD = South-of-Delta |
| CVP = Central Valley Project | M&I = municipal and industrial | SWP = State Water Project |
| Friant Division = Friant Division of the CVP | MAF = million acre-feet | TAF = thousand acre-feet |

**Figure 2-11. South-of-Delta Systemwide Operations of Alternative Plans 1 and 2**

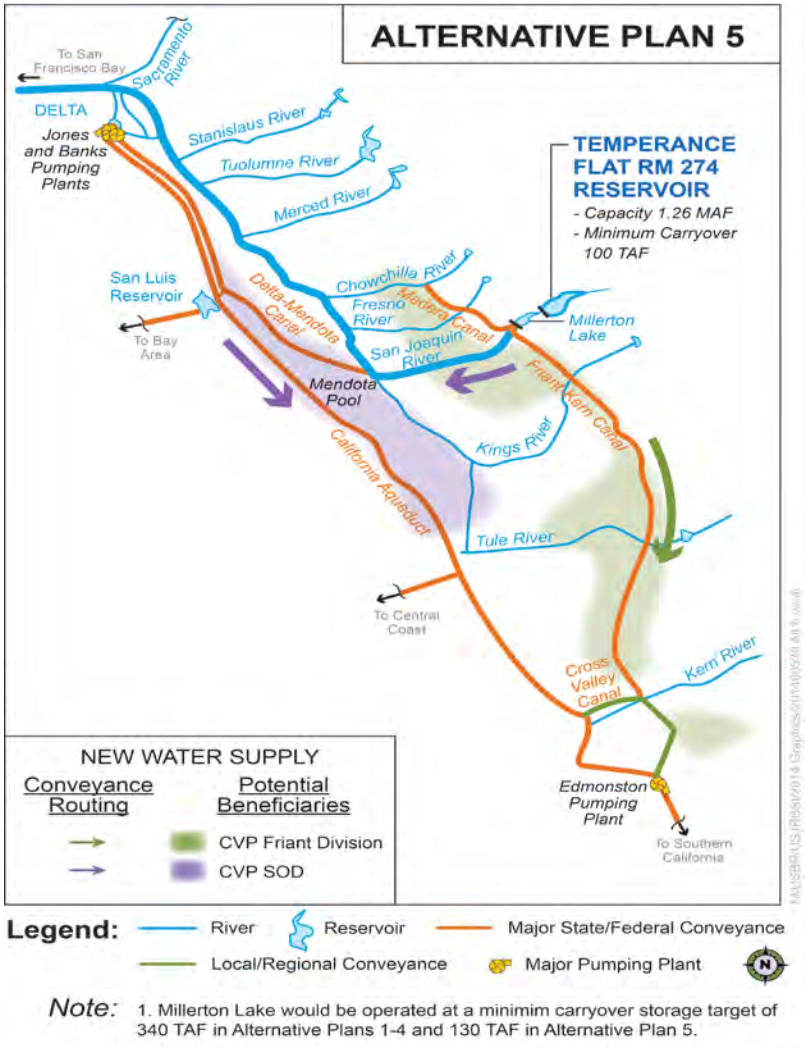


Note: 1. Millerton Lake would be operated at a minimim carryover storage target of 340 TAF in Alternative Plans 1-4 and 130 TAF in Alternative Plan 5.

Key:

Banks Pumping Plant = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
Friant Division = Friant Division of the CVP
Jones Pumping Plant = C.W. "Bill" Jones Pumping Plant
M&I = municipal and industrial
MAF = million acre-feet
SOD = South-of-Delta
SWP = State Water Project
TAF = thousand acre-feet

**Figure 2-12. South-of-Delta Systemwide Operations of Alternative Plans 3 and 4**



Note: 1. Millerton Lake would be operated at a minimim carryover storage target of 340 TAF in Alternative Plans 1-4 and 130 TAF in Alternative Plan 5.

Key:

Banks Pumping Plant = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
Friant Division = Friant Division of the CVP
Jones Pumping Plant = C.W. “Bill” Jones Pumping Plant
M&I = municipal and industrial
MAF = million acre-feet
SOD = South-of-Delta
SWP = State Water Project
TAF = thousand acre-feet

Figure 2-13. South-of-Delta Systemwide Operations of Alternative Plan 5

## Table 2-7. Summary of Operations of Action Alternatives

| Action Alternative | Conveyance Route to Friant Division of the CVP | Conveyance Route to CVP SOD Contractors | Conveyance Route to SWP SOD M&I Contractors | Millerton Lake Carryover Storage (TAF) | Temperance Flat RM 274 Carryover Storage (TAF) | Intake Structure Type[1] |
|---|---|---|---|---|---|---|
| Alternative Plan 1 | Friant-Kern/ Madera Canals | N/A | San Joaquin River[2] | 340 TAF | 200 TAF | LLIS |
| Alternative Plan 2 | Friant-Kern/ Madera Canals | San Joaquin River[2, 3] | San Joaquin River[2] | 340 TAF | 200 TAF | LLIS |
| Alternative Plan 3 | Friant-Kern/ Madera Canals | San Joaquin River[2, 3] | Friant-Kern Canal | 340 TAF | 200 TAF | LLIS |
| Alternative Plan 4 | Friant-Kern/ Madera Canals | San Joaquin River[2, 3] | San Joaquin River[2] | 340 TAF | 325 TAF | SLIS |
| Alternative Plan 5 | Friant-Kern/ Madera Canals | San Joaquin River[2, 3] | N/A | 130 TAF[4] | 100 TAF | LLIS |

Notes:

[1] SLIS may be used for water temperature management.

[2] Water supply delivered via the San Joaquin River to Mendota Pool could be available for exchange with CVP SOD contractors, CVPIA Level 2 refuge supplies, or San Joaquin River Exchange Contractor supplies.

[3] Alternative Plans 2 through 5 would exchange Temperance Flat RM 274 Reservoir water supply for Level 2 refuges supplies delivered from the Delta, diversifying the CVPIA Level 2 water supply, and freeing up Delta supplies to be delivered to CVP SOD contractors.

[4] Millerton Lake would be operated with a preference for maintaining minimum storage at 340 TAF (when Temperance Flat is not full), but allows for Millerton Lake to be drawn down to 130 TAF when needed for water supply delivery.

Key:
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
LLIS = low-level intake structure
M&I = municipal and industrial
N/A = not applicable
SWP = State Water Project
SLIS = selective-level intake structure
SOD = South-of-Delta
TAF = thousand acre-feet

### *Carryover Storage Target for Millerton Lake*

The target water surface elevation for Millerton Lake for Alternative Plans 1, 2, 3, and 4 is elevation 550 feet msl (equating to a carryover storage target of 340 TAF). In Alternative Plan 5, Millerton Lake carryover storage is also maintained at 340 TAF, but could be drawn down to 130 TAF as needed for water supply. In all action alternatives, Millerton Lake could still fill all the way to the top of active storage capacity at elevation 580.6 feet msl (450 TAF) when needed in wet years and when Temperance Flat RM 274 Reservoir would also be full. Millerton Lake and Temperance Flat RM 274 Reservoir could be operated jointly and changes in Millerton Lake operations would not affect the ability to manage the joint Millerton Lake Temperance Flat RM 274 Reservoir system for water supply (including providing Restoration Flows) and flood damage reduction.

### ***Carryover Storage Target for Temperance Flat RM 274 Reservoir***

The carryover storage target for Temperance Flat RM 274 Reservoir is 200 TAF for Alternative Plans 1 to 3; 325 TAF for Alternative Plan 4; and 100 TAF for Alternative Plan 5.

### ***Beneficiaries of New Water Supply***

Temperance Flat RM 274 Reservoir could provide water supply to a range of beneficiaries. The action alternatives illustrate some representative combinations of anticipated beneficiaries based on the strategic location of Temperance Flat RM 274 Reservoir and the Investigation problems, needs, and objectives. Friant Division contractors, other CVP SOD contractors, and SWP SOD M&I contractors are considered beneficiaries in the action alternatives. All action alternatives would deliver some portion of the new water supply from Temperance Flat RM 274 Reservoir to the Friant Division of the CVP. Alternative Plans 1, 2, 3, and 4 would also deliver some portion of the new water supply from Temperance Flat RM 274 Reservoir to SWP SOD M&I contractors. Alternative Plans 2, 3, 4, and 5 would also deliver new supply to CVP SOD contractors.

### ***Routing of New Water Supply***

New supplies to the Friant Division of the CVP would be conveyed via the Friant-Kern and Madera canals in all action alternatives. New water supplies to CVP SOD contractors would be delivered via the San Joaquin River to Mendota Pool. At Mendota Pool, water would be exchanged with DMC deliveries of Delta supply to Mendota Pool, freeing Delta supplies for delivery to CVP SOD contractors. New water supplies would be delivered to CVP SOD contractors in Alternative Plans 2, 3, 4 and 5. In Alternative Plans 1, 2, and 4, new water supplies to SWP SOD M&I contractors would be routed via the San Joaquin River and exchanged for Delta supplies at Mendota Pool, allowing an equivalent amount of Delta water to be delivered to SWP SOD M&I contractors via the California Aqueduct through another exchange at the San Luis Reservoir Forebay. In Alternative Plan 3, new water supplies to SWP SOD M&I contractors would be delivered through the Friant-Kern Canal and cross-valley conveyance to the California Aqueduct. Water delivered via the San Joaquin River for CVP SOD or SWP SOD M&I exchange with Delta supplies would create flexibility and source diversification for any contractors with access to Mendota Pool (wildlife refuges, CVP SOD contractors, Exchange Contractors).

#### *Intake Structure Configuration*

While Alternative Plans 1, 2, 3, and 5 include an LLIS, an SLIS is included in Alternative Plan 4 to provide additional flexibility to manage the cold-water pool and Temperance Flat RM 274 Reservoir release temperatures.

### Environmental Commitments Common to All Action Alternatives

Reclamation, its contractors, and/or its construction partners would incorporate certain environmental commitments and best management practices (BMP) into any action alternative identified for implementation to avoid or minimize potential impacts. Reclamation would also coordinate planning, engineering, design and construction, operation, and maintenance phases of any authorized project modifications with applicable resource agencies.

The following environmental commitments are included in all of the action alternatives for project-related construction activities.

#### *Develop and Implement Construction Management Plans*

Reclamation, its contractors, and/or its construction partners would develop and implement construction management plans to avoid or minimize potential impacts on public health and safety during project construction, to the greatest extent feasible. The construction management plans would inform contractors and subcontractors of work hours; modes and locations of transportation and parking for construction workers; location of overhead and underground utilities; worker health and safety requirements; truck routes; stockpiling and staging procedures; public access routes; terms and conditions of all project permits and approvals; and emergency response services contact information.

The construction management plans would also include construction notification procedures for the police, public works, and fire department in the cities and counties where construction would occur. Notices would also be distributed to neighboring property owners. The health and safety component of the construction management plans would be monitored for the implementation of the plan on a day-to-day basis by Certified Industrial Hygienists.

#### *Comply with Permit Terms and Conditions*

If any action alternative was approved and authorized for construction, Reclamation would require its contractors and suppliers, its general contractor, and all of the general contractor’s subcontractors and suppliers to comply with all of the terms and conditions of all required project permits, approvals, and conditions attached thereto. If necessary, additional information (e.g., detailed designs and additional documentation) would be prepared and provided for review by decision makers and the public. Reclamation would ultimately be responsible for the actions of its contractors in complying with permit conditions. Compliance with applicable laws, policies, and plans for this project is discussed in Chapter 1, “Introduction,” and Chapter 28, “Other NEPA and CEQA Conditions.”

#### *Provide Relocation Assistance through Federal Relocation Assistance Program*

All Federal, State, and local government agencies, and others receiving Federal financial assistance for public programs and projects that require the acquisition of real property must comply with the policies and provisions set forth in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (Uniform Act) (49 CFR 24). All relocation and property acquisition activities, such as those associated with temporary easements during construction or condemnation for permanent changes in the Study Area, would be performed in compliance with the Uniform Act. Any individual, family, or business displaced by implementation of any action alternative would be offered relocation assistance services for the purpose of locating a suitable replacement property, to the extent consistent with the Uniform Act.

Under the Uniform Act, relocation services for residences would include providing a determination of the housing needs and desires, a determination of the amount of replacement housing each individual or family qualifies for, a list of comparable properties, transportation to inspect housing referrals, and reimbursement of moving costs and related expenses. For business relocation activities, relocation services would include providing a determination of the relocation needs and requirements; a determination of the need for outside specialists to plan, move, and reinstall personal property; advice as to possible sources of funding and assistance from other local, State, and Federal agencies; listings of commercial properties, and reimbursement for costs incurred in relocating and reestablishing the business. No relocation payment received would be considered as income for the purpose of the Internal Revenue Code.

### *Develop and Implement Comprehensive Mitigation Strategy*

Reclamation would develop and implement a comprehensive mitigation strategy (CMS) to minimize potential impacts to physical, biological, and socioeconomic resources described in this Draft EIS. The CMS described in this section is still under development at this stage in the planning process. The CMS is being developed consistent with the guidance provided in CEQ Regulations for Implementing Procedural Provisions of NEPA (40 CFR Parts 1500–1508). The CMS is intended to minimize the potential adverse impacts associated with action alternatives described in this chapter, as required under NEPA.

The CMS will be multi-faceted in terms of spatial and temporal scales. Based on the nature of some impacts described in this DEIS, the CMS may include one or more of the following types of mitigation as defined under CEQ Guidelines, Section 1508.20–Mitigation:

- Avoiding the impact altogether by not taking a certain action or parts of an action
- Minimizing the impact by limiting the degree or magnitude of the action and its implementation
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time through preservation and maintenance operations during the life of the action
- Compensating for the impact by replacing or providing substitute resources or environments

At this stage in the planning process, the following components are being considered for the CMS:

- Land acquisition
- Conservation easements
- Upland habitat improvements
- Wetland mitigation
- Riparian habitat improvements (riparian reserves)

- Aquatic habitat improvements (river and tributaries)
- Water quality actions (metals, temperature, sediment)
- Visuals and aesthetics actions

Reclamation will address CEQ's guidance on establishing, implementing, and monitoring mitigation, which specifies that when environmental analyses are premised on commitments to mitigate environmental impacts of action alternatives, agencies should adhere to those commitments during project implementation and monitor the implementation and effectiveness of mitigation (CEQ 2011). The CMS will incorporate elements intended to comply with these requirements, specifically those requirements directing agencies to also publicly report on these efforts. The CMS, including a framework for mitigation implementation and monitoring, will be included in the Final EIS.

#### *Develop and Implement Resource Management Plan*

Reclamation would lead development of an RMP, in collaboration with BLM and State Parks, for the Temperance Flat RM 274 Reservoir area and lands potentially affected by implementation of action alternatives. The RMP would be prepared as a long-term plan to coordinate management of resources in the area and define the roles and responsibilities of each agency. The RMP would include establishment of management objectives, guidelines, and actions to achieve an integrated long-term vision for recreation and development, as well as resource protection and enhancement, within the reservoir area.

Example management objectives currently addressed by the Millerton Lake RMP/General Plan (Reclamation and State Parks 2010) that may be applicable for implementation of the action alternatives include:

- Enhancing natural resources and recreational opportunities without interruption of reservoir operations
- Providing recreational opportunities to meet the demands of a growing, diverse population
- Ensuring recreational diversity and quality

- Protecting natural, cultural, and recreational resources, and providing resource education opportunities and good stewardship
- Providing management considerations for establishing management agreements

### *Cultural Resources*

If a project was authorized, Reclamation would implement regulations at 36 CFR Part 800 to identify historic properties (including traditional cultural properties, sacred sites, and sacred areas, as appropriate), assess effects, and resolve adverse effects through the consultation process. Consulting parties for the National Historic Preservation Act Section 106 process would include the State Historic Preservation Office (SHPO), the Advisory Council on Historic Preservation (if it chose to participate), other Federal agencies where applicable, tribal representatives, and other interested parties (including non-Federally recognized Native Americans, members of the public, and other State or local agencies) to develop methods to avoid, minimize, or mitigate adverse effects. Measures to avoid, minimize, or mitigate adverse effects would be funded through the project. Reclamation could enter into a Programmatic Agreement with the Advisory Council on Historic Preservation (if it chose to participate), the SHPO, and other consulting parties that would identify how the Section 106 process would be completed for the authorized project. The Programmatic Agreement could include alternative methods for compliance or phased identification efforts/phased finding of effects efforts, as agreed upon with the consulting parties. Any human remains, funerary objects, sacred objects, or objects of cultural patrimony that were removed from federally managed or tribal lands during any project activities would be treated consistent with the Native American Graves Protection and Repatriation Act (NAGPRA). If human remains were removed from non-federally managed lands, they would be subject to the PRC regarding the treatment of human remains outside a dedicated cemetery.

To further avoid, minimize, or mitigate adverse effects to cultural resources, Reclamation would implement the following actions, as part of the Section 106 process or independently:

- Develop a Cultural Resources Data Recovery Plan.

- Conduct subsurface archaeological investigations before ground disturbing activities.
- Stop work for discovery of previously undiscovered cultural resources during project construction.
- Stop potentially damaging work if human remains are uncovered during construction.
- Reduce through the Secretary of the Interior Standards to Heritage Documentation Programs (HDP) standards for buildings that are listed, or are eligible for listing, on the National Register of Historic Places.

These actions are further described below.

**Develop a Cultural Resources Data Recovery Plan** If feasible, Reclamation would protect cultural resources in place. If resources cannot be protected in place, Reclamation would implement data recovery consistent with 14 CCR Section 15126.4(b)(3)(c) and with the guidelines set forth in the Secretary of Interior's standards and guidelines (Standards I through IV). CCR Section 15126.4(b)(3)(c) states that a data recovery plan shall be prepared and adopted before any excavation is undertaken. Because the historical significance of most archaeological sites lies in their potential to contribute to scientific research, the data recovery plan would make provision for adequately recovering the scientifically consequential data from and about the historical resource.

The Secretary of Interior's standards include following an explicit statement of objectives and employing methods that respond to needs identified in the planning process; using methods and techniques of archaeological documentation (data recovery) selected to obtain the information required by the statement of objectives; assessing the results of the archaeological documentation against the statement of objectives and integrating them into the planning process; and reporting and making public the results of the archaeological documentation. To this end, data recovery findings would be documented in a data recovery report, which would follow guidelines set forth by SHPO for such reports.

**Conduct Subsurface Archaeological Investigations Before Ground Disturbing Activities** Before ground disturbing activities, Reclamation would conduct subsurface investigations (i.e., archeological testing) for undiscovered cultural resources in the portions of the primary study area for the project elements that are identified as having moderate to high potential for undiscovered subsurface cultural resources.

The Archaeological Resources Protection Act of 1979 (Public Law 95-96) would be followed to protect archaeological resources and sites that are located on public lands. The act makes it unlawful to excavate, remove or deface archaeological resources, to sell, purchase, or exchange those resources without applicable permit, and establishes criminal and civil penalties for any such violation.

In accordance with the Archaeological and Historic Preservation Act, Reclamation would prevent irreparable loss or destruction of significant scientific, prehistorical, historical, or archeological data involving activities in connection with any Federal construction project or federally-licensed project, activity, or program through the recovery, protection, and preservation of such data, including preliminary survey or other investigation as needed.

**Stop Work for Discovery of Previously Undiscovered Cultural Resources During Project Construction** If previously undiscovered cultural resources (e.g., unusual amounts of shell, animal bone, bottle glass, ceramics, structure/building remains, etc.) are discovered during ground-disturbing activities, Reclamation would authorize the construction contractor to stop work in that area and within 100 feet of the find until a qualified archaeologist can assess the significance of the find according to NRHP and, if applicable, CEQA (including CRHR) criteria. If necessary, Reclamation would develop appropriate treatment measures for significant and potentially significant resources which may include, but would not be limited to, no action (i.e., resources determined not to be significant), avoidance of the resource through changes in construction methods or project design, and implementing a program of testing and data recovery, in accordance with PRC Section 21083.2. This action would ensure proper identification and treatment of any significant cultural resources uncovered as a result of project-related ground disturbance and would reduce the potential impact resulting from inadvertent damage or destruction of unknown cultural resources during construction.

**Stop Potentially Damaging Work if Human Remains are Uncovered During Construction** Any human remains, funerary objects, sacred objects, or objects of cultural patrimony that were uncovered on federally managed lands during any project activities would be treated consistent with the NAGPRA. If human remains or associated items of patrimony were uncovered on non-federally managed lands, they would be subject to the California Health and Safety Code Section 7050.5 and Section 7052 and California PRC Section 5097, regarding the treatment of human remains outside a dedicated cemetery.

In accordance with the NAGPRA, if any human remains, funerary objects, sacred objects, or objects of cultural patrimony are uncovered on federally managed lands during ground-disturbing activities, including construction, all such activity would cease in the area of the discovery. Reclamation would make a reasonable effort to protect the items discovered before resuming such activity, and provide notice in writing to the Secretary of the department having primary management authority of the land. Following the notification, and upon certification by the Secretary of the department or the appropriate Indian tribe that notification has been received, the activity may resume after 30 days of the certification.

Reclamation would provide any Native American human remains uncovered on federally management lands to the lineal descendants of the Native American. If such lineal descendants cannot be ascertained, and in the case of unassociated funerary objects, sacred objects, and objects of cultural patrimony, Reclamation would provide the remains or objects to the Indian tribe which has the closest cultural or aboriginal affiliation with such remains or objects and which states a claim for such remains or objects. Native American cultural items not claimed would be disposed of in accordance with regulations promulgated by the Secretary, Native American groups, representatives of museums, and the scientific community.

California law recognizes the need to protect interred human remains, particularly Native American burials and associated items of patrimony, from vandalism and inadvertent destruction. The procedures for the treatment of discovered human remains are contained in California Health and Safety Code Section 7050.5 and Section 7052 and California PRC Section 5097.

In accordance with the California Health and Safety Code, if human remains are uncovered on non-federally managed lands during ground-disturbing activities, including construction, and all such activities within a 100-foot radius of the find would be halted immediately and a designated representative would be notified. The representative would immediately notify the county coroner and a qualified professional archaeologist. The coroner is required to examine all discoveries of human remains within 48 hours of receiving notice of a discovery on private or state lands (Health and Safety Code Section 7050.5[b]).

If the coroner determines that the remains are those of a Native American, he or she must contact the Native American Heritage Commission (NAHC) by phone within 24 hours of making that determination (Health and Safety Code Section 7050[c]). The NAHC would contact the persons it believes to be most likely descended from the deceased Native American. The most likely descendant, in cooperation with the property owner and Reclamation, shall determine the ultimate disposition of the remains in accord with the provisions of California PRC Section 5097.98. If NAHC cannot identify any likely descendants, if the most likely descendant fails to make a recommendation, or Reclamation disagrees with the recommendation and mediation fails to resolve the issue, then Reclamation would reinter the human remains with appropriate dignity on a part of the property not subject to further subsurface disturbance, as is specified in Section 5097.98(b) and 14 CCR Section 1064.5(e)(2).

Reduce through the Secretary of the Interior Standards to HDPs standards for buildings that are listed, or are eligible for listing, on the National Register of Historic Places. Under the provisions of Sections 106 and 110b of the amended National Historic Preservation Act of 1966, Federal agencies must produce documentation to HDPs standards for buildings that are listed, or are eligible for listing, on the National Register of Historic Places, to reduce the adverse effects of federal actions such as demolition or substantial alteration. National Park Service regional offices oversee this aspect of HDP documentation, which is submitted to the Washington, D.C., office for final review and inclusion in the collections for the Historic American Buildings Survey, Historic American Engineering Record and the Historic American Landscapes Survey.

#### ***Develop and Implement Stormwater Pollution Prevention Plan***

Any project authorized for construction would be subject to construction-related stormwater permit requirements of the Federal CWA National Pollutant Discharge Elimination

System program. Reclamation would obtain any required permits through the Central Valley Water Board before conducting any ground-disturbing construction activity. According to the requirements of Section 402 of the CWA, Reclamation, its contractors, and/or its construction partners would prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) before construction, identifying BMPs to prevent or minimize erosion and the discharge of sediments and other contaminants with the potential to affect beneficial uses or lead to violations of water quality objectives of surface waters.

The SWPPP would include site-specific structural and operational BMPs to prevent and control impacts on runoff quality, and measures to be implemented before, during, and after each storm event. BMPs would also control short-term and long-term erosion and sedimentation effects, and stabilize soils and vegetation in areas affected by construction activities (i.e., erosion and sediment control plan). The SWPPP would contain a site map that shows the construction site perimeter, existing and proposed buildings, lots, roadways, stormwater collection and discharge points, general topography both before and after construction, and drainage patterns across the project. Additionally, the SWPPP would need to contain a visual monitoring program, a chemical monitoring program for “nonvisible” pollutants to be implemented if a BMP fails, and a sediment monitoring plan if the site discharges directly to a water body listed on the CWA 303(d) list for sediment. BMPs for the project could include, but would not be limited to, earth dikes and drainage swales, stream bank stabilization, sediment basins, sandbag barriers, silt fencing, straw bale barriers, fiber rolls, storm drain inlet protection, hydraulic mulch, and stabilized construction entrances.

**Develop and Implement Spill Prevention and Hazardous Materials Management Measures** As part of the SWPPP, Reclamation, its contractors, and/or its construction partners would develop and implement a spill prevention and control plan to minimize effects from spills of hazardous, toxic, or petroleum substances for project-related construction activities occurring in or near waterways. The accidental release of chemicals, fuels, lubricants, and nonstorm drainage water into water bodies would be prevented to the extent feasible. Spill prevention kits would always be in close proximity when hazardous materials would be used (e.g., crew trucks and other logical locations). Feasible measures would be implemented so that hazardous materials would be properly handled and the quality of aquatic resources would be protected by all reasonable means during work in or near any waterway. No fueling would be done within the ordinary high-water mark, immediate floodplain, or full pool inundation area, unless equipment stationed in these locations could not be readily relocated. Any equipment that could be readily moved out of the water body would not be fueled in the water body or immediate floodplain. As for stationary equipment, for all fueling done at the construction site, containments would be installed so that any spill would not enter the water, contaminate sediments that may come in contact with the water, or damage wetland or riparian vegetation. Any equipment that could be readily moved out of the water body would not be serviced within the ordinary high-water mark or immediate floodplain.

Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways would also be implemented. These could include, but would not be limited to, the following:

- Storage of hazardous materials in double-containment and, if possible, under a roof or other enclosure
- Disposal of all hazardous and nonhazardous products in a proper manner
- Monitoring of on-site vehicles for fluid leaks and regular maintenance to reduce the chance of leakage
- Containment (using a prefabricated temporary containment mat, a temporary earthen berm, or other measure can provide containment) of bulk storage tanks

Haulers delivering materials to the project site would be required to comply with regulations on the transport of hazardous materials codified in 49 CFR 173, 49 CFR 177, and CCR Title 26, Division 6. These regulations provide specific packaging requirements, define unacceptable hazardous materials shipments, and prescribe safe-transit practices, including route restrictions, by carriers of hazardous materials.

#### *Fisheries Conservation*

The measures discussed below would be implemented to minimize potential adverse effects on fish species.

**Implement In-Water Construction Work Windows**
Reclamation would identify and implement feasible in-water construction work windows in consultation with USFWS and CDFW. In-water work windows would be timed to occur when sensitive fish species were not present or would be least susceptible to disturbance (e.g., July through September).

**Monitor Construction Activities** A qualified biologist would monitor potential impacts to important fishery resources throughout all phases of project construction. Monitoring might not be necessary during the entire duration of the project if, based on the monitor's professional judgment (and with concurrence from Reclamation), a designated onsite contractor would suffice to monitor such activities and would agree to notify a biologist if aquatic organisms are in danger of harm. However, the qualified biologist would need to be available by phone and Internet and be able to respond promptly to any problems that arose.

**Perform Fish Rescue/Salvage** If spawning activities for sensitive fish species were encountered during construction activities, the biologist would be authorized to stop construction activities until appropriate corrective measures were completed or it was determined that the fish would not be harmed.

A qualified biologist would identify any fish species that may be affected by the project. The biologist would facilitate rescue and salvage of fish and other aquatic organisms that become entrapped within construction structures and cofferdam enclosures in the construction area, as appropriate. Any rescue, salvage, and handling of listed species would be conducted under appropriate authorization (i.e., incidental take statement/permit for the project, Federal ESA Section 4(d) scientific collection take permit, or a Memorandum of Understanding). If fish were identified as threatened with entrapment in construction structures, construction would be stopped and efforts made to allow fish to leave the project area before resuming work. If fish were unable to leave the project area of their own volition, then fish would be collected and released outside the work area. Fish entrapped in cofferdam enclosures would be rescued and salvaged, as appropriate, before the cofferdam area was completely dewatered. Appropriately sized fish screens would be installed on the suction side of any pumps used to dewater in-water enclosures.

**Reporting** A qualified biologist would prepare a letter report detailing the methodologies used and the findings of fish monitoring and rescue efforts. Monitoring logs would be maintained and provided, with monitoring reports. The reports would contain, but not be limited to, the following: summary of activities; methodology for fish capture and release; table with dates, numbers, and species captured and released; photographs of the enclosure structure and project site conditions affecting fish; and recommendations for limiting impacts during subsequent construction phases, if appropriate.

#### *Water Quality Protection*

The measures discussed below would be implemented to minimize potential adverse effects to water quality.

**Implement In-Water Construction Work Windows** All in-water construction activities along the San Joaquin River would be conducted during months when instream flows were managed outside the flood season (e.g., July to September).

**Comply with All Water Quality Permits and Regulations** Project activities would be conducted to comply with all additional requirements specified in permits relating to water quality protection. Relevant permits anticipated to be obtained for the proposed action include a California Fish and Game Code 1602 Lake and Streambed Alteration Agreement, CWA Section 401 certification, and CWA Section 404 compliance through USACE.

**Implement Water Quality Best Management Practices** BMPs that would be implemented to avoid and/or minimize potential impacts associated with dam construction are described below.

*Minimize Potential Impacts Associated with Equipment Contaminants* For in-river work, all equipment would be steam-cleaned daily to remove hazardous materials before the equipment entered the water.

*Minimize Potential Impacts Associated with Access and Staging* Existing access roads would be used to the greatest extent possible. Equipment staging areas would be located outside of the San Joaquin River ordinary high water mark or the Friant Dam full pool inundation area, and away from sensitive resources.

*Remove Temporary Fills as Appropriate* Temporary fill for access, side channel diversions, and/or side channel cofferdams, would be completely removed after completion of construction.

*Remove Equipment from River Overnight and During High Flows* Construction contractors would remove all equipment from the river at the end of the workday. Construction contractors would also monitor Reclamation's Central Valley Operations Office Web site daily for forecasted flows posted there to determine and anticipate any potential changes in releases. If flows were anticipated to inundate a work area that would normally be dry, the contractor would immediately remove all equipment from the work area.

#### *Revegetation Plan*

Reclamation, in conjunction with cooperating agencies and private landowners, would prepare a comprehensive revegetation plan to be implemented in conjunction with other management plans (e.g., SWPPP). This plan would apply to any area included as part of an action alternative, such as inundation, relocation, or mitigation activities. Overall objectives of the revegetation plan would be to reestablish native vegetation to control erosion, provide effective ground cover, minimize opportunities for nonnative plant species to establish or expand, and provide habitat diversity over time. Reclamation would work closely with cooperating agencies, private landowners, and revegetation specialists to develop the sources of native vegetation, site-specific planting patterns and species assemblages necessary for a revegetation effort of this magnitude.

#### *Invasive Species Management*

Reclamation would develop and implement a control plan to prevent the introduction of zebra/quagga mussels (*Dreissena rostriformis bugensis*), invasive plants, and other invasive species to project areas. The control plan would cover all workers, vehicles, watercraft, and equipment (both land and aquatic) that would come into contact with Millerton Reservoir, the shoreline of Millerton Reservoir, the San Joaquin River, and any riverbanks, floodplains, or riparian areas (Reclamation 2012). Plan activities could include, but would not be limited to, the following:

- Pre-inspection and cleaning of all construction vehicles, watercraft, and equipment before being shipped to project areas

- Reinspection of all construction vehicles, watercraft, and equipment on arrival at project areas
- Inspection and cleaning of all personnel before work in project areas

All inspections would be conducted by trained personnel and would include both visual and hands-on inspection methods of all vehicle and equipment surfaces, up to and including internal surfaces that have contacted raw water.

Approved cleaning methods would include a combination of the following:

- **Precleaning –** Draining, brushing, vacuuming, high-pressure water treatment, thermal treatment
- **Cleaning –** Freezing, desiccation, thermal treatment, high-pressure water treatment, chemical treatment

Onsite cleanings would require capture, treatment, and/or disposal of any and all water needed to conduct cleaning activities.

#### *Construction Material Disposal*

Reclamation's contractors would take measures to recycle or reuse demolished materials, such as steel or copper wire, concrete, asphalt, and reinforcing steel, as required and where practical. Other demolished materials would be disposed of in local or other identified permitted landfills in compliance with applicable requirements.

To reduce the risk to construction workers, the public, and the environment associated with exposure to hazardous materials and waste, Reclamation would implement the following:

- A Hazardous Materials Business Plan would be developed and implemented to provide information regarding hazardous materials to be used for project implementation and hazardous waste that would be generated. The Hazardous Materials Business Plan would also define employee training, use of protective equipment, and other procedures that provide an adequate basis for proper handling of hazardous materials to limit the potential for accidental releases of and exposure to hazardous materials. All procedures for handling hazardous materials would comply with all Federal, State, and local regulations.

- Soil to be disposed of at a landfill or recycling facility shall be transported by a licensed waste hauler.
- All relevant available asbestos survey and abatement reports and supplemental asbestos surveys would be reviewed. Removal and disposal of asbestos-containing materials would be performed in accordance with applicable Federal, State, and local regulations.
- A lead-based paint survey would be conducted to determine areas where lead-based paint is present and the possible need for abatement before construction or demolition.

#### ***Asphalt Removal***

Per California Fish and Game Code 5650 Section (a), all asphaltic roadways and parking lots inundated by project implementation would be demolished and removed according to Fresno County or Madera County standards, as applicable. Asphalt would be disposed of at an approved and permitted waste facility. Dirt roads inundated by project implementation may remain in place.

#### ***Reduce Fugitive Dust Emissions***

Reclamation, its contractors, and/or its construction partners would comply with Regulation VIII. Construction activities would not commence until SJVAPCD has approved the plan. Reclamation, its contractors, and/or its construction partners would also implement the following SJVAPCD-recommended enhanced and additional control measures to further reduce fugitive dust emissions:

- Install sandbags or other erosion control measures to prevent silt runoff to public roadways from adjacent project areas with a slope greater than 1 percent
- Suspend excavation and grading activity when winds exceed 20 miles per hour
- Limit area subject to excavation, grading, and other construction activity at any one time

#### ***Fire Protection and Prevention Plan***

Reclamation, its contractors, and/or its construction partners would prepare and implement a fire protection and prevention plan, addressing the following topics (found in 29 CFR 1926.150), to minimize the risk of wildfire or threat to workers, property, and the public:

- Dispensing of flammable/combustible liquids
- Welding and cutting
- Use, storage, and transport of compressed gas cylinders
- Managing open and enclosed storage yards or facilities
- Fire prevention measures
- Fire emergency response

### Action Alternative Construction Activities and Schedule

Various technical assessments of activities, methods, and material production rates were conducted to support the construction schedule for project features. Construction activities and schedules were based on design drawings, quantities, and cost estimate information documented in the Draft Feasibility Report (Reclamation 2014). The activities and schedule described in this section give specific attention to high-risk activities and sequencing related to the diversion works needed to start and complete dam construction.

Construction activities under all action alternatives would include the following work breakdown phases:

- **Phase 1 –** Site work, tunnel, and marine phase. A subcategory of Phase 1, Phase 1b, would include a mitigation period, if needed, to address significant risk related to establishing stable and sufficiently tight cofferdams.
- **Phase 2 –** Powerhouse/valve house and intake phase
- **Phase 3 –** Dam/reservoir phase

Construction phases are based on construction timing and feature proximity. The detailed breakdown for each phase is shown in Figure 2-14. Additional details are in the Draft Feasibility Report (Reclamation 2014).

The schedule for phases and activities is preliminary and was developed to analyze the technical, economic, and financial feasibility in the separate Draft Feasibility Report, and for the analysis of impacts and development of mitigation measures for this Draft EIS. Revisions may occur through the planning, environmental, permitting, final design, and contracting processes.

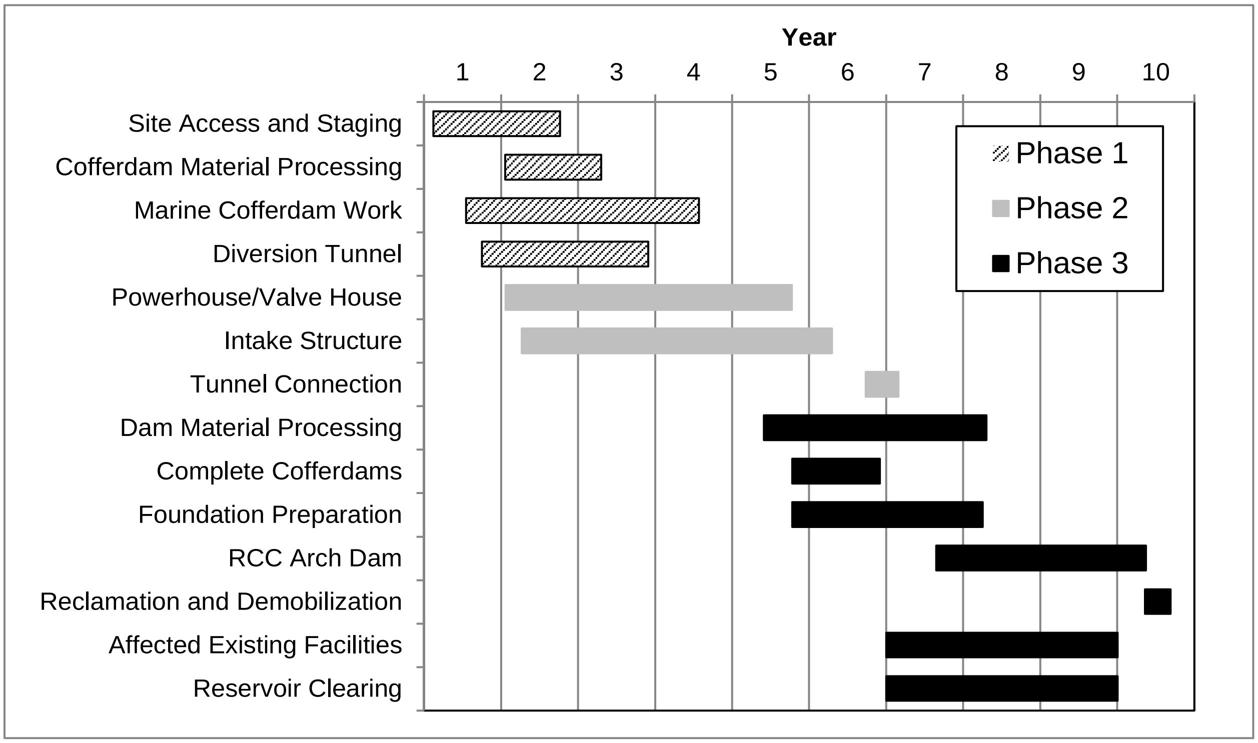


**Figure 2-14. Preliminary Construction Activities and Schedule**

***Phase 1 – Sitework, Marine Phase, and Tunnel***

Phase 1 would include activities preceding the main dam construction such as initial site access and contractor use area staging, material processing, and underwater cofferdam construction, and diversion tunnel construction. Estimates of fuel use, equipment use, and truck trips for Phase 1 activities are in the Draft Feasibility Report (Reclamation 2014).

**Site Access and Staging** This activity would include constructing haul and access roads, and developing the quarry, batch plant sites, and staging area. Embankment material would consist of excavation material, with the remaining waste excavation being stored at the quarry, staging area, or tunnel waste area. As scheduled, site access and staging construction activities would last 16 months.

The new Temperance Flat transmission line would be constructed along approximately 4.42 miles from the existing Kerckhoff-Sanger 115 kilovolt (kV) line to the proposed Temperance Flat powerhouse switch yard. The line would be constructed using 31 predominately steel monopoles with steel-reinforced, drilled concrete piers. A temporary transmission line would be built from the powerhouse site east to the inundation area. Temporary lines would then run through the inundation area to provide power at the quarry, batch plant sites, and other construction areas.

**Cofferdam Material Processing** Quarry operations in Phase 1 would include processing 2,691 thousand cubic yards of material for the rockfill cofferdams. Processing would include crushing rock to obtain the fine rockfill, and quarrying to a maximum size, to obtain the larger rockfill. Material with impervious characteristics could be borrowed from the area or, alternatively, a clayey import may be blended with some quarried and crushed well-graded gravel. Cofferdam material processing would last 15 months.

**Marine Cofferdam Work** Phase 1 would include marine or underwater construction of both cofferdams. The cofferdam foundations and trenches would be constructed and prepared using clamshell barges and underwater drill-and-blast techniques. Waste material would be placed in the quarry via truck and potentially processed into construction material.

Below elevation 535 feet msl, materials would be placed using clamshell placement supplemented by higher production bottom-dump barges. Trucks would transport material from the quarry to the clamshells/barges. Central low zones 300 to 500 feet wide across the river and at elevation 528 feet msl, would allow river passage through Millerton Lake until a cofferdam closure was made and the river was diverted. Once the cofferdams were at elevation 535 feet msl and the diversion tunnel was complete, including the approach and discharge chute excavations, the cofferdam closures would be placed to above elevation 535 feet msl, thereby diverting the river through the diversion tunnel. The diversion would only be initiated at this point if the water surface was low enough in the September-through-January low-level period.

Upon successfully diverting the river through the diversion tunnel, the area between the partial cofferdams would be unwatered and observed for stability and seepage. Marine cofferdam excavation and material placement would last 13 months. Total marine cofferdam activities, including staging, construction, dewatering, observation, and cleanup, would last 37 months.

**Diversion Tunnel** The diversion tunnel and portals would be constructed using excavators and drill-and-blast techniques. Waste material would be placed in the tunnel waste area via truck. The tunnel would then be lined with concrete. Until the tunnel was completed and the project was prepared for diversion, the reservoir banks upstream from the intake portal and downstream from the tunnel discharge portal would be left in place to protect the diversion tunnel from flooding during construction. Other assumptions are detailed in the Draft Feasibility Report (Reclamation 2014). Diversion tunnel construction would last 26 months.

### *Phase 2 – Powerhouse/Valve House and Intake Construction*

Phase 2 would include activities to construct the Temperance Flat Powerhouse/Valve House and intake structure (LLIS or SLIS). All structures would then be connected to the diversion tunnel to complete the river outlet works. Estimates of fuel use, equipment use, and truck trips for Phase 2 activities are in the Draft Feasibility Report (Reclamation 2014).

**Powerhouse/Valve House** A 200-square-foot work pad would be constructed next to the powerhouse excavation for staging. A small access road would be built to tie into proposed access/haul roads. Excavation construction of the powerhouse and valve house would occur simultaneously. A small cofferdam would be used for powerhouse tailrace and valve house chute construction. The bottom of the powerhouse would be constructed during low-water periods in Millerton Lake. The higher portion of the powerhouse (above elevation 580 feet msl) and most of the valve house are outside the influence of Millerton Lake levels and would be constructed during remaining periods of the year.

Construction would include extensive excavation for both structures and access road. Excavated material would be either disposed of in the diversion tunnel waste area or be used for infill or aggregate in powerhouse and valve house construction. Reinforced, cast-in-place concrete would be used for powerhouse and valve house structures. Cement, penstock steel, and other materials would be trucked from Fresno, California railyards via North Friant, Millerton, and Sky Harbor roads.

After construction was completed, riprap would be placed along the upstream and downstream sides of the structure to topographically tie existing ground contours to the structure, and to aid in erosion control. Temporary features that would be decommissioned once construction was complete include scaffolding and the construction staging pad. The area would be restored and revegetated. Powerhouse/valve house construction would last 45 months.

**Intake Structure** A 200-square-foot work pad would be constructed at the ridge above the intake (LLIS or SLIS) for staging. A small access road would be built to tie into proposed access/haul roads. The cofferdam used to construct the diversion tunnel was anticipated to be used for intake construction. The bottom of the intake would be constructed during low-water periods in Millerton Lake. The higher portion of the intake (above elevation 580 feet msl) would be outside the influence of Millerton Lake levels and would be constructed during remaining periods of the year.

Intake construction would include extensive excavation for both the structure and access road. Excavated material would be either disposed of in the inundation area or be used for construction aggregate. Cement, rebar, and other materials would be trucked from Fresno, California, rail yards via North Friant, Millerton, and Sky Harbour roads.

After intake construction was complete, riprap would be placed along the upstream and downstream sides of the structure to topographically tie the existing ground contours to the structure and to aid in erosion control. Temporary features that would require decommissioning once construction is complete would include scaffolding and the construction staging pad, which would be removed and the area restored and revegetated. Intake structure construction would last 49 months.

**Tunnel Connection** A crossover tunnel would be constructed once the dam was completed to connect the intake structure with the diversion tunnel. A concrete tunnel plug would be installed in the upstream end of the diversion tunnel, followed by controlled blasting techniques to excavate a tunnel from the base of the intake structure to the diversion/power tunnel downstream from the concrete plug. Excavation would be followed by concrete lining of the tunnel. The powerhouse/valve house penstock would also be connected to the diversion tunnel at this time. The tunnel connection work would last 5 months.

### *Phase 3 – Dam and Reservoir Construction*

Phase 3 would include activities to process construction materials, such as aggregate from the quarry, complete the cofferdams to elevation 580 feet msl, prepare the dam foundation, construct the RCC dam, and reclaim and demobilize the construction site. Estimates of fuel use, equipment use, and truck trips for Phase 3 activities are in the Draft Feasibility Report (Reclamation 2014).

**Dam Material Processing** Quarry operations in Phase 3 would include processing 6.9 million tons of aggregate. Large primary, multiple secondary, and multiple tertiary crushing units would be needed both for production and for particle shaping and sizing. Aggregate would be transported to the batch plant via truck for all quarry, batch plant, and haul road options. Aggregate production would last 25 months, but total material processing, from mobilization to shutdown, would be 35 months.

**Complete Cofferdams** Dry cofferdam construction would complete the cofferdams to elevation 580 feet msl. Trucks would transport material from the quarry to the cofferdams. Final cofferdam construction would last 14 months.

**Foundation Preparation** The dam foundation would be prepared using excavators and drill-and-blast techniques. Waste material would be placed and potentially processed into construction material in the quarry area via trucks. Cement, pozzolan, and metal for the foundation and dam would be trucked from Fresno, California, rail yards via Highway 41, County Road 200/210, and the proposed haul road. Foundation preparation would last 30 months.

**RCC Arch Dam** A cement batch plant site would be located near the dam’s right or left abutment depending on the quarry, batch plant, and haul road option. Multiple RCC plants, with multiple mixing units on each plant, would be likely at the batch plant site. Trucks would deliver aggregates, stockpiled high at the quarry, to the batch plant site. RCC delivery could be made with a custom conveyor or multiple conveyor system with a combined capacity meeting or exceeding the RCC plant capacity. The dam height could limit delivery to variable locations, as well as steady raising. Trucks could be used on the fill in lieu of conveyors to deliver materials to the spreading location. RCC placement would take 26 months presuming a 6-day/week placement. A total of 33 months would be needed to complete the RCC dam, including the dam crest and spillway.

**Reclamation and Demobilization** All disturbed sites, including contractor use areas and temporary roads outside of the reservoir area, would be reclaimed using the remaining excavated material stored at the quarry. Permanent access roads would be resurfaced. The downstream cofferdam would be demolished to elevation 500 feet msl, with waste material being placed at the toe of the cofferdam or at the quarry via truck. Reclamation and final demobilization would last 4 months.

**Affected Existing Facilities – Kerckhoff Project Decommissioning** All hydraulic, lubricating, and insulating oils would be drained and disposed. In addition, any refrigerants, storage batteries, or compressed gas would require disposal. Asbestos and equipment containing mercury, along with transformers and oil circuit breakers would be removed and disposed. Overhead conductors from the powerhouses to the switchyards would be removed. Transformers to be disposed of would be hauled to a licensed disposal facility in Los Angeles, 250 miles away. Construction waste would be disposed of in a Fresno, California, landfill or scrapyard. Several pieces of equipment would be salvaged and transported to the PG&E yard in Auberry, 9 miles from the Kerckhoff No. 2 site. Concrete plugs would be placed in the intake and draft tubes. The Kerckhoff penstock tunnel and surge chambers would also be plugged and backfilled. Kerckhoff Project decommissioning would last 36 months.

Inundated sections of the Kerckhoff-Le Grand and Kerckhoff-Sanger transmission lines (approximately 4 miles in length) would be reconstructed as the Le Grand–Sanger transmission line. The line would be constructed using 20 predominately steel monopoles with steel-reinforced, drilled concrete piers.

**Affected Existing Facilities – Recreation** Trail construction would use "full bench" construction whenever possible, locate trail switchbacks to reduce shortcutting, and protect environmentally sensitive areas and erodible slopes. Disturbed areas would be restored after construction. If buildings would be inundated, structures and foundations would be demolished.

Asbestos material, if discovered, would be removed and taken to an approved landfill for disposal per permit requirements. General demolition waste would also be removed and trucked to an approved landfill. Pavement in parking areas would be removed, the underlying soil ripped to 6 inches depth, and then the area would be hydroseeded. Whenever possible, new recreational structures would use renewable, local, and/or recycled content materials; use natural lighting, renewable energy, and high-efficiency utilities; and protect sensitive areas and erodible slopes.

Roadway construction activities would involve, but not be limited to, demolition of existing roadways as required; clearing, grubbing, and site preparation of work areas, as required; grading road alignments to meet finished grades; placing road subgrade; paving operations; installing storm drain culverts; constructing retaining wall systems; installing road appurtenances such as guardrails; and performing construction-related traffic control. Boat ramp construction activities would involve, but not be limited to, clearing, grubbing and site preparation of work areas; and heavy earthwork operations. Recreations facility demolition and relocations would last 36 months.

**Affected Existing Facilities – Utilities** All utilities associated with demolished buildings would be disconnected (typically 6 inches deep), capped, and/or removed per permit requirements and governing utility standards. Potable water and wastewater lines that would be relocated would use trenching and backfilling. Water removed from the construction area would be treated to remove sediment and discharged to the closest drainage way.

Relocated potable water wells would require a rotary drill rig. A concrete pad would be constructed at the top of the well to keep contaminated water away from the well. The concrete pad would also typically accommodate a small pump and small bladder tank. Power would need to be routed to the new well to power the pump.

Relocating wastewater septic systems would include excavating a pit approximately 17 feet long, 11 feet wide, and 9 feet deep for the septic tank. The tank would be placed and backfilled to grade. A trench approximately 100 feet long, 3 feet wide, and 3 feet deep would be excavated for the leach field. The perforated leach pipe and approved backfill would be added to the trench and the trench backfilled to grade.

Power distribution poles and wires affected by inundation would be removed and disposed of at an approved landfill. Relocated wood-pole or steel-pole foundations could be directly embedded in the ground (typically 6 feet) with crushed rock or concrete backfill, or installed using reinforced-concrete caissons and anchor bolts. Utilities demolition and relocations would last 36 months.

**Reservoir Clearing** Three vegetation removal prescriptions would be applied to the inundation area. Complete removal (331 acres) would clear all existing vegetation and would generally be applied to areas adjacent to proposed recreation developments to reduce water recreation hazards. Overstory removal (3,249 acres) would remove all trees greater than 10 inches in diameter at breast height or greater than 15 feet in height, and would be applied to most areas outside of complete removal areas. No treatment (1,066 acres) would generally be applied to areas assumed to support little to no vegetation, and would also apply to special habitat areas to maximize habitat benefits of inundated and residual vegetation.

For complete removal and overstory removal areas, timber would be harvested by standard or specialized logging machinery and hand crews. Lumber would be removed via existing roads or proposed haul and access roads. Understory vegetation (for complete removal areas) and waste would be disposed of using self-contained incinerators.

## Summary of Potential Accomplishments of Action Alternatives

This section summarizes the potential accomplishments of all action alternatives. Model simulations completed to assess the physical accomplishments are described in detail in the Modeling Appendix. The physical characteristics and potential physical accomplishments of the action alternatives are summarized in Table 2-8 and Table 2-9.

## Table 2-8. Physical Characteristics for Temperance Flat RM 274 Reservoir

| Physical Characteristics | Alternative Plan 1 | Alternative Plan 2 | Alternative Plan 3 | Alternative Plan 4 | Alternative Plan 5 |
|---|---|---|---|---|---|
| Temperance Flat RM 274 Reservoir Net Additional Storage Capacity (TAF)[1] | 1,260 | 1,260 | 1,260 | 1,260 | 1,260 |
| Total Carryover Storage Capacity (Millerton and Temperance Flat RM 274) (TAF) | 540 | 540 | 540 | 665 | 230 |
| Temperance Flat Carryover Storage Capacity (TAF) | 200 | 200 | 200 | 325 | 100 |
| Millerton Lake Carryover Storage Capacity (TAF) | 340 | 340 | 340 | 340 | 130 |
| Powerhouse Tailrace Elevation and Millerton Lake Carryover Storage Elevation (feet)[2] | 550 | 550 | 550 | 550 | 550 |

Notes:

[1] Total storage in Temperance Flat RM 274 Reservoir would be 1331 TAF, with 75 TAF overlapping with existing Millerton Lake.

[2] Elevation reported in North American Vertical Datum 88.

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

## Table 2-9. Potential Physical Accomplishments for Temperance Flat RM 274 Reservoir

| Potential Physical Accomplishments[1,2] | Alternative Plan 1 | Alternative Plan 2 | Alternative Plan 3 | Alternative Plan 4 | Alternative Plan 5 |
|---|---|---|---|---|---|
| Dry and Critical Year Increase in Total Delivery (TAF) | 19 | 24 | 30 | 21 | 121 |
| Long-Term Average Annual Increase in Agricultural Delivery (TAF)[3] | 30 | 49 | 52 | 41 | 94 |
| Long-Term Average Annual Increase in M&I Delivery (TAF) | 40 | 22 | 24 | 20 | -7 |
| Long-Term Average Annual Increase in Total Delivery (TAF) | 70 | 71 | 76 | 61 | 87 |
| Long-Term Average Annual Spring-Run Chinook Abundance Increase–High SAR (percent)[4] | 2.8% | 2.8% | 0.6% | 4.9% | -8.8% |
| Dry and Critical Year Spring-Run Chinook Abundance Increase–High SAR (percent)[4] | 15.9% | 13.2% | 14.7% | 13.2% | 18.3% |
| Long-Term Average Annual Spring-Run Chinook Abundance Increase–Low SAR (percent)[4] | 0.6% | 0.4% | -0.6% | 2.8% | -13.1% |
| Dry and Critical Year Spring-Run Chinook Abundance Increase–Low SAR (percent)[4] | 14.0% | 9.2% | 13.3% | 11.1% | 16.3% |
| Net Increase in Friant Dam Hydropower Generation (GWh/year) | 15.7 | 15.6 | 15.6 | 15.7 | 14.0 |
| Replacement of Kerckhoff Hydroelectric Project Value (percent)[6] | 83.8% | 83.8% | 83.8% | 91.2% | 73.4% |
| Increase in Recreation (thousands of visitor-days)[7] | 108 | 109 | 106 | 120 | 69 |
| Increase in Incidental Flood Space (TAF)[8] | 354 – 481 | 353 – 479 | 351 – 470 | 243 – 347 | 406 – 555 |

Notes:

[1] Operations based on Reclamation March 2012 CalSim II Benchmark with Formal ESA Consultation on the Proposed Coordinated Operations of the CVP and SWP (USFWS 2008) and Biological Opinion and Conference Opinion on the Long-Term Operations of the CVP and SWP (NMFS 2009).

[2] Accomplishments are reported as changes in comparison to No Action Alternative.

[3] Simulated water demands in the Friant Division of the CVP are based on existing Class 1 and Class 2 contracts.

[4] Action alternatives are compared to the No Action Alternative, which varies depending on the SAR.

[5] Emergency water supply represented by supply available for disruption due to 10-island levee breach.

[6] Impacts to Kerckhoff Hydroelectric Project will be mitigated. Costs include additional reimbursement required after onsite replacement.

[7] Sum of potential annual visitor days at Millerton Lake and Temperance Flat RM 274 Reservoir.

[8] Incidental flood space is the flood space available during November through March at the 90 percent exceedance.

Key:

CVP = Central Valley Project
GWh/year = gigawatt hours per year
M&I = municipal and industrial
RM = river mile
SAR = smolt-to-adult return rate
SWP = State Water Project
TAF = thousand acre-feet

### Increase Water Supply Reliability and System Operational Flexibility

The primary planning objective to increase water supply reliability and system operational flexibility could address water supplies and demands for CVP agricultural and SWP M&I water contractors. In addition to providing long-term average or dry-year water supply reliability, Temperance Flat RM 274 Reservoir could provide emergency water supplies to SOD M&I water users during emergency Delta pumping outages. Both water supply reliability and emergency water supplies are considered to meet this planning objective.

#### *Water Supply Reliability*

In the Draft Feasibility and Plan Refinement Phase, analyses of Temperance Flat RM 274 Reservoir conditions and operations under the 2008 USFWS and 2009 NMFS BOs (USFWS 2008, NMFS 2009) focused on storing and managing water that would otherwise have been released from Friant Dam as flood releases or Section 215 deliveries. This operation would provide water supply reliability and operational flexibility to the CVP and SWP systems. The action alternatives were analyzed for water supplies to the Friant Division contractors, SWP SOD M&I contractors, CVP SOD contractors, and CVP San Joaquin Valley wildlife refuges, based on CalSim II simulations. Table 2-10 summarizes the long-term average annual change in deliveries to the beneficiaries in each action alternative compared to the No Action Alternative. Table 2-11 lists the long-term average annual change in deliveries systemwide for all water year types for all action alternatives compared to the No Action Alternative.

The long-term average annual change in systemwide deliveries accounted for reduced Delta pumping to SWP and CVP SOD contractors due to the reduction in Delta inflows during wet years (flood flows) from the San Joaquin River. On average, the action alternatives would provide between 61 to 87 TAF per year of additional CVP and SWP systemwide water deliveries, depending on operations for a particular action alternative. The CalSim II modeling shows some infrequent, minor changes to CVP and SWP water operations north of the Delta. These changes are a result of the model response to reductions in San Joaquin River inflow to the Delta and implementation of the complex system of Delta inflows, exports, regulations, hydrodynamic and salinity interaction rules and their interactions with the Coordinated Operations Agreement on how water supply and regulatory responsibility are shared by the CVP and SWP north of the Delta in the model. The model follows the built in rules governing these interactions and cannot deviate from these rules when new or unexpected interactions occur.

These minor changes indicated in the modeling, and any potential impacts from these changes, are expected to be consistent between alternatives, and would not make any difference in the comparative analysis performed using the CalSim II simulation results. During project implementation corrective actions could be included in the project operating plan so that these potential impacts would be avoided in real-time operations. Because these small upstream changes are not expected to occur in real-time, would be small and infrequent, could have a positive or negative impact on SOD deliveries, and would be expected to be consistent between simulations, they are ignored for the purposes of this document.

In addition to carryover storage targets, the magnitude of long-term water supply reliability accomplishments was strongly influenced by CVP and SWP operating conditions. Evaluation of Temperance Flat RM 274 Reservoir, integrated with the broader CVP and SWP SOD exports and storage systems under potential future conditions with increased flexibility for CVP and SWP Delta export operations, would likely result in significantly greater estimates of water supply reliability by capturing additional Delta water supply in wet years through exchange.

### Table 2-10. Long-Term Average Annual Change in Deliveries for Temperance Flat RM 274 Reservoir (in TAF)

| Average Annual Change in Delivery[1] | Alternative Plan 1 | Alternative Plan 2 | Alternative Plan 3 | Alternative Plan 4 | Alternative Plan 5 |
|---|---|---|---|---|---|
| Friant Division of the CVP | 43 | 36 | 38 | 27 | 48 |
| CVP SOD Ag[2] | -10 | 16 | 16 | 16 | 48 |
| SWP SOD M&I[2] | 40 | 22 | 25 | 21 | -7 |
| **Total CVP and SWP Change In Deliveries[3]** | **70** | **71** | **76** | **61** | **87** |

Notes:

[1] Action alternatives are compared to the No Action Alternative.

[2] Because Temperance Flat RM 274 Reservoir would increase the capacity to capture San Joaquin River flood flows, Delta inflows from the San Joaquin River would be reduced, therefore reducing CVP and SWP deliveries from the Delta in some years. In some action alternatives, the long-term annual average delivery to CVP SOD would be slightly less than the No Action Alternative.

[3] Total CVP and SWP delivery includes SWP Ag and CVP M&I, which are not included as water supply beneficiaries; consequently, line items may not sum to totals.

Key:
Ag = agricultural
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
M&I = municipal and industrial
RM = river mile
SOD = South-of-Delta
SWP = State Water Project
TAF = thousand acre-feet

## Table 2-11. Long-Term Average Annual Change in Deliveries for Action Alternatives[1] (in TAF)

| Action Alternative | WY Type San Joaquin Index[2] | Change in Systemwide Delivery[3] | Total Friant Ag | Class 1 | Class 2 | Section 215 | Total SWP SOD | SWP SOD Ag | SWP SOD M&I | Total CVP SOD[2] | CVP SOD Ag | CVP SOD M&I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alternative Plan 1 | Wet | 112 | 102 | (1) | 239 | (137) | 33 | (10) | 44 | (23) | (22) | (1) |
| | Above Normal | 152 | 82 | 2 | 133 | (53) | 79 | (3) | 82 | (9) | (9) | 0 |
| | Below Normal | 1 | (49) | (3) | (14) | (32) | 53 | 7 | 46 | (3) | (3) | 0 |
| | Dry and Critical | 19 | 12 | 4 | 23 | (15) | 13 | 0 | 13 | (5) | (5) | (1) |
| | **All Years** | **70** | **43** | **1** | **103** | **(61)** | **38** | **(3)** | **40** | **(11)** | **(10)** | **0** |
| Alternative Plan 2 | Wet | 115 | 99 | (1) | 237 | (137) | 0 | (10) | 10 | 16 | 17 | (1) |
| | Above Normal | 145 | 65 | 1 | 117 | (53) | 43 | (3) | 46 | 36 | 37 | 0 |
| | Below Normal | (4) | (65) | (3) | (30) | (32) | 42 | 7 | 35 | 19 | 19 | 0 |
| | Dry and Critical | 24 | 8 | 6 | 18 | (15) | 15 | 1 | 13 | 1 | 1 | (1) |
| | **All Years** | **71** | **36** | **1** | **95** | **(61)** | **20** | **(2)** | **22** | **16** | **16** | **0** |
| Alternative Plan 3 | Wet | 116 | 86 | (1) | 224 | (138) | 22 | (10) | 33 | 9 | 10 | 0 |
| | Above Normal | 152 | 62 | 1 | 113 | (53) | 48 | (3) | 51 | 42 | 43 | 0 |
| | Below Normal | 7 | (38) | (3) | (2) | (32) | 21 | 6 | 15 | 23 | 23 | 0 |
| | Dry and Critical | 30 | 18 | 7 | 27 | (15) | 8 | 1 | 7 | 3 | 3 | (1) |
| | **All Years** | **76** | **38** | **2** | **98** | **(62)** | **22** | **(2)** | **25** | **15** | **16** | **0** |
| Alternative Plan 4 | Wet | 99 | 91 | (1) | 220 | (128) | (2) | (10) | 8 | 10 | 11 | 0 |
| | Above Normal | 122 | 39 | 2 | 90 | (53) | 40 | (3) | 43 | 42 | 42 | 0 |
| | Below Normal | 2 | (62) | (3) | (27) | (32) | 40 | 6 | 34 | 23 | 23 | 0 |
| | Dry and Critical | 21 | 6 | 6 | 15 | (15) | 14 | 1 | 12 | 2 | 3 | 0 |
| | **All Years** | **61** | **27** | **2** | **85** | **(59)** | **18** | **(2)** | **21** | **16** | **16** | **0** |
| Alternative Plan 5 | Wet | 0 | 20 | (1) | 158 | (137) | (45) | (11) | (35) | 26 | 27 | 0 |
| | Above Normal | 152 | 84 | (1) | 138 | (53) | (8) | (3) | (4) | 76 | 76 | 0 |
| | Below Normal | 89 | (6) | (29) | 55 | (32) | 18 | 7 | 11 | 78 | 78 | 0 |
| | Dry and Critical | 121 | 75 | 25 | 66 | (15) | 8 | 1 | 6 | 39 | 39 | (1) |
| | **All Years** | **87** | **48** | **4** | **106** | **(61)** | **(10)** | **(2)** | **(7)** | **48** | **48** | **0** |

Notes:

[1] Changes in deliveries as simulated with CalSim II March 2012 Benchmark with future (2030) level of development and 82-year hydrologic period of record from October 1921 to September 2003.

[2] San Joaquin Year Type or 60-20-20 Year Type – This classification system is based on the historical and forecasted unimpaired inflows of the Stanislaus, Tuolumne, Merced, and San Joaquin rivers to the San Joaquin River Basin, as defined in State Water Resources Control Board Decision 1641. The classification consists of five year types: wet, above normal, below normal, dry, and critical. Average for all years is weighted average based on proportion of each year type out of 82-year period of record.

[3] Action Alternatives are compared to the No Action Alternative.

Key:
Ag = agricultural
CVP = Central Valley Project
M&I = municipal and industrial
SOD = South-of-Delta
SWP = State Water Project
TAF = thousand acre-feet
WY = water year

## Enhance Water Temperature and Flow Conditions

A primary planning objective is to enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish.

### *Ecosystem – Cold-Water Pool and River Release Temperature*

The action alternatives could improve the capability, reliability, and flexibility to release water at suitable temperatures for anadromous fish downstream from Friant Dam. Reservoir and river water temperature simulations were performed for all action alternatives. Alternative Plan 4 also includes an SLIS to better manage reservoir cold-water pool and San Joaquin River release temperatures for anadromous fish.

All action alternatives would increase the total volume of cold water in Millerton Lake and Temperance Flat RM 274 Reservoir, with larger available cold-water pools in action alternatives with higher carryover storage. The SLIS included in Alternative Plan 4 would also allow for better management of the cold-water pool resulting in improved temperature conditions for anadromous fish in the San Joaquin River.

The action alternatives could improve San Joaquin River release temperatures from the critical September through December spawning period, as shown in Figure 2-15, at the cost of slightly warmer winter releases than in the No Action Alternative. However, in the winter months, release temperatures would still be cooler than required for successful anadromous fish survival (see Modeling Appendix for further detail on reservoir and river temperatures). Inclusion of an SLIS in Alternative Plan 4 would reduce release temperatures by up to 5 degrees Fahrenheit (°F) more than without the SLIS during falls months. The colder release temperatures would also slightly extend the distance downstream from Friant Dam where mean daily river temperatures would stay below 55°F, a critical temperature for anadromous fish (Figure 2-16).

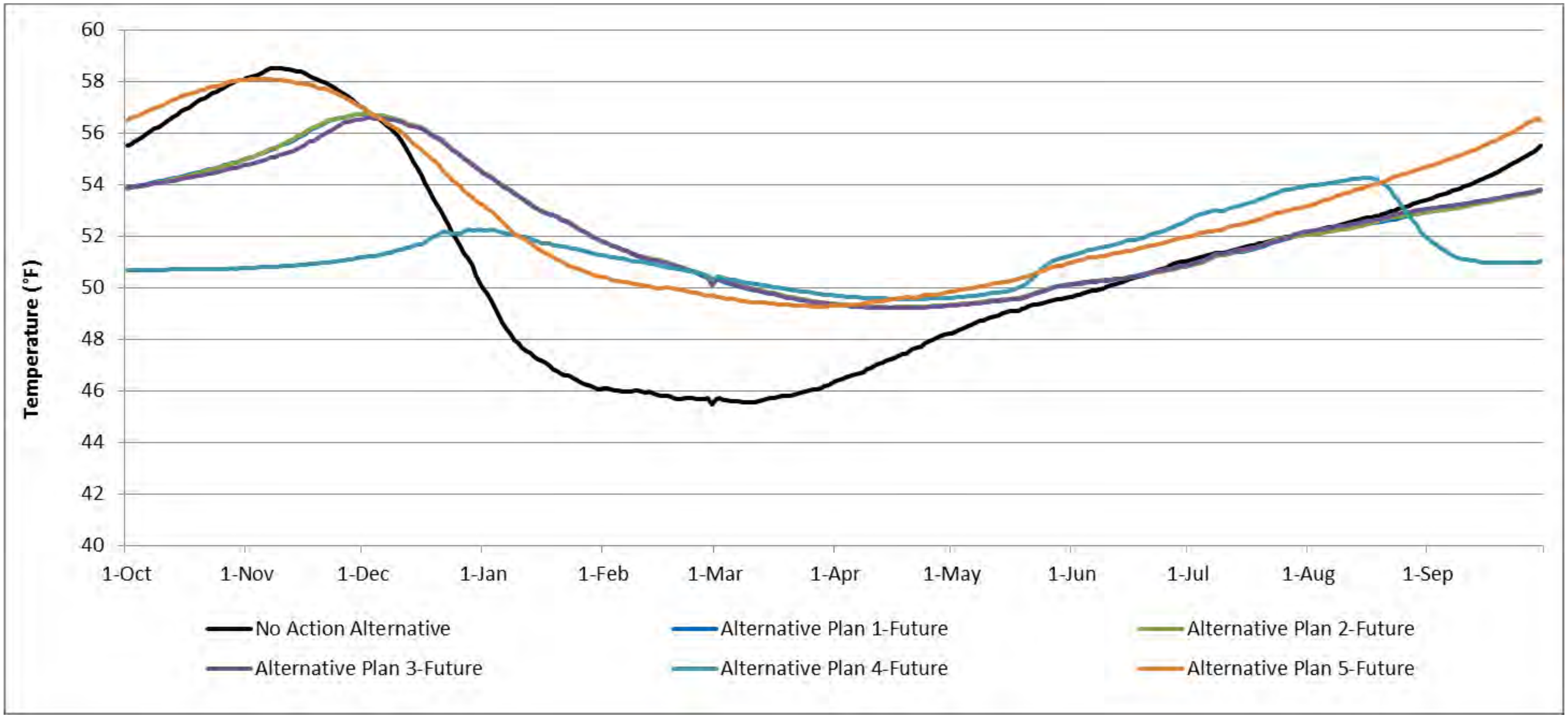


**Figure 2-15. Mean Daily Temperature (°F) of Friant Dam Release to San Joaquin River – All Years**

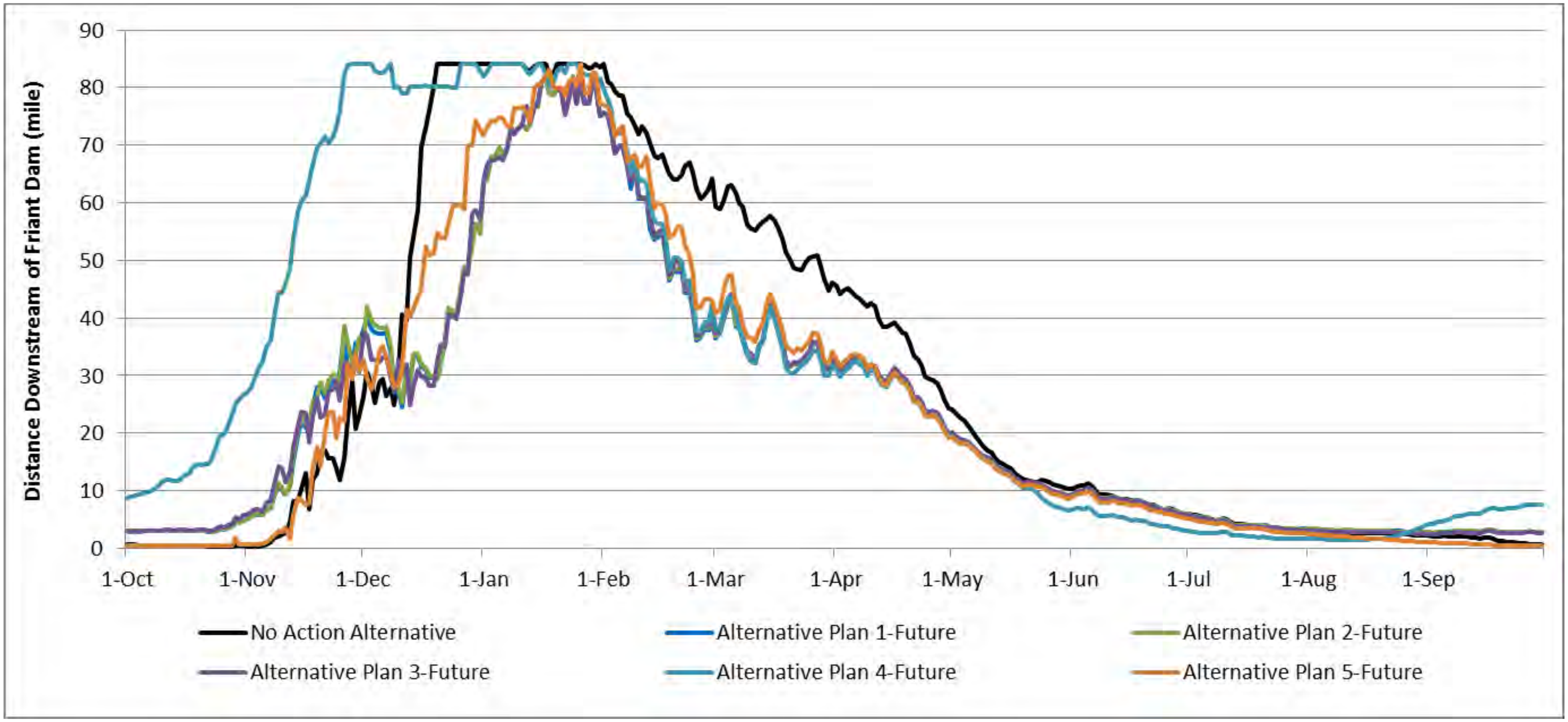


Figure 2-16. Distance Downstream from Friant Dam Where Mean Daily San Joaquin River Temperature <= 55° F – All Years

#### *Ecosystem – Improvement in Spring-Run Chinook Salmon Abundance*

The Ecosystem Diagnosis and Treatment (EDT) model (Mobrand et al. 1997, Blair et al. 2009) was used to estimate potential improvements to San Joaquin River spring-run Chinook salmon habitat that could be achieved by action alternatives. EDT output included variables describing the productivity and capacity of fish habitat that could develop under flow and temperature regimes for each action alternative. Productivity and capacity were both represented in the abundance metric estimated by the EDT model, representing the number of spawning fish the habitat could sustain. Productivity represented habitat quality, was based on the density-independent survival rate (i.e., survival without competition), and was a function of temperature, water quality, and food. Capacity was the maximum abundance that could be supported by the quantity of suitable habitat and the density of fish in that habitat, and it was a function of the quantity of habitat, productivity, and food. Due to uncertainty and limited data regarding the survival of salmon as they migrate below the Merced River to the ocean and then returned to spawn, results were developed to demonstrate a range of potential results for a low and high potential smolt-to-adult return rate (SAR). EDT modeling is described in further detail in the Modeling Appendix.

Potential improvements due to Temperance Flat RM 274 Reservoir operations for spring-run Chinook salmon habitat were measured by comparing the abundance for each action alternative to that of the No Action Alternative as a percent improvement in abundance. Equilibrium abundance was the best estimate for maximum number of returning/spawning adult fish that could be supported considering both habitat quantity and quality. Table 2-12 shows the change in abundance of spring-run Chinook salmon habitat in the San Joaquin River due to improvements in flow and water temperature for weighted long-term average annual and dry year types. Alternative Plan 4, which includes an SLIS, would provide the highest long-term average annual improvement in equilibrium abundance. Improvements in abundance due to the action alternatives were related to a combination of temperature improvements from additional flow or cold-water pool management through carryover storage and/or an SLIS, and additional flow in the San Joaquin River from Friant Dam to Mendota Pool (for water supply deliveries and/or exchanges).

### Table 2-12. Percent Change in Abundance of Spring-Run Chinook Salmon for Action Alternatives

| SAR | Measured Timeframe | Alternative Plan 1 | Alternative Plan 2 | Alternative Plan 3 | Alternative Plan 4 | Alternative Plan 5 |
|---|---|---|---|---|---|---|
| High | Long-Term Average | 2.8% | 2.8% | 0.6% | 4.9% | -8.8% |
| | Dry Year | 15.9% | 13.2% | 14.7% | 13.2% | 18.3% |
| Low | Long-Term Average | 0.6% | 0.4% | -0.6% | 2.8% | -13.1% |
| | Dry Year | 14.0% | 9.2% | 13.3% | 11.1% | 16.3% |

Notes:
Further details are presented in the Modeling Appendix.
[1] Action alternatives are compared to the No Action Alternative, which varies depending on the smolt-to-adult return rate.
Key:
SAR = smolt-to-adult return rate

## Flood Damage Reduction, Hydropower, Recreation, San Joaquin River Water Quality, Urban Water Quality

Physical accomplishments of the action alternatives regarding flood management, hydropower generation, and recreation are described below. San Joaquin River and urban water quality accomplishments other than temperature would be minor and therefore are not discussed.

### *Increase in Incidental Flood Space*

Incidental flood storage was evaluated as the total storage between Millerton Lake and Temperance Flat RM 274 Reservoir available 90 percent of the time on a monthly basis. Increased storage with Temperance Flat RM 274 Reservoir would allow greater ability to capture flood flows. Figure 2-17 shows the 90 percent exceedence flood storage availability for action alternatives compared to the No Action Alternative. Available storage in November through March also assumed that up to 85 TAF of flood storage was available above Temperance Flat RM 274 Reservoir in Mammoth Pool. Action alternatives with lower carryover storage targets (Alternative Plans 1, 2, 3, and 5) would have more active storage available for flood management, but all action alternatives, including Alternative Plan 4, would have at least 200 TAF more flood storage availability in the rain flood season from October to March, compared to the No Action Alternative.

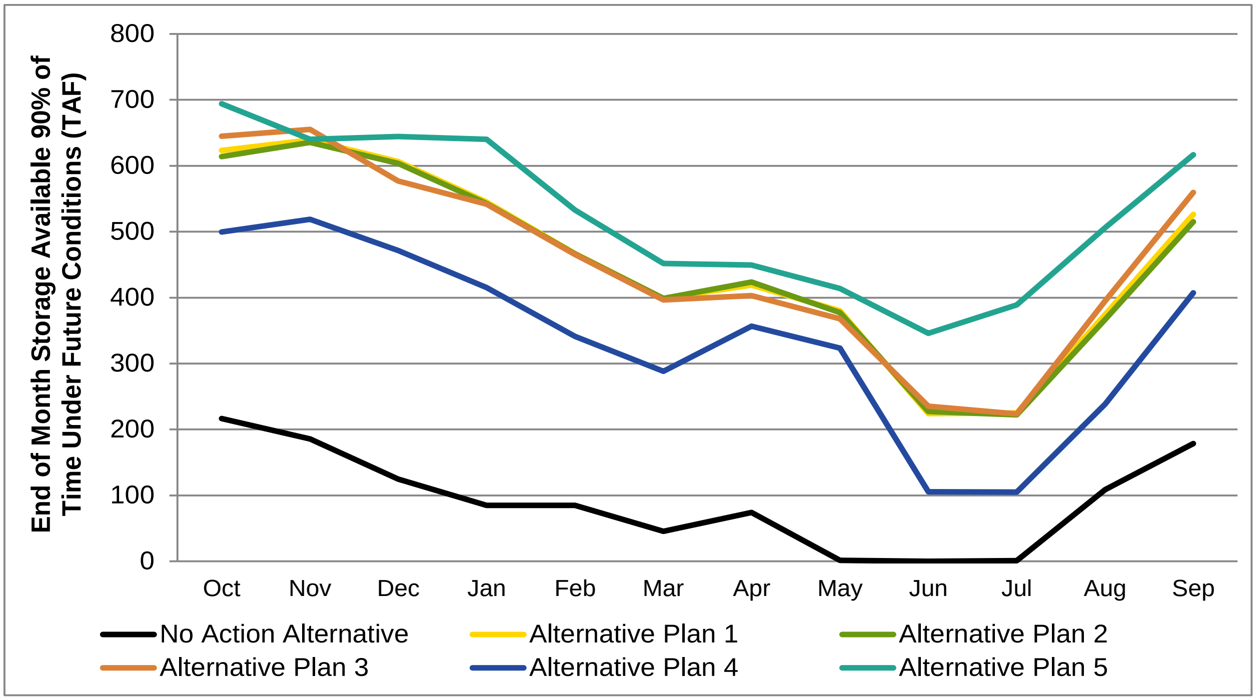


**Figure 2-17. 90 Percent Exceedence Flood Storage Availability by Month for All Scenarios**

### *Hydropower and Replacement of Impacted Hydropower Value*

The ability of action alternatives to replace the value of the Kerckhoff Hydroelectric Project powerhouses would vary greatly, depending on how carryover storage was managed in Millerton Lake and Temperance Flat RM 274 Reservoir. Alternative Plans 1, 2, and 3 could replace all but 101 gigawatt-hours (GWh) per year (GWh/year) (83.8 percent) of impacted Kerckhoff Hydroelectric Project generation using onsite hydropower generation. Alternative Plan 4 could replace all but 54 GWh/year (91.2 percent) of impacted Kerckhoff Hydroelectric Project generation using onsite hydropower generation because of higher carryover storage in Alternative Plan 4 allowing for higher head for power generation. Alternative Plan 5 could replace all but 164 GWh/year (73.4 percent) of impacted Kerckhoff Hydroelectric Project generation using onsite hydropower generation. The Alternative Plan 5 carryover storage targets in both Millerton Lake and Temperance Flat RM 274 Reservoir would create a wider range of head and would inhibit hydropower generation more than other action alternatives.

Table 2-13 shows the simulated long-term average hydropower generation change from the No Action Alternative. Alternative

Plans 1 through 4 would operate Millerton Lake with a fixed water surface at elevation 550 (carryover storage target of 340 TAF). The fixed elevation would allow Friant Dam powerhouses to generate an additional 15.7 to 15.8 GWh/year, on average, compared to the No Action Alternative. Alternative Plan 5 would operate Millerton Lake with a variable water surface elevation, resulting in smaller increases in generation at Friant Dam relative to the other action alternatives.

**Table 2-13. Friant Dam Hydropower Generation and Kerckhoff Hydroelectric Project Onsite Generation**

| Hydropower Generation Parameter | Alternative Plan 1 | Alternative Plan 2 | Alternative Plan 3 | Alternative Plan 4 | Alternative Plan 5 |
|---|---|---|---|---|---|
| Change in Hydropower Generation (GWh/year) (Kerckhoff Hydroelectric Project generation minus Temperance Flat RM 274 Powerhouse generation)[1] | -100.1 | -100.1 | -100.1 | -54.3 | -163.8 |
| Percent Generation Replacement of Kerckhoff Hydroelectric Project[1] | 83.8 | 83.8 | 83.8 | 91.2 | 73.4 |
| Change in Hydropower Generation at Friant Dam from No Action Alternative (GWh/year)[1] | 15.7 | 15.6 | 15.6 | 15.7 | 14.0 |

Note:
[1] Action alternatives are compared to No Action Alternative. Remaining requirements for Kerckhoff Hydroelectric Project are addressed in project costs.
Key:
GWh = gigawatt-hour
RM = river mile

### *Recreational Opportunities*

Opportunities for recreational development would vary, depending on balancing of reservoir storage levels between Millerton Lake and Temperance Flat RM 274 Reservoir and water supply beneficiaries. Operating the reservoir balancing to generally keep Millerton Lake at a fixed elevation could improve early- and late-season boating opportunities in Millerton Lake, but at lower elevations, could allow vehicular access that would degrade shoreline use conditions. Operating Millerton Lake with a fixed elevation between elevations 540 to 560 feet msl would allow the best balance of shoreline and reservoir use. All action alternatives would be operated with a fixed Millerton Lake elevation of 550 feet msl. Boating and waterskiing activities would generate the highest economic value for Millerton Lake, followed by picnicking.

Temperance Flat RM 274 Reservoir could also support recreation, particularly boating activities. Recreational visitation at Temperance Flat RM 274 Reservoir was estimated as proportionate to Millerton Lake average visitation, considering the simulated 50 percent exceedence Temperance Flat RM 274 Reservoir surface area as compared to the historical 50 percent exceedence Millerton Lake surface area. As a much larger reservoir, Temperance Flat RM 274 Reservoir under Alternative Plan 4 could support 96,400 new visitor-days. Potential Temperance Flat RM 274 Reservoir recreational visitation might be understated because only peak recreational season boating activity participation was estimated, no land-based activity or camping participation was estimated, and no off-season participation was considered. Table 2-14 summarizes the increase in recreational visitor-days for action alternatives, considering recreation at Millerton Lake and Temperance Flat RM 274 Reservoir. Estimates of annual increases in recreation visitor-days range from 113,600 to 130,400.

### Table 2-14. Estimated Increase in Recreation Visitor-Days Compared to No Action Alternative

| Recreational Parameter | Alternative Plan 1 | Alternative Plan 2 | Alternative Plan 3 | Alternative Plan 4 | Alternative Plan 5 |
|---|---|---|---|---|---|
| Potential Annual Increase in Visitation at Millerton Lake[1] (1,000 visitor-days/year) | 34 | 34 | 34 | 34 | 32 |
| Potential Annual Visitation at Temperance Flat RM 274 Reservoir[1,2,3] (1,000 visitor-days/year) | 74 | 75 | 72 | 86 | 37 |
| **Total Potential Annual Increase in Recreation Visitation (1,000 visitor-days/year)** | **108** | **109** | **106** | **120** | **69** |

Notes:

[1] Action alternatives are compared to No Action Alternative. Visitor-day values are net increases.

[2] Potential annual visitation at Temperance Flat RM 274 Reservoir is based solely on boating activities and peak recreational season Temperance Flat RM 274 Reservoir surface acres. Boating activities include waterskiing/wakeboarding, personal water craft, boat fishing, and general boating. This is considered a conservative estimate because with creation of Temperance Flat RM 274 Reservoir it is expected that new land-based recreation and camping facilities would be developed and support these recreational activities.

Key:
RM = river mile

## Preferred Alternative and Rationale for Selection

This Draft EIS does not identify a preferred alternative for implementation. Consistent with CEQ Regulations, 40 CFR Part 46.425, a preferred alternative (or alternatives, if there is more than one) will be identified in the Final EIS. The preferred alternative(s) will be identified in the Final EIS based on the information presented in this Draft EIS, in light of any potential revisions made in response to comments received on this Draft EIS. After the Final EIS is published, Reclamation may prepare and adopt a ROD. The ROD, which is the final step in the NEPA process, will document the Secretary of the Interior's determination of whether the requirements of NEPA have been met and which actions, if any, to recommend. It will also describe other alternative plans considered, identify any mitigation plans, and describe factors and comments taken into consideration when making its recommendation. Congress will make the final decision on authorizing a project for implementation, or not.

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# Chapter 3
# Considerations for Describing Affected Environment and Environmental Consequences

Chapters 4 through 7 and 9 through 26 of this Draft EIS are organized by environmental resource area. Each chapter describes the affected environment and potential environmental consequences that could result from implementing the proposed action alternatives. Where the action alternatives would have identical or nearly identical impacts regardless of which action alternative is implemented, the action alternatives are described together. Where impacts would differ, the action alternatives are described separately.

The potential cumulative effects of implementing the action alternatives are described in Chapter 27, "Cumulative Effects."

## Chapter Contents and Definition of Terms

Chapters 4 through 27 are organized into the following resource and issue areas:

- **Chapter 4** – Air Quality and Greenhouse Gas Emissions
- **Chapter 5** – Biological Resources – Fisheries and Aquatic Ecosystems
- **Chapter 6** – Biological Resources – Botanical and Wetlands
- **Chapter 7** – Biological Resources – Wildlife
- **Chapter 8** – Climate Change
- **Chapter 9** – Cultural Resources
- **Chapter 10** – Environmental Justice
- **Chapter 11** – Geology and Soils

- **Chapter 12** – Hydrology – Flood Management
- **Chapter 13** – Hydrology – Groundwater
- **Chapter 14** – Hydrology – Surface Water Supplies and Facilities Operations
- **Chapter 15** – Hydrology – Surface Water Quality
- **Chapter 16** – Indian Trust Assets
- **Chapter 17** – Land Use Planning and Agricultural Resources
- **Chapter 18** – Noise and Vibration
- **Chapter 19** – Paleontological Resources
- **Chapter 20** – Power and Energy
- **Chapter 21** – Public Health and Hazardous Materials
- **Chapter 22** – Recreation
- **Chapter 23** – Socioeconomics, Population, and Housing
- **Chapter 24** – Transportation, Circulation, and Infrastructure
- **Chapter 25** – Utilities and Service Systems
- **Chapter 26** – Visual Resources
- **Chapter 27** – Cumulative Effects

For some of these resource and issue areas, additional information pertaining to the analyses is contained in the appendices to this Draft EIS: the Modeling Appendix, Physical Resources Appendix, and Plan Formulation Appendix.

## NEPA Requirements

CEQ regulations for implementing NEPA include the following requirements for an EIS (40 CFR 1502.15):

> *[An] EIS shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced.*

## Approach to Affected Environment

Chapters 4 through 26 provide a description of the existing physical environment and socioeconomic conditions that could be affected by the No Action Alternative and action alternatives considered in this Draft EIS. This information was obtained from published environmental and planning documents, books, Web sites, journal articles, field surveys, and communications with technical experts. Descriptions of the affected environment are organized by geographic region. Conditions in the primary study area – San Joaquin River upstream from Friant Dam to Kerckhoff Dam, including Millerton Lake and the area that would be inundated by the proposed Temperance Flat RM 274 Reservoir; and areas that could be directly affected by construction-related activities, including the footprint of proposed temporary and permanent facilities upstream from Friant Dam – are described first, followed by descriptions of conditions in the extended study area. The extended study area consists of the San Joaquin River downstream from Friant Dam, including the Delta; lands served by San Joaquin River water rights; the Friant Division of the CVP, including underlying groundwater basins in the eastern San Joaquin Valley; and SOD water service areas of the CVP and SWP. In certain resource areas, the geographic regions are organized slightly differently than how they are defined in Chapter 1, “Introduction.”

## Methods and Assumptions

Chapters 4 through 7 and 9 through 26 also document the analysis of the direct and indirect effects of the alternatives for each environmental resource area. Direct effects are those that would be caused by the action and would occur at the same time and place. Indirect effects are reasonably foreseeable consequences that may occur at a later time or at a distance from the project area. Examples of indirect effects are growth inducement or other effects related to changes in land use patterns, population density, or growth rate, and related effects on the physical environment.

The effects of the alternatives were determined by comparing estimates of resulting conditions with baseline conditions. These baseline conditions differ between NEPA and CEQA. Under NEPA, the No Action Alternative (i.e., expected future conditions without the project) is the baseline to which the action alternatives are compared; the No Action Alternative is also compared to existing conditions. Under CEQA, existing conditions are the baseline to which alternatives are compared.

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is a determining factor in whether an environmental impact statement must be prepared. An environmental document prepared to comply with CEQA must identify the significance of the environmental effects of a proposed project. As stated in Section 15382 of the State CEQA Guidelines, a significant effect on the environment means “a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project.”

### CVP and SWP Operational Assumptions

Reclamation uses CalSim II (a specific application of the Water Resources Integrated Modeling System [WRIMS] to Central Valley water operations), to comparatively study operations, benefits, and effects of new facilities and operational parameters for the CVP and SWP. In this Draft EIS, the quantitative assessment of actions related to water resources relied primarily on two CalSim II baselines for CEQA and NEPA:

- “Existing Conditions,” based on a 2005 level of land use development and current facilities in place as of January 2014.

- “Future Conditions (No Action Alternative),” expected future conditions without the project, based on a mix of forecasted 2020 and 2030 land use development and reasonably foreseeable future projects and facilities anticipated to be in place by 2030 (including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete as of the date of preparation of this Draft EIS). This is the most recent "future" level hydrology available for use with the CalSim II model, and is referred to throughout this document as the 2030 land use level of development.

Operational assumptions for refinement, modeling, and evaluation of potential effects of the No Action Alternative and action alternatives included in this Draft EIS were derived from the following sources:

- The 2008 Long-Term Operations BA (Reclamation 2008)
- The 2008 USFWS BO (USFWS 2008)
- The 2009 NMFS BO (NMFS 2009)
- Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP, signed in 1986 and ratified by Congress through Public Law 99-546.

As Reclamation has advanced the Investigation, the environmental, hydrologic, and regulatory conditions in the San Joaquin River basin and Delta have changed considerably. Among these changes have been substantial declines in the populations of delta smelt within the Delta. These changes have led to a series of documents and decisions that have affected CVP and SWP operations. This section describes historical decisions related to CVP and SWP operations and the ways in which they have influenced the Investigation.

In 2008, Reclamation initiated formal Section 7 consultation and provided the USFWS and NMFS a BA on the continued long-term operation of the CVP and SWP (Reclamation 2008).USFWS and NMFS released their BOs in 2008 and 2009, respectively (USFWS 2008, NMFS 2009). In the 2008 USFWS BO, the USFWS concluded that the long-term operations of the CVP and SWP would jeopardize the continued existence of and destroy or adversely modify critical habitat for delta smelt (*Hypomesus transpacificus*). Consequently, the USFWS developed a Reasonable and Prudent Alternative (RPA) to avoid jeopardy. In the 2009 NMFS BO, NMFS similarly concluded that the long-term operations of the CVP and SWP would jeopardize populations of listed salmonids, steelhead (*Oncorhynchus mykiss*), green sturgeon (*Acipenser medirostris*), and killer whales (*Orcinus orca*); and destroy or adversely modify critical habitat for listed species of salmonids, steelhead, and green sturgeon. It also developed an RPA to avoid jeopardy to the species. The RPA included conditions for revised water operations, habitat restoration and enhancement actions, and fish passage actions, and are considered reasonably foreseeable future actions for the purposes of this Draft EIS. Water operations defined in RPAs were included in the modeling evaluations in this Draft EIS for both existing and future conditions, and therefore were included in the cumulative effects analyses presented in Chapter 27, “Cumulative Impacts.” Other actions included in the RPAs were not included in the modeling evaluations, but were assessed qualitatively in the cumulative effects analyses presented in Chapter 27, “Cumulative Impacts.”

Actions were brought challenging the NMFS and USFWS BOs (2008 and 2009) under ESA and the Administrative Procedure Act concerning the effects of the CVP and SWP on endangered fish species.

In September 2011, the District Court remanded the 2009 NMFS BO to NMFS, without vacatur, finding in favor of the Federal government on some counts and in favor of water contractor plaintiffs on other counts. The District Court ordered NMFS to prepare a draft BO no later than October 1, 2016, and a final BO by February 1, 2018. Reclamation must prepare an EIS on any RPA included in the draft NMFS BO by February 1, 2018; NMFS must release a final BO by that same date. Reclamation must issue a ROD, deciding whether to accept the RPA or an alternative, by April 29, 2018. The United States has appealed the District Court’s decision, and that appeal is still pending in the Ninth Circuit Court of Appeals.

On December 27, 2010, the District Court entered an “Amended Order on Cross-Motions for Summary Judgment” (Doc. 761), remanding the 2008 USFWS BO to the USFWS without vacatur.

On May 4, 2011, the District Court issued an amended Final Judgment, ordering the USFWS to complete a final revised BO by December 1, 2013.

In August 2011, the District Court enjoined implementation of USFWS RPA Component 3 (Action 4), the fall X2 requirements, which require a monthly average position of not greater than 74 km in wet years or 81 km in above normal water years eastward of the Golden Gate Bridge. That injunction is no longer in-effect.

The United States and NRDC appealed the District Court's decision invalidating the 2008 USFWS BO. NRDC also challenged the District Court's finding that Reclamation was required to prepare an EIS on its provisional acceptance of the RPA included in the 2008 USFWS BO. Water user plaintiffs cross-appealed the District Court's opinion. On March 13, 2014, the Ninth Circuit Court of Appeals reversed that part of the District Court's opinion that questioned the validity of the 2008 USFWS BO, but affirmed the District Court's finding that Reclamation violated NEPA in failing to prepare an EIS on its provisional acceptance of the RPA included in the 2008 USFWS BO. Water user plaintiffs have petitioned for *en banc* review by the Ninth Circuit Court of Appeals.

In February 2013, Reclamation requested reinitiation of ESA Section 7 consultation, to which USFWS and NMFS agreed. Currently, although the Ninth Circuit upheld the validity of the 2008 USFWS BO, the USFWS is obligated to issue (or reissue) a BO by December 1, 2015. On that same date, Reclamation must issue a final EIS analyzing the environmental impacts associated with operating the CVP and SWP under the USFWS BO. NMFS must issue a draft BO to Reclamation no later than October 1, 2016. Reclamation must issue a draft NEPA document evaluating the environmental impacts associated with implementing the draft NMFS BO by April 1, 2017 (six months after receiving the draft BO), and a final NEPA document no later than February 1, 2018. On that same date, February 1, 2018, NMFS must release a final BO. Reclamation has until April 29, 2018 to issue a ROD. At this time, both the court-ordered remands and litigation over the 2008 USFWS BO and 2009 NMFS BO continue.

In 2012, Reclamation updated the operational assumptions and modeling to reflect operations described in the 2008 Long-Term Operations BA, the 2008 USFWS BO, and the 2009 NMFS BO. These assumptions were used to guide refinement, modeling, and evaluation of alternatives and were used as the basis of analysis in this Draft EIS. Despite the uncertainty resulting from the ongoing reconsultation process, the 2008 Long-Term Operations BA and the 2008 and 2009 BOs issued by the fishery agencies contain the most recent estimate of potential changes in water operations that could occur in the near future. Furthermore, it is currently anticipated that the final BOs issued by the resource agencies will contain similar RPAs.

### Water Year Types and Indices

Throughout this Draft EIS, data are reported using water year types that correspond to various indices. The indices used in this Draft EIS include the following:

- **Sacramento Valley Water Year Index** – Water year type classification is based on unimpaired runoff in the Sacramento Valley, as published annually by DWR in Bulletin 120.
- **San Joaquin Valley Water Year Index** – Water year type classification is based on unimpaired runoff in the San Joaquin Valley, as published annually by DWR in Bulletin 120.
- **Restoration Water Year Index** – Water year type classification is based on historical unimpaired runoff at Friant Dam during water years 1922-2004, as defined in the Settlement.

Unless otherwise noted in the text, water year type classification in this Draft EIS is under the Restoration Water Year Index. The criteria used to assign water year type classifications for each index are shown in Table 3-1.

**Table 3-1. Water Year Type Classification Criteria for Three Water Year Type Indices**

| Water Year Type Index | Water Year Type | Classification Criteria |
|---|---|---|
| Sacramento Valley | Wet | Equal to or greater than 9.2 MAF unimpaired runoff |
| | Above Normal | Less than 9.2 and greater than 7.8 MAF unimpaired runoff |
| | Below Normal | Equal to or less than 7.8 and greater than 6.5 MAF unimpaired runoff |
| | Dry | Equal to or less than 6.5 and greater than 5.4 MAF unimpaired runoff |
| | Critical | Equal to or less than 5.4 MAF unimpaired runoff |

**Table 3-1. Water Year Type Classification Criteria for Three Water Year Type Indices (contd.)**

| Water Year Type Index | Water Year Type | Classification Criteria |
|---|---|---|
| San Joaquin Valley | Wet | Equal to or greater than 3.8 MAF unimpaired runoff |
| | Above Normal | Less than 3.8 and greater than 3.1 MAF unimpaired runoff |
| | Below Normal | Equal to or less than 3.1 and greater than 2.5 MAF unimpaired runoff |
| | Dry | Equal to or less than 2.5 and greater than 2.1 MAF unimpaired runoff |
| | Critical | Equal to or less than 2.1 MAF unimpaired runoff |
| Restoration | Wet | Greater than 2,500 TAF unimpaired runoff |
| | Normal-Wet | Equal to or less than 2,500 and greater than 1,450 TAF unimpaired runoff |
| | Normal-Dry | Equal to or less than 1,450 and greater than 930 TAF unimpaired runoff |
| | Dry | Equal to or less than 930 and greater than 670 TAF unimpaired runoff |
| | Critical-High | Equal to or less than 670 and greater than 400 TAF unimpaired runoff |
| | Critical-Low | Less than 400 TAF unimpaired runoff |

Key:
MAF = million acre-feet
TAF = thousand acre-feet

## Consideration of San Joaquin River Restoration Program Water Management Actions

As described in Chapter 2, "Alternatives," SJRRP actions implemented as of January 2014 are considered part of the existing conditions evaluated in this Draft EIS. Additional SJRRP actions are considered reasonably foreseeable under the No Action Alternative and are included in the future conditions as well. These actions include physical modifications to the San Joaquin River for the Restoration Goal pursuant to Paragraphs 11 and 12 of the Settlement; reintroduction of salmonids to the San Joaquin River, pursuant to Paragraph 14 of the Settlement; additional actions to recapture Restoration Flows at existing facilities on the San Joaquin River, pursuant to Paragraph 16; and improvements in the Friant Division of the CVP pursuant to Part III of Public Law 111-11.

Some SJRRP actions included in the future conditions are assessed qualitatively in the analyses in this document, and are not included in CalSim II or other modeling used to assess the impacts of the alternatives. These include actions to achieve the

Water Management Goal, such as recapture of Restoration Flows at existing, modified, or new facilities on the San Joaquin River or existing facilities in the Delta pursuant to Paragraph 16, and improvements in the Friant Division of the CVP pursuant to Part III of Public Law 111-11. This analysis provides a conservative assessment of potential environmental effects for resource areas evaluated in this Draft EIS.

### Effects of Project Implementation with Climate Change

On February 18, 2010, CEQ issued guidance on including GHG emissions and climate change impacts in environmental review documents under NEPA. CEQ guidance suggests that Federal agencies consider opportunities to reduce GHG emissions caused by proposed Federal actions, adapt their actions to climate change impacts throughout the NEPA process, and address these issues in agency NEPA procedures. The following are the two main factors to consider when addressing climate change in environmental documentation:

- Effects of a proposed action and alternative actions on GHG emissions
- Impacts of climate change on a proposed action or alternatives

CEQ notes that “significant” national policy decisions with “substantial” GHG impacts require analysis of their GHG effects. That is, the GHG effects of a proposed action must be analyzed if the action would cause “substantial” annual direct emissions; would implicate energy conservation or reduced energy use or GHG emissions; or would promote cleaner, more efficient renewable-energy technologies.

The GHG emissions effects of the alternatives are described in Chapter 4, “Air Quality and Greenhouse Gas Emissions.” Chapter 8, “Climate Change,” includes an assessment of the relationship of climate change effects to the action alternatives, focusing on the potential for the environmental impacts and needed mitigation measures described in Chapters 4 through 7, and 9 through 26 to change under potential future climate conditions.

The Modeling Appendix provides a summary of global climate forecasts and a discussion of the implications of climate change for California water resources. This appendix also includes quantitative analyses of climate change for the Investigation.

The discussion of climate change implications provided in the Modeling Appendix provides context for the assessment presented in Chapter 8, “Climate Change.”

## Significance Criteria

Significance criteria for each resource area are provided in each resource chapter of this Draft EIS. These criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines; factual or scientific information and data; and regulatory standards of Federal, State, and local agencies. These criteria also encompass the factors taken into account under NEPA to determine the significance of an action in terms of the context and the intensity of its effects.

## Impact Comparisons and Definitions

Mechanisms that could cause impacts are documented for each resource area. General categories of impact mechanisms are construction and activities related to future operation and maintenance, as described in Chapter 2, “Alternatives.” Project-related impacts are categorized as follows, to describe the intensity or duration of the impact:

- A **temporary** impact would last less than 3–4 years and typically would occur only during construction.

- A **short-term** impact could occur during construction and could last from the time construction ceases to within 3–5 years after construction.

- A **long-term** impact would last longer than 5 years after the completion of construction. In some cases, a long-term impact could be a permanent impact.

- A **direct** impact is an impact that would be caused by an action and would occur at the same time and place as the action.

- An **indirect** impact is an impact that would be caused by an action but would occur later in time or at another location, yet is reasonably foreseeable in the future.

- A **cumulative** impact is an impact which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions (40 CFR 1508.7, 1508.25, and 43 CFR 46.155). The incremental impacts of a project are not "cumulatively considerable" solely because other projects would have a significant cumulative impact; rather, the project would also need to contribute considerably to a significant cumulative impact (State CEQA Guidelines, Section 15064(h)(1)).

## Impact Levels

The terminology listed below is used to denote the significance of environmental impacts of the No Action Alternative and action alternatives. The use of this specific terminology is intended to allow the use of this Draft EIS for CEQA purposes.

- **No impact** would occur if the construction, operation, and maintenance of the alternative under consideration would not have any direct or indirect effects on the environment. "No impact" means no change from existing conditions. This impact level does not need mitigation.

- An impact that would not result in a substantial and adverse change in the environment would be **less than significant**. This impact level does not require mitigation under CEQA, even if applicable measures are available.

- A **significant** impact is defined by California PRC Section 21068 as "a substantial, or potentially substantial, adverse change in the environment." Levels of significance can vary by project, based on the change in the existing physical condition. This Draft EIS uses the CEQA definition of "significant impact."

- A **potentially significant** impact is one that, if it were to occur, would be considered a significant impact as described above; however, the occurrence of the impact cannot be immediately determined with certainty. For CEQA purposes, a potentially significant impact is treated as if it were a significant impact. Therefore, under CEQA, feasible mitigation measures or alternatives to the proposed action must be identified, where applicable, to reduce the magnitude of potentially significant impacts.

- A **significant and unavoidable impact** is a substantial or potentially substantial adverse effect on the environment that cannot be reduced to a less-than-significant level even with any feasible mitigation. Under CEQA, a project with significant and unavoidable impacts could proceed, but the lead agency would be required to do the following:
  - Conclude in findings that there are no feasible means of substantially lessening or avoiding the significant impact in accordance with Section 15091(a)(3) of the State CEQA Guidelines (i.e., CCR Title 14, Section 15091(a)(3)).
  - Prepare a statement of overriding considerations, in accordance with Section 15093 of the State CEQA Guidelines, explaining why the lead agency would proceed with a project in spite of the potential for significant impacts.
- A **significant cumulative** impact would occur when the project would make a "cumulatively considerable incremental contribution" to an overall significant cumulative impact. If an overall cumulative impact would not be significant, even when the project would make a cumulatively considerable incremental contribution to the cumulative impact, then it is determined that the project would not cause a significant cumulative impact.
- A **beneficial** impact is a positive change or improvement in the environment and for which no mitigation measures are required.
- An impact may have a level of significance that is too uncertain to be reasonably determined. Such an impact would be designated **too speculative for meaningful evaluation**, in accordance with Section 15145 of the State CEQA Guidelines. Where some degree of evidence points to the reasonable potential for a significant effect, the Draft EIS may explain that a determination of significance is uncertain, but is still assumed to be "potentially significant," as described above. In other circumstances, after thorough

investigation, the determination of significance may still be too speculative to be meaningful. This is an effect for which the degree of significance cannot be determined for specific reasons. For example, aspects of the impact itself may be unpredictable or the severity of consequences cannot be known at this time.

## Mitigation Development Process and Objectives

Mitigation measures are presented where feasible to avoid, minimize, rectify, reduce, or compensate for significant and potentially significant impacts of the proposed action and alternatives, in accordance with NEPA regulations (40 CFR 1508.20) and the State CEQA Guidelines (Section 15126.4). Each mitigation measure is identified numerically to correspond with the number of the impact being mitigated by the measure. No mitigation measures are needed when an impact is determined to be “less than significant” or “beneficial,” or where no impact would occur. Where sufficient feasible mitigation is not available to reduce an impact to a less-than-significant level, the impact is identified as “significant and unavoidable.”

## Significance After Mitigation

For every impact that would be significant or potentially significant, mitigation is applied, if feasible, to avoid or reduce the impact to a less-than-significant level and one of two conclusions is reached:

- The mitigation would reduce the impact to a less-than-significant level.

OR

- No feasible mitigation exists to reduce the impact to a less-than-significant level, and thus the impact would be significant and unavoidable.

Impact significance is reevaluated after application of mitigation in this Draft EIS.

## Cumulative Effects

Chapter 27, “Cumulative Effects,” provides an analysis of overall cumulative effects of the No Action Alternative and action alternatives. Cumulative effects are determined by analyzing the potential for impacts of an alternative to combine with the impacts of other past, present, and reasonably foreseeable future projects to produce project-related impacts (as defined above). This analysis follows applicable guidance provided by CEQ in *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997) and *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis* (CEQ 2005).

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# Chapter 4
# Air Quality and Greenhouse Gas Emissions

This chapter describes the affected environment for air quality and GHG emissions, as well as potential environmental consequences and associated mitigation measures, as they pertain to implementing the alternatives. This chapter presents information on the primary study area (area of project features, the Temperance Flat Reservoir Area, and Millerton Lake below RM 274). It also discusses the extended study area (San Joaquin River from Friant Dam to the Merced River, the San Joaquin River from the Merced River to the Delta, the Delta, and the CVP and SWP water service areas).

## Affected Environment

This section describes existing air quality conditions and GHG emissions in the primary study area for the dam and reservoir modifications proposed under the Investigation. The climate and the emissions of criteria air pollutants and toxic air contaminants (TAC) from Friant Dam to Kerckhoff Dam, including Millerton Lake, in the San Joaquin River watershed are described. In addition, the attainment statuses within the Study Area relative to national and State air quality standards are summarized.

The primary study area for this analysis has two components – local and regional. The local area is the immediate vicinity of Millerton Lake, where project construction would occur. Regionally, Madera and Fresno counties are located in the San Joaquin Valley Air Basin (SJVAB). The SJVAB also includes all of San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, and Tulare counties; and the San Joaquin Valley portion of Kern County.

The action alternatives would not include any construction or operational activities in the extended study area that would affect air quality or contribute to any GHG emissions. Therefore, this section only minimally discusses air quality conditions and does not discuss any GHG emissions in the extended study area.

## Topography, Climate, and Meteorology

The SJVAB is bounded by the Sacramento-San Joaquin River Delta to the north, the Sierra Nevada Range to the east, the Transverse Range to the south, and Coastal Ranges to the west. The SJVAB is particularly vulnerable to air pollution formation because of its topography, climate, and growing population. Surrounding mountains trap airborne pollutants near the San Joaquin Valley floor, and summer temperatures promote the formation of harmful ground-level ozone (i.e., smog). The valley is often subject to inversion layers that, coupled with geographic barriers and high summer temperatures, create high potential for air pollution problems.

## Criteria Air Pollutants

Concentrations of the following air pollutants are used as indicators of ambient air quality conditions: ozone, carbon monoxide (CO), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), respirable and fine particulate matter ($PM_{10}$ and $PM_{2.5}$), and lead. Because these are the most prevalent air pollutants known to be deleterious to human health, they are commonly referred to as “criteria air pollutants.”

### *Ozone*

Ozone is a photochemical oxidant and the primary component of smog. Ozone is not directly emitted into the air, but is formed through complex chemical reactions between precursor emissions of reactive organic gases (ROG) and oxides of nitrogen ($NO_X$) in the presence of sunlight. ROGs are volatile organic compounds (VOC). ROG emissions result primarily from incomplete combustion and the evaporation of chemical solvents and fuels. $NO_X$ are a group of gaseous compounds of nitrogen and oxygen that results from the combustion of fuels.

Ozone located in the lower atmosphere is a major health and environmental concern. Meteorology and terrain play a major role in ozone formation. Low wind speeds or stagnant air coupled with warm temperatures and clear skies provide the optimum conditions for ozone formation. Therefore, summer is the peak ozone season. Ozone is a regional pollutant that often affects large areas. Ozone concentrations over or near urban and rural areas reflect an interplay of emissions of ozone precursors, transport, meteorology, and atmospheric chemistry (Godish 2004).

### *Carbon Monoxide*

CO is a colorless, odorless, and poisonous gas produced by incomplete burning of carbon in fuels, primarily from mobile (transportation) sources. Approximately 77 percent of the nation's CO emissions are from mobile sources. The other 23 percent consist of CO emissions from wood-burning stoves, incinerators, and industrial sources. The highest concentrations are generally associated with cold, stagnant weather conditions that occur during winter. In contrast to ozone, which is a regional pollutant, CO causes problems on a local scale.

### *Nitrogen Dioxide*

$NO_2$ is a brownish, highly reactive gas that is present in all urban environments. The major human-made sources of $NO_2$ are combustion devices, such as boilers, gas turbines, and mobile and stationary combustion engines. $NO_2$ forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to formation of ground-level ozone and fine particle pollution, $NO_2$ is linked with a number of adverse respiratory system effects (EPA 2010). The combined emissions of NO and $NO_2$ are referred to as $NO_X$, which are reported as equivalent $NO_2$. Because $NO_2$ is formed and depleted by reactions associated with ozone, the $NO_2$ concentration in a particular geographical area may not be representative of the local $NO_X$ emission sources.

### *Sulfur Dioxide*

$SO_2$ is produced by such stationary sources such as coal and oil combustion, steel mills, refineries, and pulp and paper mills. $SO_2$ is a respiratory irritant. On contact with the moist mucous membranes, $SO_2$ produces sulfurous acid.

### *Particulate Matter*

Respirable particulate matter with an aerodynamic diameter of 10 micrometers or less is referred to as $PM_{10}$. $PM_{10}$ consists of particulate matter emitted directly into the air, such as fugitive dust, soot, and smoke from mobile and stationary sources, construction operations, fires, and natural windblown dust, and particulate matter formed in the atmosphere by condensation and/or transformation of $SO_2$ and ROGs. $PM_{2.5}$ includes a subgroup of finer particles that have an aerodynamic diameter of 2.5 micrometers or less.

### *Lead*

Lead is a metal found naturally in the environment and in manufactured products. The major sources of lead emissions have historically been mobile and industrial sources. As a result of the phase-out of leaded gasoline, metal processing is currently the primary source of lead emissions. The highest levels of lead in air are generally found near lead smelters.

Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers.

### Criteria Air Pollutant Monitoring and Attainment

Concentrations of criteria air pollutants are measured at several monitoring stations in Fresno and Madera counties. The Clovis-N Villa Avenue station is the closest station to the area of project features with recent data for ozone and particulate matter. In general, the ambient air quality measurements from these stations are representative of the primary study area's air quality. Table 4-1 summarizes the air quality data from the most recent 3 years. The data are compared with the ambient air quality standards as noted below. Refer to Table 4-2 for a full listing of all ambient air quality standards.

The monitoring data are used to designate areas according to attainment status for criteria air pollutants. The purpose of these designations is to identify areas with air quality problems and thereby initiate planning efforts for improvement. The three basic designation categories are "nonattainment," "attainment," and "unclassified (see notes in Table 4-2 for full definitions)." "Unclassified" is used in an area that cannot be classified on the basis of available information as meeting or not meeting the standards. In addition, the California designations include a subcategory of the nonattainment designation, "nonattainment-transitional," that is given to nonattainment areas that are progressing and nearing attainment.

The most current attainment designations for Fresno County are shown in Table 4-2 for each criteria air pollutant. Much of the extended study area, including the San Joaquin River watershed, is located in the SJVAB, which is a Federal and State nonattainment area for ozone and $PM_{10}$; and is in State nonattainment with and $PM_{2.5}$.

## Table 4-1. Summary of Annual Ambient Air Quality Data (2009 – 2011)

| Criteria Air Pollutant | 2009 | 2010 | 2011 |
|---|---|---|---|
| **OZONE** | | | |
| **Clovis-N Villa Avenue Monitoring Station** | | | |
| California maximum concentration (1-hour/8-hour average, ppm) | 0.119/ 0.105 | 0.133/ 0.105 | 0.133/ 0.103 |
| Number of days State 1-hour/8-hour standard exceeded | 33/64 | 22/58 | 32/72 |
| Number of days national 1-hour/8-hour standard exceeded | 0/48 | 3/39 | 2/49 |
| **FINE PARTICULATE MATTER ($PM_{2.5}$)** | | | |
| **Clovis-N Villa Avenue Monitoring Station** | | | |
| California maximum concentration ($\mu g/m^3$) | 71.0 | 75.2 | 76.4 |
| Number of days national standard exceeded (measured[1]) | 26 | 19 | 38 |
| **RESPIRABLE PARTICULATE MATTER ($PM_{10}$)** | | | |
| **Clovis-N Villa Avenue Monitoring Station** | | | |
| Maximum concentration ($\mu g/m^3$) | 65.2 | 62.2 | 77.0 |
| Number of days State standard exceeded (measured/calculated[1]) | 5/32.8 | 8/47.9 | 9/53.0 |
| Number of days national standard exceeded (measured/calculated[1]) | 0/0 | 0/0 | 0/0 |

*Source: ARB 2011a, ARB 2011b*

Note:

[1] Measured days are those days that an actual measurement was greater than the level of the State daily standard or the national daily standard. Measurements are typically collected every 6 days. Calculated days are the estimated number of days that a measurement would have been greater than the level of the standard had measurements been collected every day. The number of days above the standard is not necessarily the number of violations of the standard for the year.

Key:
$\mu g/m^3$ = micrograms per cubic meter
$PM_{2.5}$ = fine particulate matter with an aerodynamic diameter of 2.5 micrometers or less
$PM_{10}$ = respirable particulate matter with an aerodynamic diameter of 10 micrometers or less
ppm = parts per million

### Table 4-1. Summary of Annual Ambient Air Quality Data (2009 – 2011) (contd.)

| | **2009** | **2010** | **2011** |
|---|---|---|---|
| **RESPIRABLE PARTICULATE MATTER ($PM_{10}$)** | | | |
| **Clovis-N Villa Avenue Monitoring Station** | | | |
| Maximum concentration (µg/$m^3$) | 65.2 | 62.2 | 77.0 |
| Number of days State standard exceeded (measured/calculated[a]) | 5/32.8 | 8/47.9 | 9/53.0 |
| Number of days national standard exceeded (measured/calculated[a]) | 0/0 | 0/0 | 0/0 |

*Source: ARB 2011a, ARB 2011b*

Note:
[a] Measured days are those days that an actual measurement was greater than the level of the State daily standard or the national daily standard. Measurements are typically collected every 6 days. Calculated days are the estimated number of days that a measurement would have been greater than the level of the standard had measurements been collected every day. The number of days above the standard is not necessarily the number of violations of the standard for the year.

Key:
µg/$m^3$ = micrograms per cubic meter
$PM_{2.5}$ = fine particulate matter with an aerodynamic diameter of 2.5 micrometers or less
$PM_{10}$ = respirable particulate matter with an aerodynamic diameter of 10 micrometers or less
ppm = parts per million

**Table 4-2. Ambient Air Quality Standards and Designations**

| Pollutant | Averaging Time | California | | National Standards[1] | | |
|---|---|---|---|---|---|---|
| | | Standards [2,3] | Attainment Status (Fresno County) [4] | Primary [3,5] | Secondary [3,6] | Attainment Status (Fresno County) [7] |
| Ozone | 1-hour | 0.09 ppm<br>(180 µg/m$^3$) | N (Severe) | [8] | Same as primary standard | – |
| | 8-hour | 0.070 ppm | – | 0.075 ppm<br>(147 µg/m$^3$) | Same as primary standard | N |
| Carbon monoxide | 1-hour | 20 ppm<br>(23 mg/m$^3$) | A | 35 ppm<br>(40 mg/m$^3$) | – | U/A |
| | 8-hour | 9 ppm<br>(10 mg/m$^3$) | A | 9 ppm<br>(10 mg/m$^3$) | – | U/A |
| | 8-hour (Lake Tahoe) | 6 ppm<br>(7 mg/m$^3$) | – | – | – | – |
| Nitrogen dioxide (NO$_2$) | Annual Arithmetic Mean | 0.030 ppm<br>(57 µg/m$^3$) | – | 0.053 ppm<br>(100 µg/m$^3$) [9] | Same as primary standard | U/A |
| | 1-hour | 0.18 ppm<br>(339 µg/m$^3$) | A | 0.100 ppm<br>(188 µg/m$^3$) [9] | Same as primary standard | – |
| Sulfur dioxide (SO$_2$) | 24-hour | 0.04 ppm<br>(105 µg/m$^3$) | A | – | – | U |
| | 3-hour | – | – | – | 0.5 ppm<br>(1300 µg/m$^3$) [10] | U |
| | 1-hour | 0.25 ppm<br>(655 µg/m$^3$) | A | 0.075 ppm<br>(196 µg/m$^3$) [10] | – | – |
| Respirable particulate matter (PM$_{10}$) | Annual Arithmetic Mean | 20 µg/m$^3$ | N | – | Same as primary standard | A |
| | 24-hour | 50 µg/m$^3$ | N | 150 µg/m$^3$ (6) | Same as primary standard | A |
| Fine particulate matter (PM$_{2.5}$) | Annual Arithmetic Mean | 12 µg/m$^3$ | N | 15 µg/m$^3$ | Same as primary standard | N |
| | 24-hour | – | – | 35 µg/m$^3$ | Same as primary standard | N |

## Table 4-2. Ambient Air Quality Standards and Designations (contd.)

| Pollutant | Averaging Time | California | | National Standards [1] | | |
|---|---|---|---|---|---|---|
| | | Standards [2,3] | Attainment Status (Fresno County) [4] | Primary [3,5] | Secondary [3,6] | Attainment Status (Fresno County) [7] |
| Lead [11] | 30-day Average | 1.5 µg/m$^3$ | A | – | – | – |
| | Calendar Quarter | – | – | 1.5 µg/m$^3$ | Same as primary standard | A |
| | Rolling 3 Month Average | – | – | 0.15 µg/m$^3$ | Same as primary standard | A |
| Sulfates | 24-hour | 25 µg/m$^3$ | A | No national standards | | |
| Hydrogen sulfide | 1-hour | 0.03 ppm<br>(42 µg/m$^3$) | U | No national standards | | |
| Vinyl chloride [11] | 24-hour | 0.01 ppm<br>(26 µg/m$^3$) | U/A | No national standards | | |
| Visibility-reducing particle matter | 8-hour | Extinction coefficient of 0.23 per kilometer—visibility of 10 mi or more | U | No national standards | | |

*Sources: ARB 2011a, 2011b*

Notes:

[1] National standards (other than ozone, particulate matter, and those based on annual averages or annual arithmetic means) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. The PM10 24-hour standard is attained when 99 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. The PM2.5 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. Contact the U.S. Environmental Protection Agency (EPA) for further clarification and current Federal policies.

[2] California standards for ozone, CO (except Lake Tahoe), SO2 (1- and 24-hour), NO2, particulate matter, and visibility-reducing particles are values that are not to be exceeded. All others are not to be equaled or exceeded. California ambient air quality standards are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

[3] Concentration is expressed first in units in which it was promulgated (i.e., parts per million (ppm) or micrograms per cubic meter (µg/m3)). Equivalent units given in parentheses are based upon a reference temperature of 25 degrees Celsius (°C) and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

[4] Unclassified (U): A pollutant is designated unclassified if the data are incomplete and do not support a designation of attainment or nonattainment. Attainment (A): A pollutant is designated attainment if the State standard for that pollutant was not violated at any site in the area during a 3-year period. Nonattainment (N): A pollutant is designated nonattainment if there was a least one violation of a State standard for that pollutant in the area. Nonattainment/Transitional (NT): A subcategory of the nonattainment designation. An area is designated nonattainment/transitional to signify that the area is close to attaining the standard for that pollutant.

## Table 4-2. Ambient Air Quality Standards and Designations (contd.)

Notes: (contd.)

[5] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

[6] National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

[7] Nonattainment (N): Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant. Attainment (A): Any area that meets the national primary or secondary ambient air quality standard for the pollutant. Unclassifiable (U): Any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

[8] The 1-hour ozone national ambient air quality standard was revoked on June 15, 2005, for all areas in California.

[9] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 part per million (ppm) (effective January 22, 2010). Note that the EPA standards are in units of parts per billion (ppb). California standards are in units of ppm. To directly compare the national standards to the California standards, the units can be converted from ppb to ppm. In this case, the national standards of 53 ppb and 100 ppb are identical to 0.053 ppm and 0.100 ppm, respectively.

[10] On June 2, 2010, EPA established a new 1-hour $SO_2$ standard, effective August 23, 2010, which is based on the 3-year average of the annual 99th percentile of 1-hour daily maximum concentrations. EPA also proposed a new automated Federal Reference Method (FRM) using ultraviolet technology, but will retain the older pararosaniline methods until the new FRM have adequately permeated State monitoring networks. EPA also revoked both the existing 24-hour $SO_2$ standard of 0.14 ppm and the annual primary $SO_2$ standard of 0.030 ppm, effective August 23, 2010. The secondary $SO_2$ standard was not revised at that time; however, the secondary standard is undergoing a separate review by EPA. Note that the new standard is in ppb. California standards are in ppm. To directly compare the new primary national standard to the California standard the units can be converted to ppm. In this case, the national standard of 75 ppb is identical to 0.075 ppm.

[11] The California Air Resources Board has identified lead and vinyl chloride as toxic air contaminants with no threshold of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

Key:
µg/m$^3$ = micrograms per cubic meter
mg/m$^3$ = milligrams per cubic meter
ppm = parts per million

### Toxic Air Contaminants

TACs, or in Federal terms, hazardous air pollutants (HAP), are air pollutants that may cause or contribute to an increase in mortality or in serious illness, or that may pose a hazard to human health. TACs are usually present in minute quantities in the ambient air; however, their high toxicity or health risk may pose a threat to public health even at low concentrations. Of the TACs for which data are available in California, diesel particulate matter (diesel PM), naturally occurring asbestos, benzene, 1,3-butadiene, acetaldehyde, carbon tetrachloride, hexavalent chromium, para-dichlorobenzene, formaldehyde, methylene chloride, and perchloroethylene pose the greatest known health risks. Dioxins are also considered to pose substantial health risk, and diesel PM poses the greatest health risk. Current facilities permitted by SJVAPCD near the primary study area are Calmat Company, Celestial Family Holdings, LLC, the Federal Aviation Administration, Fort Washington Country Club, Professional Exchange Service Corporation, the Ponderosa Telephone Company, and Verizon Wireless–Friant (ARB 2008).

### Odors

Odors are generally regarded as an annoyance rather than a health hazard. However, manifestations of a person’s reaction to foul odors can range from psychological (e.g., irritation, anger, or anxiety) to physiological (e.g., circulatory and respiratory effects, nausea, vomiting, and headache).

With respect to odors, the human nose is the sole sensing device. The ability to detect odors varies considerably among the population and overall is quite subjective. Some individuals have the ability to smell very minute quantities of specific substances; others may not have the same sensitivity but may be sensitive to odors of other substances. In addition, people may have different reactions to the same odor; an odor that is offensive to one person may be perfectly acceptable to another (e.g., fast-food restaurant). It is important to also note that an unfamiliar odor is more easily detected and is more likely to cause complaints than a familiar one. This is because of the phenomenon known as odor fatigue, in which a person can become desensitized to almost any odor and recognition only occurs when the intensity of the odor changes.

Quality and intensity are two properties present in any odor. The quality of an odor indicates the nature of the smell experience. For instance, if a person describes an odor as flowery or sweet, then the person is describing the quality of the odor. Intensity refers to the strength of the odor. For example, a person may use the word “strong” to describe the intensity of an odor. Odor intensity depends on the odorant concentration in the air. When an odorous sample is progressively diluted, the concentration decreases. As this occurs, the intensity of the odor weakens and eventually becomes so low that the odor is quite difficult to detect or recognize. At some point during dilution, the concentration of the odorant reaches a detection threshold. An odorant concentration below the threshold means that the concentration in the air is not detectable by the average human.

There are no existing potential sources of odors in the primary study area. The nearest landfill to the site is the River Road Transfer Station, located at 10463 North Rice Road in Fresno, CA, approximately 12 miles southwest of the primary study area.

### Existing Sensitive Receptors

Sensitive receptors are more susceptible to the effects of air pollution than the general population. SJVAPCD defines sensitive receptors as “facilities that house or attract children, the elderly, people with illnesses, or others who are especially sensitive to the effects of air pollutants,” such as hospitals, schools, convalescent facilities, and residential areas.

Sensitive receptors in the vicinity of the area of project features include residences scattered around Millerton Lake and the community of Friant, to the southwest. Residences closest to the project site are located along Sky Harbour Road, approximately 1 mile north and west of the area of project features, and scattered rural residences approximately 0.75 north of the area of project features in Madera County.

### Greenhouse Gases and Climate Change Science

Certain gases in the earth’s atmosphere, classified as GHGs, play a critical role in determining the earth’s surface temperature. Solar radiation enters the earth’s atmosphere from space. A portion of the radiation is absorbed by the earth’s surface, and a smaller portion of this radiation is reflected back toward space. This absorbed radiation is then emitted from the earth as low-frequency infrared radiation. The frequencies at which bodies emit radiation are proportional to temperature. The earth has a much lower temperature than the sun; therefore, the earth emits lower frequency radiation. Most solar radiation passes through GHGs; however, infrared radiation is absorbed by these gases. As a result, radiation that otherwise would have escaped back into space is instead "trapped," resulting in a warming of the atmosphere. This phenomenon, known as the greenhouse effect, is responsible for maintaining a habitable climate on Earth. Without the greenhouse effect, Earth would not be able to support life as we know it.

Prominent GHGs contributing to the greenhouse effect are water vapor, carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$), among others. Human-caused emissions of these GHGs in excess of natural ambient concentrations are responsible for intensifying the greenhouse effect and have led to a trend of unnatural warming of the earth's climate, known as global climate change or global warming. It is extremely unlikely that global climate change of the past 50 years can be explained without the contribution from human activities (IPCC 2007).

Climate change is a global problem. GHGs are global pollutants, unlike criteria air pollutants and TACs, which are pollutants of regional and local concern. Whereas pollutants with localized air quality effects have relatively short atmospheric lifetimes (about 1 day), GHGs have long atmospheric lifetimes (1 year to several thousand years). GHGs persist in the atmosphere for long enough time periods to be dispersed around the globe. Although the exact lifetime of any particular GHG molecule is dependent on multiple variables and cannot be pinpointed, it is understood that more $CO_2$ is emitted into the atmosphere than is sequestered by ocean uptake, vegetation, and other forms of sequestration. Of the total annual human-caused $CO_2$ emissions, approximately 54 percent is sequestered through ocean uptake, uptake by northern hemisphere forest regrowth, and other terrestrial sinks within a year, whereas the remaining 46 percent of human-caused $CO_2$ emissions remains stored in the atmosphere (Seinfeld and Pandis 1998).

### Greenhouse Gas Emissions Sources

Emissions of GHGs contributing to global climate change are attributable in large part to human activities associated with the transportation, industrial/manufacturing, utility, residential, commercial and agricultural sectors (ARB 2014). California produced 448 million gross metric tons (MT) of carbon dioxide equivalent ($CO_2e$) in 2011 (ARB 2014).

Combustion of fossil fuel in the transportation sector was the single largest source of California's GHG emissions in 2011, accounting for 38 percent of total GHG emissions in the state (ARB 2014). This sector was followed by the industrial sector (21 percent) and the electric power sector (including both in- and out-of-state generation) (19 percent) (ARB 2014). California GHG emissions inventory and projections are summarized in Table 4-3.

**Table 4-3. California Greenhouse Gas Emissions Inventory and Projections**

| Emissions Sector | MMT $CO_2$e/yr | | | | |
|---|---|---|---|---|---|
| | 1990 | 2000 | 2005 | 2011 | 2020 |
| Electric Power[1] | 110.6 | 104.9 | 107.9 | 86.6 | 110.4 |
| Residential/Commercial | 44.1 | 43.6 | 42.5 | 45.5 | 45.3 |
| Transportation | 150.7 | 176.3 | 188.9 | 168.4 | 183.9 |
| Industrial | 103.0 | 95.8 | 94.2 | 93.2 | 91.5 |
| High GWP | -[2] | 7.1 | 9.3 | 15.2 | 37.9 |
| Agriculture | 23.4 | 29.0 | 32.8 | 32.2 | 29.1 |
| Recycling and Waste | -[2] | 6.1 | 6.5 | 6.9 | 8.5 |
| Forestry | 0.2 | - | - | - | 0.2 |
| Gross Total Emissions[3] | 433 | 462.9 | 482.1 | 448.1 | 506.8 |
| Carbon Sequestration | -6.7 | *see notes | *see notes | *see notes | *see notes |
| Net Emissions[3] | 427 | *see notes | *see notes | *see notes | *see notes |

*Source: ARB 2007:6, 2013, 2014.*

Notes:
*Inventory reporting methodology change initiated by ARB no longer accounts for carbon sequestration.
[1] Includes in-state-generated and imported electricity production.
[2] Contained within Industrial Sector emissions.
[3] Totals may not sum exactly due to rounding.

Key:
GWP = global warming potential
MMT $CO_2$e/yr = million metric tons carbon dioxide equivalent per year.

## Environmental Consequences and Mitigation Measures

This section describes potential environmental consequences on air quality and GHG emissions that could result from implementing any of the alternatives. It also describes the methods of environmental evaluation, assumptions, and specific criteria that were used to determine the significance of impacts on air quality and GHG emissions. It then discusses the potential impacts and proposes mitigation where appropriate. The potential impacts on air quality and GHG emissions and associated mitigation measures are summarized in Table 4-4.

## Table 4-4. Summary of Impacts and Mitigation Measures for Air Quality and Greenhouse Gas Emissions

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| AQ-1: Project-Generated Construction-Related Criteria Air Pollutant and Precursor Emissions that would Violate or Contribute Substantially to an Existing or Projected Violation, or Expose Sensitive Receptors to Substantial Pollutant Concentrations | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | S | AQ-1: Reduce Mobile-Source Exhaust Emissions | SU |
| | | Alternative Plan 2 | S | | SU |
| | | Alternative Plan 3 | S | | SU |
| | | Alternative Plan 4 | S | | SU |
| | | Alternative Plan 5 | S | | SU |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| AQ-2: Project-Generated Construction-Related Toxic Air Contaminant Emissions that would Expose Sensitive Receptors to Substantial Pollutant Concentrations and Increased Health Risks | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | S | AQ-2: Implement Mitigation Measure AQ-1, Reduce Mobile-Source Exhaust Emissions | LTS |
| | | Alternative Plan 2 | S | | LTS |
| | | Alternative Plan 3 | S | | LTS |
| | | Alternative Plan 4 | S | | LTS |
| | | Alternative Plan 5 | S | | LTS |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |

## Table 4-4. Summary of Impacts and Mitigation Measures for Air Quality and Greenhouse Gas Emissions (contd.)

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| AQ-3: Project-Generated Operational Criteria Air Pollutant and Precursor Emissions that would Violate or Contribute Substantially to an Existing or Projected Violation, or Expose Sensitive Receptors to Substantial Pollutant Concentrations | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| AQ-4: Generation of Greenhouse Gas Emissions that would Significantly Impact the Environment | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | S | AQ-4: Reduce Greenhouse Gas Emissions | SU |
| | | Alternative Plan 2 | S | | SU |
| | | Alternative Plan 3 | S | | SU |
| | | Alternative Plan 4 | S | | SU |
| | | Alternative Plan 5 | S | | SU |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |

Key:
- = Not Applicable
LTS = less than significant
NI = no impact
S = significant
SU = significant and unavoidable

## Methods and Assumptions

### *Air Quality*

Analysis of potential impacts on air quality is based on guidance developed by SJVAPCD. The action alternatives consist of implementing construction activities for the dam structure; construction of the dam, diversion tunnel, intake structure, and permanent and temporary access/haul routes for construction and maintenance; clearing the reservoir area that would be affected by inundation; and construction of related facilities such as a powerhouse/valve house, and transmission facilities.

The analysis was based on project-specific details, where available, along with SJVAPCD-recommended inputs and model default settings. A project-specific detailed list of heavy-duty construction equipment (i.e., proposed work hours and fuel consumption for each activity type) under each action alternative was available. The number of truck trips and trip distances for export of spoils and import of materials, volumes of material to be hauled, and construction schedules and phasing estimates was also available. For operational activities, primary data inputs were the number of vehicle trips and average trip distances associated with visitation to the recreation facilities.

Quantification of criteria air pollutant (and precursor) emissions were based on a combination of methods, including the use of fugitive dust emission factors from EPA’s published Air Pollution (AP)-42 guidance, exhaust emission factors derived from ARB’s off- and on-road emissions factor models (OFFROAD 2007 and EMFAC 2011, respectively), and the SJVAPCD-approved California Emissions Estimator Model (CalEEMod) version 2013.2. Each method is explained in more detail below.

Emission factors obtained from EPA’s AP-42 guidance were used to model fugitive dust emissions ($PM_{10}$) from construction activities (e.g., grading, earthmoving, blasting, stockpiling of material, and road travel for truck haul and for worker commute trips). Three primary construction activities were identified that would represent the worst-case fugitive dust emissions from all action alternatives: aggregate handling and truck loading/unloading of material at the different quarry, batch plant, and haul road locations (i.e., option A, B, or C), grading/earth moving, and concrete batching (see discussion below). EPA's AP-42 guidance provides emission factors that estimate fugitive dust emissions from the loading of aggregate onto storage piles, equipment traffic in storage areas, wind erosion from pile surfaces, loadout of aggregate for shipment or return to the process stream (e.g., batch or continuous drop operations), and from bulldozing/grading.

Primary inputs to model fugitive dust from aggregate handling and storage piles included total quantities of excavated material and heavy-duty construction equipment hours (e.g., graders, bulldozers, scrapers, and excavators).

For fugitive dust emissions associated with the concrete batch plant, emission factors from the Concrete Batching Policy Manual, published by the Sacramento Metropolitan Air Quality Management District, were relied upon for various batch plant-related processes. More specifically, these include aggregate transfer, sand transfer, cement unloading, cement supplement unloading, hopper loading, and mixer loading. Primary inputs to estimate fugitive dust from the concrete batching operations included total quantities of aggregate material that would be required by each construction phase of each action alternative.

Exhaust emissions of ROG, $NO_X$, $PM_{10}$, and $CO_2$ from heavy-duty construction equipment were estimated using emission factors derived from OFFROAD 2007. OFFROAD is a database that contains an off-road emissions inventory of the population, activity, and emissions estimate of the varied types of off-road equipment within each county in California. The major categories of engines and vehicles include agricultural, construction, lawn and garden, and off-road recreation. OFFROAD was run for San Joaquin Valley in 2015 (exhaust emissions would decrease in the future, thus 2015 was used as a conservative assumption) and used to generate a fleet-wide emission rate for each exhaust pollutant based on fuel consumption.

EMFAC 2011 is a model developed by ARB to estimate emissions from on-road vehicles. EMFAC 2011 was run for San Joaquin Valley in 2015 and used to generate exhaust emission rates for worker commute trips and truck hauling trips. Emission rates were applied to daily truck trips and worker commute trips required by each action alternative.

CalEEMod was developed in collaboration with the air districts of California. Default data (e.g., emission factors, trip lengths, meteorology, and source inventory) were provided by the various California air districts to account for local requirements and conditions. CalEEMod can be used to estimate air pollutant emissions from construction activities, mobile-source emissions, and operational emissions from mobile and area sources. CalEEMod was used to estimate mobile-source emissions of criteria air pollutants (and precursors) (i.e., ROG, NOx, $PM_{10}$, and CO) from operational trips associated with visitation to the recreational sites. CalEEMod was also used to obtain certain regional attributes (e.g., vehicle fleet composition, annual precipitation) needed for input to methods described above.

TACs and odors were also analyzed in accordance with SJVAPCD, ARB, and EPA guidance, policies, and rules.

In addition to modeling mass emissions of criteria air pollutants (and precursors), as discussed above, cancer risk as a result of exposure from diesel PM from construction activities was also modeled for all quarry, batch plant, and haul road options for Alternative Plan 4. Alternative Plan 4 would generate the most mass emissions compared to the other alternatives and thus options A, B, and C under Alternative Plan 4 represent the worst-case scenario.

Diesel PM concentrations were modeled with AERMOD, an air dispersion model, and the associated cancer risk was determined using SJVAPCD-approved methods. All modeling was conducted in coordination with SJVAPCD. The AERMOD modeling included 130 nearby receptors, primarily single-family residences and commercial structures. Source inputs included construction staging areas, construction activity areas, and the onsite quarry as area sources; as well as access/haul roads as line volume sources. Resultant concentrations averaged over the entire period of meteorological data were then multiplied by SJVAPCD-provided adjustment factor to estimate cancer risk.

Refer to the Physical Resources Appendix for detailed model input assumptions and output results.

#### *Greenhouse Gas Emissions*

GHG emission levels associated with the action alternatives would be generated by short-term construction activities from the use of heavy-duty construction equipment and mobile sources such as worker commuter and vendor hauling of materials. All action alternatives would also partially clear vegetation/trees from the reservoir area that would be affected by inundation. This would result in loss of $CO_2$ sequestration. Operational GHG emissions would result from energy consumption and recreational activities.

GHG emissions were estimated using a combination of methods. GHG exhaust emissions from heavy-duty construction equipment were estimated using the most recent version of ARB's off-road emission factor model OFFROAD. The model was run for the San Joaquin Valley in 2015 (exhaust emissions would decrease in the future, thus 2015 was used as a conservative assumption) and was used to generate a county fleet-wide emission rate for GHG based on diesel fuel consumption.

The most recent version of ARB's on-road emission factors model (EMFAC 2011) was used for estimating emissions from on-road vehicles. EMFAC 2011 was run for San Joaquin Valley in 2015 (exhaust emissions would decrease in the future, thus 2015 was used as a conservative assumption) and was used to generate exhaust emission rates for worker commute trips and truck hauling trips. Emission rates were applied to daily truck trips and worker commute trips required by each action alternative.

CalEEMod was used to estimate mobile-source GHG emissions from operational trips associated with visitation to the recreational sites of the project as well as to estimate loss of $CO_2$ sequestration from vegetation clearing.

Operational GHG emissions were estimated with utility specific intensity factors for PG&E based on total annual electricity consumption for each action alternative.

Construction-generated emissions were amortized over the lifetime of the project (i.e., 50 years) and added to operational emissions to determine the overall level of GHG generation.

SVJAPCD has not determined a quantitative level of GHG emissions increase, above which a project would have a significant impact on the environment, and below which would have a less-than-significant impact. SJVAPCD has developed a tiered approach to determining project-level significance on a project-by-project basis, as discussed below. This analysis follows the SJVAPCD-recommended approach.

However, because the SVJAPCD does not currently have an adopted quantitative threshold, this analysis also considers other GHG thresholds currently being used in other parts of California to provide context for the GHG emission estimates.

The criteria suggested by various agencies primarily address operational emissions, and not the relatively short-term emissions of construction activities. One of the more commonly suggested mass emissions thresholds is 25,000 MT $CO_2e$ per year. This value has been selected because it is the threshold established for mandatory emissions reporting for most sources in California under AB 32. Project emissions were compared to this threshold to determine significance.

Refer to the Physical Resources Appendix for detailed model input assumptions and output results.

### Criteria for Determining Significance of Impacts

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental impacts that would be caused by, or result from, implementing the No Action Alternative and the range of action alternatives. Under NEPA, the severity and context of an impact must be characterized. An environmental document prepared to comply with CEQA must identify the potentially significant environmental impacts of a proposed project and a reasonable range of alternatives, if required. A “[s]ignificant effect on the environment” means “a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project” (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental impacts (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental impacts as required under NEPA. Impacts of an alternative on air quality or GHG emissions would be significant under CEQA if project implementation would do any of the following:

- Conflict with or obstruct implementation of the applicable air quality plan
- Violate any air quality standard or contribute substantially to an existing or projected air quality violation

- Expose sensitive receptors to substantial pollutant concentrations

- Create objectionable odors affecting a substantial number or people

- Generate GHG emissions, either directly or indirectly that exceed 25,000 MT/year that may have a significant impact on the environment

- Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing GHG emissions

As stated in the CEQA guidelines, where available, the significance established by the applicable air quality management of air pollution control district may be relied upon to make the above determinations. Thus, criteria considered in the analysis below include SJVAPCD-recommend thresholds of significance for criteria air pollutants and TACs. SJVAPCD policy also provides for a tiered approach in assessing significance of project specific GHG emission increases, as follows:

- Projects complying with an approved GHG emission reduction plan or GHG mitigation program which avoids or substantially reduces GHG emissions within the geographic area in which the project is located would be determined to have a less than significant individual and cumulative impact for GHG emissions. Such plans or programs must be specified in law or approved by the lead agency with jurisdiction over the affected resource and supported by a CEQA compliant environmental review document adopted by the lead agency. Projects complying with an approved GHG emission reduction plan or GHG mitigation program would not be required to implement Best Performance Standards (BPS).

- Projects implementing BPS would not require quantification of project specific GHG emissions. Consistent with CEQA Guidelines, such projects would be determined to have a less than significant individual and cumulative impact for GHG emissions.

- Projects not implementing BPS would require quantification of project specific GHG emissions and demonstration that project specific GHG emissions would be reduced or mitigated by at least 29 percent, compared to Business as Usual (BAU), including GHG emission reductions achieved since the 2002-2004 baseline period, consistent with GHG emission reduction targets established in ARB's AB 32 Scoping Plan.

### Topics Eliminated from Further Consideration

Construction activities for each of the action alternatives would involve blasting for aggregate production which could result in fugitive dust emissions. However, dust emissions would be minimal and would not represent a substantial portion of the total dust emissions in comparison to all other construction activities. Thus, this issue is not addressed further.

Implementation of the action alternatives would not result in the long-term operation of a major odor source and construction-generated odors would dissipate quickly (e.g., diesel emissions from heavy-duty construction equipment) and not be located within typical odor screening distances (e.g., operation of the concrete batch plant would be located at least 2,000 feet from any sensitive receptor). In addition, implementing any of the action alternatives would not result in locating any new sensitive receptors near existing odor sources. Thus, the creation of objectionable odors affecting a substantial number of people is not discussed further in this analysis.

Once construction is complete, operations would be limited to minor maintenance activities. Long-term operational activities would not involve the use of heavy-duty diesel construction equipment or haul trucks and thus would not result in increased emissions of toxic air contaminants or increased health risk at any nearby sensitive receptors. Therefore, project-generated operational-related toxic air contaminants are not discussed further in this analysis.

The action alternatives would not generate GHG emissions in the extended study area; therefore the potential to create any GHG emissions in the extended study area is not discussed further in this analysis.

No topics related to climate change (including GHGs) that are included in the significance criteria listed above were eliminated from further consideration.

All other relevant topics are analyzed below.

## Direct and Indirect Effects

The following section describes the potential environmental consequences of the alternatives. Where the action alternatives would have identical or nearly identical impacts regardless of which action alternative is implemented, the action alternatives are described together. Where impacts would differ, the action alternatives are described separately.

Impacts related to the generation of GHGs, described under Impact AQ-4, focus on the contribution of the alternatives to the buildup of GHGs in the atmosphere, which has been shown to contribute to climate change (IPCC 2007). It is unlikely that any single project by itself could have a significant impact on the environment with respect to GHGs. However, the cumulative effect of human activities has been clearly linked to quantifiable changes in the composition of the atmosphere, which has in turn been shown to be the main cause of global climate change (IPCC 2007). Therefore, analysis of the environmental effects of GHG emissions from implementing the alternatives is addressed below as a cumulative impact analysis.

### *Impact AQ-1: Project-Generated Construction-Related Criteria Air Pollutant and Precursor Emissions that would Violate or Contribute Substantially to an Existing or Projected Violation, or Expose Sensitive Receptors to Substantial Pollutant Concentrations*

#### Primary Study Area

*No Action Alternative* No project-related construction or operation activities would occur under the No Action Alternative. There would be **no impact** under the No Action Alternative.

*Action Alternatives* Construction-related activities under the action alternatives would result in a direct effect on air quality from project-generated criteria air pollutant ($PM_{10}$) and precursor emissions (ROG and $NO_X$). Based on the modeling conducted, as summarized in Table 4-5, annual project-generated construction-related emissions would exceed SJVAPCD's significance thresholds for ROG, $NO_X$, and $PM_{10}$ (shown in bold font in Table 4-5). All control measures in compliance with the requirements of Regulation VIII are currently incorporated into the project description, as described in Chapter 2, "Alternatives." However, the remaining dust emissions could violate or contribute substantially to an existing or projected air quality violation, especially considering the current nonattainment status of the area. Consequently, project-generated construction-related emissions could expose nearby existing sensitive receptors to substantial pollutant concentrations. Refer to the Physical Resources Appendix for the general conformity determination.

This impact would be **significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

**Table 4-5. Summary of Modeled Project-Generated Construction-Related Criteria Air Pollutant and Precursor Emissions Under All Action Alternatives**

| **Phase and Duration** | **ROG** | **$NO_X$** | **$PM_{10}$ (Exhaust/ Fugitive Dust/Total)** |
|---|---|---|---|
| | **Tons Per Year (TPY)** | | |
| **Quarry, Batch Plant, and Haul Road Option A** | | | |
| **Alternative Plans 1, 2, 3, 5** | | | |
| Overall Annual Average | 17[1] | 148[1] | 5/42[1]/47[1] |
| Phase 1 | 21[1] | 189[1] | 6/33[1]/39[1] |
| Phase 2 | 4 | 35[1] | 1/2/3 |
| Phase 3 | 21[1] | 200[1] | 7/59[1]/66[1] |
| **Alternative Plan 4** | | | |
| Overall Annual Average | 18[1] | 150[1] | 5/42[1]/47[1] |
| Phase 1 | 21[1] | 189[1] | 6/33[1]/39[1] |
| Phase 2 | 5 | 41[1] | 1/2/3 |
| Phase 3 | 21[1] | 200[1] | 7/59[1]/66[1] |
| **SJVAPCD Significance Threshold** | 10 | 10 | 15 |
| **Quarry, Batch Plant, and Haul Road Option B** | | | |
| **Alternative Plans 1, 2, 3, 5** | | | |
| Overall Annual Average | 17[1] | 142[1] | 5/41[1]/46[1] |
| Phase 1 | 20[1] | 185[1] | 6/33/39 |
| Phase 2 | 4 | 35[1] | 1/2/3 |
| Phase 3 | 20[1] | 192[1] | 6/58[1]/64[1] |

## Table 4-5. Summary of Modeled Project-Generated Construction-Related Criteria Air Pollutant and Precursor Emissions under All Action Alternatives (contd.)

| Phase and Duration | ROG | $NO_X$ | $PM_{10}$ (Exhaust/ Fugitive Dust/Total) |
|---|---|---|---|
| | Tons Per Year (TPY) | | |
| **Quarry, Batch Plant, and Haul Road Option B** | | | |
| **Alternative Plan 4** | | | |
| Overall Annual Average | 17[1] | 145[1] | 5/41[1]/46[1] |
| Phase 1 | 20[1] | 185[1] | 6/33[1]/39[1] |
| Phase 2 | 5 | 41[1] | 1/2/3 |
| Phase 3 | 20[1] | 192[1] | 6/58[1]/64[1] |
| **SJVAPCD Significance Threshold** | 10 | 10 | 15 |
| **Quarry, Batch Plant, and Haul Road Option C** | | | |
| **Alternative Plans 1, 2, 3, 5** | | | |
| Overall Annual Average | 23[1] | 187[1] | 7/43[1]/50[1] |
| Phase 1 | 23[1] | 211[1] | 7/36[1]/43[1] |
| Phase 2 | 4 | 37 | 1/2/3 |
| Phase 3 | 29[1] | 262[1] | 9/58[1]/67[1] |
| **Alternative Plan 4** | | | |
| Overall Annual Average | 23[1] | 190[1] | 7/43[1]/50[1] |
| Phase 1 | 23[1] | 190[1] | 7/36[1]/43[1] |
| Phase 2 | 23[1] | 211[1] | 2/2/4 |
| Phase 3 | 5 | 43[1] | 9/58[1]/67[1] |
| **SJVAPCD Significance Threshold** | 10 | 10 | 15 |

Notes:

[1] Modeled level exceeds SJVAPCD's thresholds.

Key:

$NO_X$ = oxides of nitrogen

$PM_{10}$ = respirable particulate matter with an aerodynamic diameter of 10 micrometers or less

ROG = reactive organic gases

SJVAPCD = San Joaquin Valley Air Pollution Control District

### *Impact AQ-2: Project-Generated Construction-Related Toxic Air Contaminant Emissions that would Expose Sensitive Receptors to Substantial Pollutant Concentrations and Increased Health Risks*

**Primary Study Area**

*No Action Alternative* No project-related construction or operation activities would occur under the No Action Alternative.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* Construction-related activities under all the action alternatives would result in a direct effect on air quality from project-generated TAC emissions (i.e., diesel PM) from heavy-duty truck travel on proposed haul routes and heavy-duty construction equipment.

As discussed in Chapter 2, “Alternatives,” because of uncertainties in adequacy of rock for aggregate, three quarry, batch plant, and haul road options are being considered within each action alterative. The main dam batch plant location and haul road connecting the potential quarry site to main dam batch plant would also vary depending on quarry option. The location of construction activity relative to nearby receptors could influence health risk.

Risk modeling was conducted using the worst-case emissions scenario for each action alternative. Due to the type of intake structure proposed under Alternative Plan 4, additional heavy-duty equipment would be required in comparison to the other action alternatives. Therefore, Alternative Plan 4 represents the worst-case emissions scenario among all action alternatives. Emissions of diesel PM would vary based on the three quarry, batch plant, and haul road options (i.e., between Option A, B, and C). Thus, worst-case modeling is represented by modeling Alternative Plan 4 Option A, Alternative Plan 4 Option B, and Alternative Plan 4 Option C. Impacts are discussed for each option separately, where appropriate.

*Quarry, Batch Plant, and Haul Road Options A and C* Emission sources and receptors included in the model for Option A and C are shown below in Figure 4-1 and Figure 4-2, respectively. Quarry and haul road locations are described in further detail in Chapter 2, “Alternatives.”

Based on the modeling conducted, the worst-case project-generated construction-related excess cancer risk for Option A and C would be 2.4 and 7.4 chances per million, respectively, which would not exceed SJVAPCD's significance threshold of 10 chances per million, as shown in Table 4-6. Consequently, project-generated construction-related emissions for all action alternatives with either Option A or C would not result in the exposure of nearby existing sensitive receptors to substantial TAC concentrations.

*Quarry, Batch Plant, and Haul Road Option B*

Emission sources and receptors included in the model for Option B are shown below in Figure 4-3. Quarry, batch plant, and haul road Option B would result in locating the quarry in close proximity to other construction activities as well as nearby sensitive receptors. Quarry and haul road locations are described in further detail in Chapter 2, "Alternatives."

Based on the modeling conducted, the worst-case project-generated construction-related excess cancer risk for Option B would be 16.5 chances per million, which would exceed SJVAPCD's significance threshold of 10 chances per million, as shown in Table 4-6. Consequently, project-generated construction-related emissions for quarry, batch plant, and haul road Option B under any action alternative would result in the exposure of nearby existing sensitive receptors to substantial TAC concentrations.

This impact would be **significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

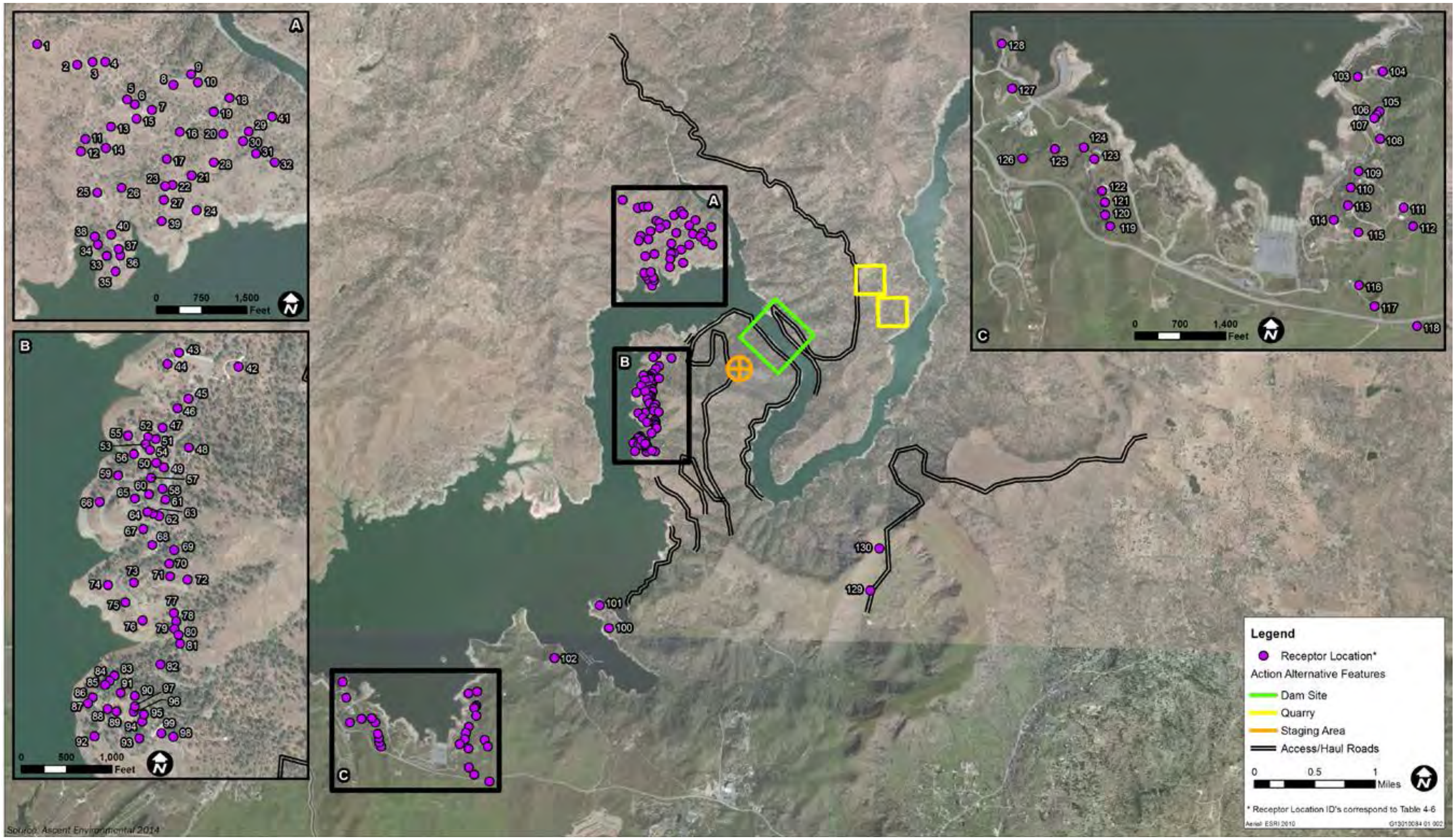

Figure 4-1. Receptor Locations for Cancer Risk (Quarry, Batch Plant, and Haul Road Option A)

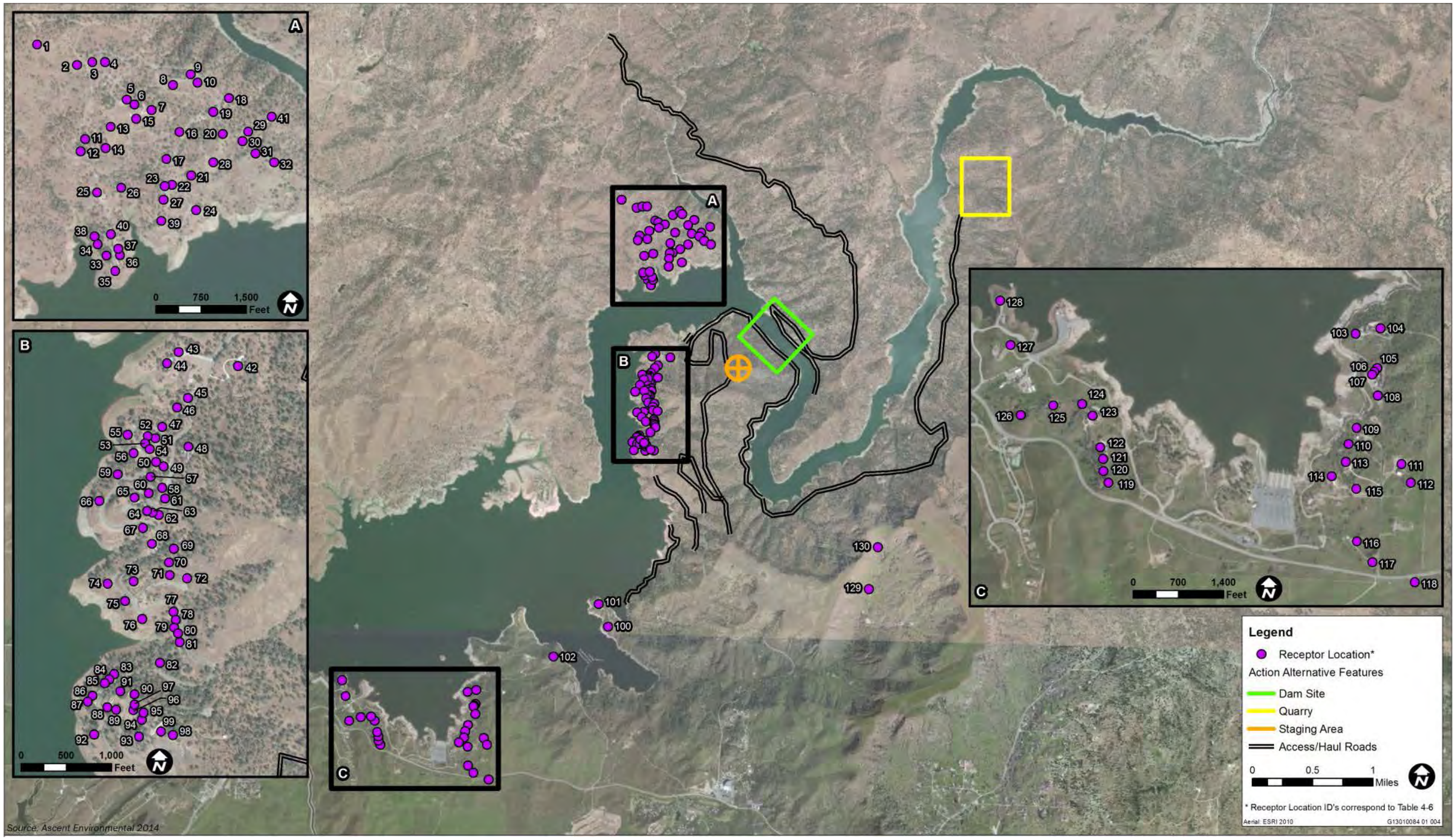

Figure 4-2. Receptor Locations for Cancer Risk (Quarry, Batch Plant, and Haul Road Option C)

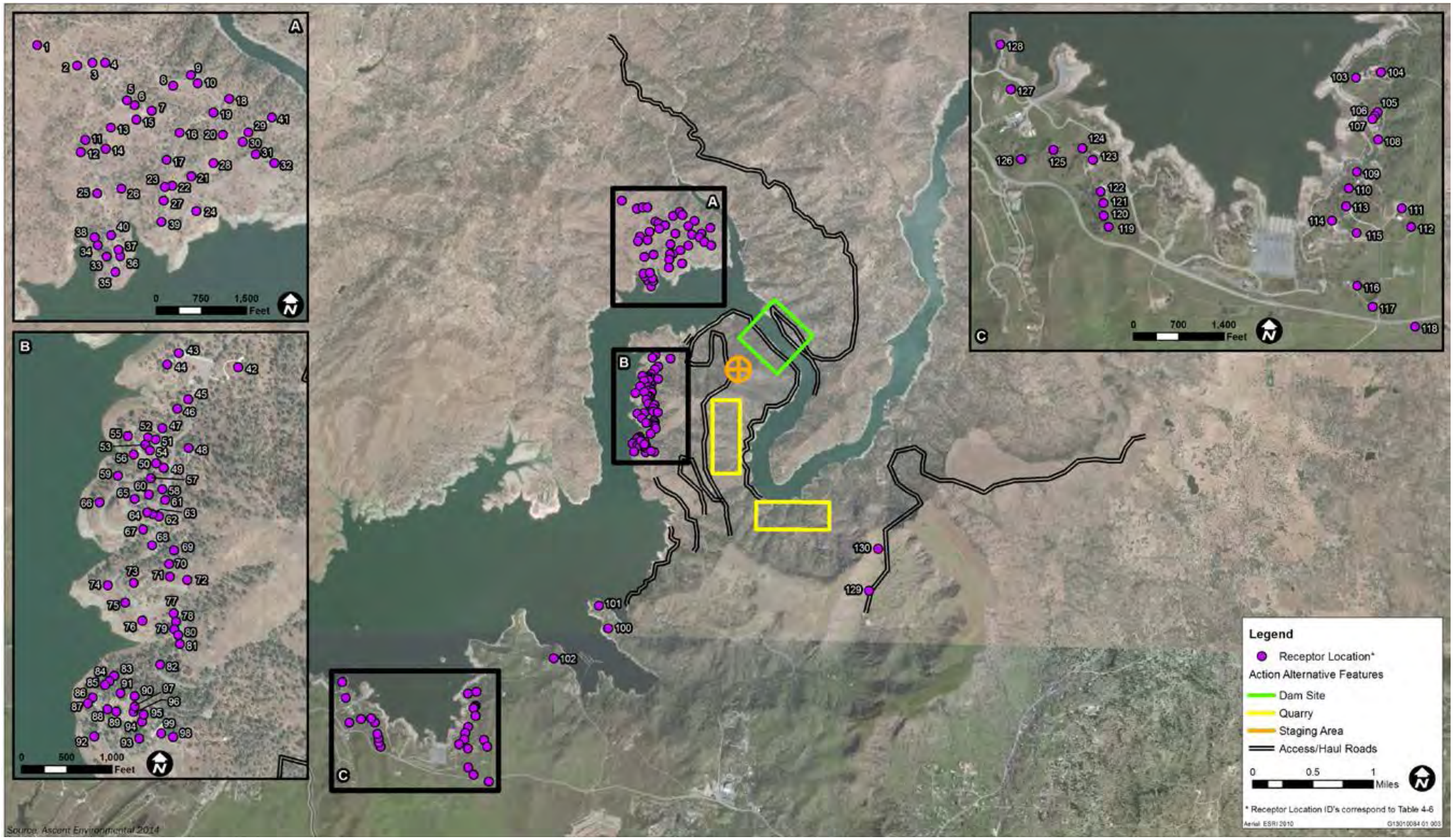

Figure 4-3. Receptor Locations for Cancer Risk (Quarry, Batch Plant, and Haul Road Option B)

## Table 4-6. Worst-Case Modeled Excess Cancer Risk (chances per million) by Receptor Location ID for each Quarry, Batch Plant, and Haul Road Option (Options A, B, and C) of the Action Alternatives

| Receptor ID[1] | Cancer Risk (Option A) | Cancer Risk (Option B) | Cancer Risk (Option C) | Receptor ID[1] | Cancer Risk (Option A) | Cancer Risk (Option B) | Cancer Risk (Option C) | Receptor ID[1] | Cancer Risk (Option A) | Cancer Risk (Option B) | Cancer Risk (Option C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 45 | 1 | 9 | 3 | 88 | <1 | 12 | 1 |
| 2 | 1 | 2 | 1 | 46 | 1 | 10 | 3 | 89 | <1 | 12 | 1 |
| 3 | 1 | 2 | 1 | 47 | 1 | 10 | 2 | 90 | <1 | 13 | 1 |
| 4 | 1 | 2 | 1 | 48 | 1 | 12 | 3 | 91 | <1 | 13 | 1 |
| 5 | 1 | 2 | 2 | 49 | 1 | 12 | 2 | 92 | <1 | 11 | 1 |
| 6 | 1 | 2 | 2 | 50 | 1 | 12 | 2 | 93 | <1 | 13 | 1 |
| 7 | 2 | 2 | 3 | 51 | 1 | 11 | 3 | 94 | <1 | 13 | 1 |
| 8 | 1 | 2 | 2 | 52 | 1 | 10 | 3 | 95 | <1 | 14 | 1 |
| 9 | 1 | 1 | 2 | 53 | 1 | 11 | 3 | 96 | <1 | 13 | 1 |
| 10 | 1 | 1 | 2 | 54 | 1 | 11 | 2 | 97 | <1 | 13 | 1 |
| 11 | 2 | 2 | 3 | 55 | 1 | 10 | 2 | 98 | <1 | 15 | 1 |
| 12 | 2 | 3 | 3 | 56 | 1 | 11 | 2 | 99 | <1 | 14 | 1 |
| 13 | 2 | 3 | 3 | 57 | <1 | 12 | 2 | 100 | <1 | 1 | 1 |
| 14 | 2 | 3 | 3 | 58 | <1 | 13 | 2 | 101 | <1 | 1 | 1 |
| 15 | 2 | 2 | 3 | 59 | <1 | 11 | 2 | 102 | <1 | 1 | <1 |
| 16 | 2 | 2 | 5 | 60 | <1 | 12 | 2 | 103 | <1 | 1 | 1 |
| 17 | 2 | 2 | 7 | 61 | <1 | 13 | 2 | 104 | <1 | 1 | 1 |
| 18 | 2 | 2 | 2 | 62 | <1 | 13 | 2 | 105 | <1 | 1 | 1 |
| 19 | 2 | 2 | 3 | 63 | <1 | 13 | 2 | 106 | <1 | 1 | 1 |
| 20 | 2 | 2 | 3 | 64 | <1 | 13 | 2 | 107 | <1 | 1 | 1 |

### Table 4-6. Worst-Case Modeled Excess Cancer Risk (chances per million) by Receptor Location ID for each Quarry, Batch Plant, and Haul Road Option (Options A, B, and C) of the Action Alternatives (contd.)

| Receptor ID[1] | Cancer Risk (Option A) | Cancer Risk (Option B) | Cancer Risk (Option C) | Receptor ID[1] | Cancer Risk (Option A) | Cancer Risk (Option B) | Cancer Risk (Option C) | Receptor ID[1] | Cancer Risk (Option A) | Cancer Risk (Option B) | Cancer Risk (Option C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 2 | 3 | 7 | 65 | <1 | 12 | 2 | 108 | <1 | 1 | 1 |
| 22 | 2 | 3 | 6 | 66 | <1 | 10 | 2 | 109 | <1 | 1 | <1 |
| 23 | 2 | 3 | 6 | 67 | <1 | 13 | 2 | 110 | <1 | 1 | <1 |
| 24 | 2 | 3 | 7 | 68 | <1 | 14 | 2 | 111 | <1 | 1 | <1 |
| 25 | 2 | 2 | 6 | 69 | <1 | 15 | 2 | 112 | <1 | <1 | <1 |
| 26 | 2 | 3 | 7 | 70 | <1 | 15 | 2 | 113 | <1 | 1 | <1 |
| 27 | 2 | 3 | 7 | 71 | <1 | 15 | 2 | 114 | <1 | 1 | <1 |
| 28 | 2 | 2 | 4 | 72 | <1 | 16 | 1 | 115 | <1 | 1 | <1 |
| 29 | 2 | 2 | 2 | 73 | <1 | 13 | 2 | 116 | <1 | <1 | <1 |
| 30 | 2 | 2 | 2 | 74 | <1 | 12 | 2 | 117 | <1 | <1 | <1 |
| 31 | 2 | 2 | 2 | 75 | <1 | 13 | 2 | 118 | <1 | <1 | <1 |
| 32 | 2 | 3 | 3 | 76 | <1 | 14 | 2 | 119 | <1 | 1 | 1 |
| 33 | 2 | 3 | 5 | 77 | <1 | 16 | 2 | 120 | <1 | 1 | 1 |
| 34 | 1 | 3 | 5 | 78 | <1 | 16 | 2 | 121 | <1 | 1 | 1 |
| 35 | 2 | 3 | 5 | 79 | <1 | 16 | 2 | 122 | <1 | 1 | 1 |
| 36 | 2 | 3 | 5 | 80 | <1 | 16 | 2 | 123 | <1 | <1 | 1 |
| 37 | 2 | 3 | 6 | 81 | <1 | 16 | 2 | 124 | <1 | <1 | <1 |
| 38 | 1 | 2 | 5 | 82 | <1 | 15 | 1 | 125 | <1 | <1 | <1 |
| 39 | 2 | 3 | 7 | 83 | <1 | 12 | 1 | 126 | <1 | <1 | <1 |
| 40 | 2 | 3 | 6 | 84 | <1 | 12 | 1 | 127 | <1 | <1 | <1 |
| 41 | 2 | 2 | 2 | 85 | <1 | 12 | 1 | 128 | <1 | 1 | <1 |
| 42 | 1 | 7 | 4 | 86 | <1 | 12 | 1 | 129 | <1 | 7 | <1 |
| 43 | 1 | 7 | 3 | 87 | <1 | 11 | 1 | 130 | <1 | 4 | <1 |
| 44 | 1 | 8 | 3 |  |  |  |  |  |  |  |  |

Notes:

[1] Receptor identification number corresponding to receptor location in Figures 4-1, 4-2, and 4-3.

Key:
ID = receptor identification number

### *Impact AQ-3: Project-Generated Operational Criteria Air Pollutant and Precursor Emissions that would Violate or Contribute Substantially to an Existing or Projected Violation, or Expose Sensitive Receptors to Substantial Pollutant Concentrations*

#### Primary Study Area

*No Action Alternative* No project-related construction or operation activities would occur under the No Action Alternative.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* Operations under the action alternatives would result in a direct effect on air quality from project-generated criteria air pollutant ($PM_{10}$) and precursor emissions (ROG and NOx) associated with recreational activities. Based on the modeling conducted, as summarized in Table 4-7, annual project-generated operational emissions would not exceed SJVAPCD's significance thresholds for ROG, NOx, and $PM_{10.}$

Therefore, this impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

**Table 4-7. Summary of Modeled Project-Generated Operational Criteria Air Pollutant and Precursor Emissions Under All Action Alternatives (Unmitigated)**

| Alternative Plan | ROG | $NO_X$ | $PM_{10}$ |
|---|---|---|---|
| | Tons Per Year | | |
| 1 | <1 | <1 | <1 |
| 2 | <1 | <1 | <1 |
| 3 | <1 | <1 | <1 |
| 4 | <1 | <1 | <1 |
| 5 | <1 | <1 | <1 |
| SJVAPCD Significance Threshold | 10 | 10 | 15 |

Key:
$NO_X$ = oxides of nitrogen
$PM_{10}$ = respirable particulate matter with an aerodynamic diameter of 10 micrometers or less
ROG = reactive organic gases
SJVAPCD = San Joaquin Valley Air Pollution Control District

### *Impact AQ-4: Generation of Greenhouse Gas Emissions that would Significantly Impact the Environment*

**Primary Study Area**

*No Action Alternative* No project-related construction or operation activities would occur under the No Action Alternative.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* Implementation of the action alternatives would result in direct and indirect generation of GHG emissions (i.e., from energy consumption). Construction activities for the action alternatives would result in increased generation of GHG emissions. Heavy-duty off-road equipment, materials transport in haul trucks, and worker commute would result in exhaust emissions of GHGs. GHG emissions associated with operation of the project would consist of GHG emissions from increases in visitors to new recreation areas, energy consumption from increases in pumping, and a loss of $CO_2$ sequestration from vegetation clearing that would be conducted throughout the inundation areas.

The total net increase in GHG emissions was estimated using the methods described above and is summarized below in Table 4-8.

**Table 4-8. Summary of GHG Emissions Associated with the Action Alternatives**

| **Source** | **$CO_2$e MT/Year** | | |
|---|---|---|---|
| **Alternative Plan 1** | **Option A** | **Option B** | **Option C** |
| Construction (Amortized over 50 years)[1] | 5,215 | 4,922 | 6,321 |
| Recreational Visitation Trips | 136 | 136 | 136 |
| Energy Consumption | 54,493 | 54,493 | 54,493 |
| Loss from Vegetation Accumulation | 18,033 | 18,033 | 18,033 |
| **Total** | **77,877** | **77,584** | **78,983** |

### Table 4-8. Summary of GHG Emissions Associated with the Action Alternatives (contd.)

| **Source** | **$CO_2$e MT/Year** | | |
|---|---|---|---|
| **Alternative Plan 2** | **Option A** | **Option B** | **Option C** |
| Construction (Amortized over 50 years)[1] | 5,215 | 4,922 | 6,321 |
| Recreational Visitation Trips | 138 | 138 | 138 |
| Energy Consumption | 39,607 | 39,607 | 39,607 |
| Loss from Vegetation Accumulation | 18,033 | 18,033 | 18,033 |
| **Total** | **62,993** | **62,700** | **64,099** |
| **Alternative Plan 3** | **Option A** | **Option B** | **Option C** |
| Construction (Amortized over 50 years)[1] | 5,215 | 4,922 | 6,321 |
| Recreational Visitation Trips | 132 | 132 | 132 |
| Energy Consumption | 41,417 | 41,417 | 41,417 |
| Loss from Vegetation Accumulation | 18,033 | 18,033 | 18,033 |
| **Total** | **64,797** | **64,504** | **65,903** |
| **Alternative Plan 4** | **Option A** | **Option B** | **Option C** |
| Construction (Amortized over 50 years)[1] | 5,290 | 4,997 | 6,396 |
| Recreational Visitation Trips | 158 | 158 | 158 |
| Energy Consumption | 32,194 | 32,194 | 32,194 |
| Loss from Vegetation Accumulation | 18,033 | 18,033 | 18,033 |
| **Total** | **55,675** | **55,382** | **56,781** |
| **Alternative Plan 5** | **Option A** | **Option B** | **Option C** |
| Construction (Amortized over 50 years)[1] | 5,215 | 4,922 | 6,321 |
| Recreational Visitation Trips | 68 | 68 | 68 |
| Energy Consumption | 19,877 | 19,877 | 19,877 |
| Loss from Vegetation Accumulation | 18,033 | 18,033 | 18,033 |
| **Total** | **43,193** | **42,900** | **44,299** |

Note:

[1] Construction emissions were calculated for each year of each phase and summed for the entire Alternative. Alternative totals were then amortized over 50 years to be easily added to annual operational emissions. Refer to Physical Resourced Appendix for detailed modeling input data and output results.

Key:

$CO_2$e MT/Year = metric tons of carbon dioxide equivalent per year

GHG = greenhouse gas

Based on SJVAPCD-recommended procedures for evaluating GHG emissions, the action alternatives (including all quarry, batch plant, and haul road options) would not be subject to incorporation of any BPS, as no stationary GHG sources would result. However, although the SJVAPCD does not have quantitative thresholds in place that relate directly to this type of project, GHG emissions were compared to other adopted GHG thresholds, as described in the Methods and Assumptions section above. Estimated annual GHG emissions would exceed the applicable threshold of 25,000 MT/year for all action alternatives, and would cause a cumulatively considerable incremental contribution to the overall significant cumulative impact.

This impact would be **significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

## Mitigation Measures

This section discusses mitigation measures for each significant impact described in the Direct and Indirect Impacts section, as presented in Table 4-4.

No mitigation is required for Impact AQ-3 within the primary study area, because this impact would be less than significant for all action alternatives. Impacts AQ-1 through AQ-4 would not occur in the extended study area.

Mitigation Measures AQ-1, AQ-2, and AQ-4, described below, are required for Impacts AQ-1, AQ-2, and AQ-4, respectively, in the primary study area for all action alternatives.

### *Mitigation Measure AQ-1: Reduce Mobile-Source Exhaust Emissions*

For the reduction of construction-related mobile-source exhaust emissions of ROG, $NO_X$, and $PM_{10}$, Reclamation will implement the following actions:

- Exhaust emissions for construction equipment greater than 50 horsepower used or associated with the project shall be reduced by 20 percent of the total $NO_X$ and by 45 percent of the total $PM_{10}$ emissions from the statewide average as estimated by the ARB by using less polluting construction equipment, which can be achieved by utilizing add-on controls, cleaner fuels, or newer lower emitting equipment.

- Provide commercial electric power to the project site in adequate capacity to avoid or minimize the use of portable electric generators and the equipment.
- Where feasible, substitute electric-powered equipment for diesel engine driven equipment.
- When not in use, on-site equipment shall not be left idling.
- Limit the hours of operation of heavy duty equipment and/or the amount of equipment in use at any one time.
- Curtail construction during periods of high ambient pollutant concentrations (e.g., Spare the Air Days).
- Before construction contracts are issued, the project applicants shall perform a review of new technology, as it relates to heavy-duty equipment, to determine what (if any) advances in emissions reductions are available for use and are economically feasible. Construction contract and bid specifications shall require contractors to use the available and economically feasible technology on an established percentage of the equipment fleet. It is anticipated that in the near future both $NO_X$ and $PM_{10}$ control equipment will be available. The SJVAPCD shall be consulted with on this process.

Implementing Mitigation Measure AQ-1 would result in a 5, 20, and 45 percent reduction in ROG, $NO_X$, and $PM_{10}$ mobile-source exhaust emissions, respectively. However, this mitigation would not be sufficient to reduce this air quality effect to a less-than-significant level. As a result, Impact AQ-1 would remain **significant and unavoidable** under the action alternatives.

#### *Mitigation Measure AQ-2: Implement Mitigation Measure AQ-1, Reduce Mobile-Source Exhaust Emissions*

Implementing Mitigation Measure AQ-2 would reduce health risk from 16 chances in one million to 9 chances in one million due to the reduction of diesel PM and thus would reduce Impact AQ-2 to a **less than-significant** level.

### *Mitigation Measure AQ-4: Reduce Greenhouse Gas Emissions*

For the reduction of GHG emissions, Reclamation will implement the following actions during the construction phase:

- Improve fuel efficiency from construction equipment by:
  - Maintaining all construction equipment in proper working condition according to manufacturer's specifications. The equipment must be checked by a certified mechanic and determined to be running in proper condition before it is operated; and
  - Ensuring that all equipment operators are trained in proper use of equipment.
- Reduce electricity use in the construction offices by using compact fluorescent bulbs, powering off computers every day, and using energy-efficient (i.e., EPA EnergyStar Rated) appliances (e.g., heating and cooling units);
- Recycle or salvage non-hazardous construction and demolition debris; and
- Use locally sourced or recycled materials for construction materials.

Reclamation will implement the following actions during the operations phase:

- Reduce consumption of non-renewable energy. This could be accomplished by providing onsite renewable energy such as solar panels, or similar means to offset fossil fuel-powered electricity generation (e.g., solar panels for pumps).

Implementation of Mitigation Measure AQ-4 would reduce GHG emissions associated with construction and operations. Actions to reduce construction-related GHG emissions are BMPs and do not relate to a clear, quantifiable reduction in GHG emissions. Due to the magnitude of construction activities and heavy-duty construction equipment required, minimal GHG reduction from construction activities would be achieved. The most effective way to reduce GHG emissions would be to use renewable energy sources that do not use fossil fuels for electricity generation. However, the level at which proposed project components could rely on solar power at this time is unknown. Implementation of Mitigation Measure AQ-4 would result in some level of GHG emissions reduction. However, due to the magnitude of annual GHG emissions and the availability of space (e.g., land, roofs of structures/building), solar panels would not be anticipated to reduce annual GHG emissions to below the 25,000 MT/year threshold. As a result, Impact AQ-4 would remain **significant and unavoidable** under the action alternatives.

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# Chapter 5
# Biological Resources – Fisheries and Aquatic Ecosystems

This chapter describes the affected environment for aquatic resources, as well as potential environmental consequences and associated mitigation measures, as they pertain to implementing the alternatives. This chapter presents information on the primary study area (area of project features, the Temperance Flat Reservoir Area, and Millerton Lake below RM 274). It also discusses the extended study area (San Joaquin River from Friant Dam to the Merced River, the San Joaquin River from the Merced River to the Delta, the Delta, and the CVP and SWP water service areas).

## Affected Environment

The affected environment for aquatic resources includes a discussion of the key fish species and their respective habitats in the primary and extended study areas.

### Primary Study Area

#### *Temperance Flat Reservoir Area*

The Temperance Flat Reservoir Area currently consists of the San Joaquin River from upper Millerton Lake to Kerckhoff Dam and the upper section of Millerton Lake. The following describes both the San Joaquin River and the upper lake habitat.

**Aquatic Habitat** The reach of the San Joaquin River between Kerckhoff Dam and Millerton Lake has a bedrock channel, many long narrow pools, and an occasional steep cascade. In the past, sluicing to remove sediments from Kerckhoff Reservoir resulted in extremely high levels of sediments in this reach of the river, but flood flows in intervening years may have flushed these sediments from the river into Millerton Lake.

Overall, the section of the San Joaquin River between Kerckhoff Dam and Millerton Lake consists of extensive stretches of bedrock walls above and below the water line. Large boulders and cobble are abundant. The quality and quantity of smaller gravels have not been evaluated.

The predominant habitat types are mostly pool and run habitats (with few glide habitat units). Run habitat was classified as being fairly swiftly flowing segments with some surface agitation, no major flow obstructions, and substrates dominated by gravel and cobble. Glide habitat was classified as areas with wide, uniform channel bottoms; low-to-moderate water velocity and without obvious turbulence; and substrates dominated by cobble, gravel, and sand.

Riffle habitat appeared to be predominantly high gradient (i.e., greater than 4 percent) or even cascade (high gradient consisting of alternating small waterfalls and shallow pools) habitat types, many of which are likely passage impediments for some fish. Low-gradient riffles (i.e., less than 4 percent) are less common.

Because of the abundance of bedrock, gravel recruitment into the river is low and, as a result, gravel that could be used by riverine fishes for spawning is probably fairly highly embedded, thus reducing the quality of spawning habitat.

Riparian vegetation along most of the river is poorly developed because the river margins are steep and rocky and flood flows frequently scour the channel. However, riparian vegetation occurs at the confluence of small streams in the upper portion of this reach. Where bedrock does not dominate the banks, riparian habitat consists of primarily coniferous trees; where the channel is less confined, alders and willows are more abundant.

The San Joaquin River Basin consists of granitic soils with low mineral nutrient content. Millerton Lake, therefore, has relatively low productivity. No information is available regarding the plankton communities of the reservoir.

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 (see Chapter 20, “Power and Energy”). Operation of these reservoirs affects timing of inflow to Millerton Lake. Big Sandy Creek, Fine Gold Creek, and several smaller, ephemeral streams also provide flows directly into Millerton Lake. Flow released from the powerhouses into the lower reach of the San Joaquin River is colder than that in the river since the waters travel at high velocities through tunnels from Kerckhoff Dam directly to the powerhouses.

During summer, cold-water outflows from the Kerckhoff powerhouses bypass the San Joaquin River through tunnels from Kerckhoff Lake to the upper extent of Millerton Lake. The cold, dense river inflow submerges at a location referred to as the plunge point and continues to flow downstream below the warmer, surface layer in the reservoir (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 the Millerton Lake area (PG&E 1990). This affects fish spawning habitat.

**Fish Species** Native fish species in this reach of river include hardhead (*Mylopharodon conocephalus*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), and rainbow trout (*Oncorhynchus mykiss*). Kern brook lamprey (*Lampetra hubbsi*) were originally thought to be endemic to the east side of the San Joaquin Valley; however, in recent years, they have been found in the San Joaquin River downstream from Friant Dam and in several tributaries of the Sacramento River (Goodman 2014). The San Joaquin River between Kerckhoff Dam to the upper portion of Millerton Lake contains spawning habitat for nonnative American shad (*Alosa sapidissima*) and striped bass (*Morone saxatilis*).

The commonly occurring species in the Temperance Flat Reservoir Area include reservoir fish that spawn in riverine habitat as well as fully riverine fish species. Several native nongame species have been collected from the reservoir, including Sacramento sucker, Sacramento pikeminnow, Sacramento blackfish (*Orthodon microlepidotus*), hitch (*Levinia exilicauda*), and hardhead. Aquatic species reported in the primary study area are listed in Table 5-1.

**Table 5-1. Fish Species in the Primary Study Area**

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

*Source: Mitchell 2006*
Note:
[1] Presence of Kern brook lamprey is uncertain.

In addition to fish, beds of the large, freshwater pearlshell clam (*Margaritifera* spp.) have been found on the substrate in the river between Kerckhoff Dam and Millerton Lake. The clam is listed as a Special Animal by CDFW, with its status in California classified as uncertain; however, it is fairly common in the San Joaquin River, downstream from Friant Dam (Mitchell 2006). The pearlshell clam was considered for inclusion as a species for evaluation but was not selected because of its downstream abundance. The Special Animal listing provides no regulatory protection to the species, and pearlshell clam overall distribution and abundance are poorly known.

None of the fish species in the Temperance Flat Reservoir Area are federally or State-listed as threatened or endangered. However, three species, hardhead, hitch, and Kern brook lamprey, have special Federal and/or State status because they are considered potentially rare or are declining in abundance and/or distribution. A number of introduced warm-water species that commonly occur in Millerton Lake are important sport fish species. Rainbow trout, also an important sport fish species, is frequently abundant in the San Joaquin River reach between Kerckhoff Dam and Millerton Lake. The following sections describe the fish species found in the Temperance Flat Reservoir Area in more detail.

*Hardhead* Hardhead are a native minnow (*Cyprinidae*) species and are a USFS Sensitive Species and a California Species of Special Concern. The species is widely distributed throughout low to mid-elevation streams in the Sacramento–San Joaquin and Russian River drainages (Moyle 2002); however, hardhead populations have substantially declined in recent decades, especially in the southern half of their range, and some populations have disappeared (Moyle et al. 1995).

Hardhead are most commonly found in undisturbed portions of larger streams. Pools with sand-gravel substrates and slow water velocities are the species' preferred habitat; adult fish inhabit the lower half of the water column, while juvenile fish remain in shallow water closer to stream edges. They are abundant in a few, small mid-elevation reservoirs located on major rivers, including Kerckhoff and Redinger reservoirs on the San Joaquin River upstream from Millerton Lake, but are basically absent from Millerton Lake and other large warm-water reservoirs with highly fluctuating water levels. In the primary study area, hardhead primarily occur in the San Joaquin River reach between Kerckhoff Dam and Millerton Lake. They were once found regularly in upper Millerton Lake but have since largely disappeared from the reservoir (Mitchell 2006).

The life history of hardhead is poorly known. Spawning has not been observed, but is believed to occur on beds of gravel in swift water (Moyle 2002). They spawn as 3-year-olds during April and May. Fry are believed to reside along stream edges in dense cover of flooded vegetation or woody debris (Devine Tarbell and Associates, Inc., and Stillwater Sciences 2005). Juvenile hardhead tend to prefer warmer water with substrate consisting of large cobble and boulders. As the fish grow, they move to deeper, quieter water.

Factors that potentially affect hardhead growth and survival include habitat conditions, forage, predation, and water quality. Hardhead typically feed on small invertebrates and aquatic plants at the bottom of quiet water. They are able to withstand summer water temperatures above 68°F but will select lower temperatures when available (Moyle 2002). Hardhead are relatively intolerant of poorly oxygenated waters, particularly at higher water temperatures (Moyle 2002).

*Kern Brook Lamprey* Kern brook lamprey are a California Species of Special Concern and were originally thought to be endemic to the east side of the San Joaquin Valley. However, in recent years, they have been found in the San Joaquin River downstream from Friant Dam and in several tributaries of the Sacramento River (Goodman 2014). The status of the Kern brook lamprey is poorly known because identification of the species is difficult, particularly in the larval stage, but remaining populations are likely scattered and isolated (Moyle 2002). Kern brook lamprey were first collected in the Friant-Kern Canal and have since been found in the lower Merced, Kaweah, Kings, and San Joaquin rivers. Ammocoetes (larvae) possibly belonging to this species were collected in the upper San Joaquin River between Kerckhoff Dam and Millerton Lake from 1979 through 1982 (Wang 1986). The species is unlikely to occur anywhere else in the primary study area because they inhabit riverine habitat.

The life history of the Kern brook lamprey is poorly known. Adults spawn in the spring or summer (Moyle 2002, Wang 1986). The ammocoetes probably live for several years before metamorphosing to the adult stage in the fall. No feeding occurs after metamorphosis, and adults die after spawning (Moyle 2002).

Kern brook lamprey typically inhabit silty backwaters of the lower portions of rivers emerging from the Sierras. The ammocoetes occur in shallow pools and other areas of low-flow velocities, favoring substrates consisting of sand and mud. Adults seek riffle habitat with gravel for spawning and rubble for cover (Moyle 2002).

Limiting factors for Kern brook lamprey are poorly understood. The ammocoetes probably feed on algae and organic matter. They avoid habitats with water temperatures exceeding about 77°F (Moyle 2002).

*Striped Bass* Striped bass are native to the Atlantic and Gulf coasts and were first introduced to the Bay-Delta in 1879. They are currently among the most highly valued sport fish in California. Striped bass have been planted in a number of California reservoirs and have successfully spawned in a few of these, including Millerton Lake. Young striped bass are regularly entrained in water pumped from the California Aqueduct into San Luis Reservoir and a number of reservoirs in Southern California (Moyle 2002). The reservoir fisheries are relatively small, but are valuable because striped bass are highly sought by some anglers.

Striped bass were first planted in Millerton Lake from 1955 through 1957. This population spawned successfully in Millerton Lake before the addition of the Kerckhoff No. 2 Powerhouse, but the new powerhouse caused changes in river flows that seem to have negatively affected their spawning (Mitchell 2006). In addition, heavy fishing pressure precluded the spawning from sustaining the population. Therefore, CDFW and the California Striped Bass Association (CSBA) periodically replenish the population with plantings of young fish obtained from San Luis Reservoir. In the study area, striped bass occur primarily in open waters of Millerton Lake; but during spring, spawning adults attempt to migrate upstream to the San Joaquin River near Kerckhoff No. 2 Powerhouse.

Striped bass spawn from April through June in the open water of rivers (Wang 1986). The eggs are slightly heavier than water, so they sink slowly as they are transported downstream. They hatch in approximately 2 days at about 66°F. Adult and pre-adult striped bass are open-water predators and opportunistic feeders at the top of the food web, preying on threadfin shad (*Dorosoma pretense*), American shad, smaller striped bass, and any other fish they can catch. Threadfin shad are the most important prey for striped bass in Millerton Lake (Goodson 1966). Striped bass growth is rapid in Millerton Lake, probably because threadfin shad are abundant in the reservoir. By the end of their fourth year, Millerton Lake striped bass are typically 22 inches long (Moyle 2002). The age of maturity for striped bass is generally 4 to 6 years for females and 2 to 3 years for males (Moyle 2002).

The optimum water temperatures for spawning striped bass are about 59°F to 68°F, and spawning ceases at temperatures above 70°F (Moyle 2002). Juveniles and adults become stressed at water temperatures above about 77°F, and temperatures over 85°F are generally lethal.

*Rainbow Trout* Rainbow trout are native to California, but because of extensive transplanting, only a few populations in California retain their original genetic integrity. In the primary study area, rainbow trout occur primarily in the San Joaquin

River reach between Kerckhoff Dam and Millerton Lake and the uppermost portion of Millerton Lake. Many large trout are captured by anglers near the Kerckhoff No. 2 Powerhouse (Mitchell 2006). Rainbow trout were planted in Millerton Lake in 1964, even though trout were present in the San Joaquin River before Friant Dam was constructed. Many of the trout currently found in the primary study area are likely recruited from upstream stream reaches and reservoirs.

Rainbow trout typically inhabit cool, clear, fast-flowing streams and rivers, where riffles are more prevalent than pools. They are also found in reservoirs, but require spawning habitat in streams for successful reproduction. They seek habitat with abundant cover, including vegetation and large woody material, undercut banks, cobbles, rock, and boulders, and deep water or turbulent flow. Younger, smaller fish are more likely to be found in the smaller riffles, intermediate-sized fish occupy runs, and larger fish use pools.

Rainbow trout tolerate a fairly wide range of water temperatures. The optimum temperature range for rainbow trout growth is about 59°F to 64°F, but the optimum for fry is somewhat lower (Moyle 2002). In warm water, the trout seek out deeper pools where the water is cooler, briefly moving to riffles to feed. Rainbow trout spawn in the spring in nests (redds) dug in coarse gravel in a stream riffle or tail of a pool. The eggs hatch in 3 to 4 weeks at 50°F to 59°F, and fry emerge from the gravel 2 to 3 weeks later (Moyle 2002).

*Sacramento Sucker* Sacramento sucker are largely distributed throughout California, including streams and reservoirs of the Sacramento River and San Joaquin River watersheds. They occupy waters from cold, high velocity streams to warm, nearly stagnant sloughs. They are common at moderate elevations (650 feet to 2,000 feet). Sacramento suckers can tolerate a wide range of temperature fluctuations, from streams that rarely exceed 59°F to those that reach up to 86°F. Sacramento suckers have the ability to colonize new habitats readily (Moyle 2002).

Sacramento sucker usually spawn for the first time in their fourth or fifth years over riffles from February through June when water temperatures are approximately 54°F to 64°F. When they cannot move upstream, and end up spawning in lake habitat, they typically orient themselves near areas where spring freshets flow into the lake. The young fish typically live in the natal stream for a couple years before moving downstream to a reservoir or large river (Moyle 2002).

*American Shad* American shad are native to the Atlantic coast and were first introduced into the Bay-Delta in 1871 (Wang 1986). American shad populations are normally anadromous; however, American shad were accidentally introduced into Millerton Lake between 1955 and 1957. These introductions produced a spawning, self-sustaining population in the reservoir. This is now the only known naturally reproducing, landlocked population of American shad. Populations of American shad also occur in San Luis Reservoir and O'Neill Forebay, but these populations are believed to be maintained by eggs, fry, and small fish pumped in with water from the California Aqueduct rather than by successful spawning in the reservoirs (Stephens 2006). The Millerton Lake population rears throughout the reservoir and spawns near the San Joaquin River inflow to Millerton Lake, upstream from the plunge point (PG&E 1986).

American shad 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. It is also an important prey item for adult striped bass (CSBA 2006). Because of its unique status as the only known successfully spawning, landlocked population, Millerton Lake American shad has attracted scientific interest and has been intensively studied in connection with PG&E FERC relicensing studies for the Kerckhoff No. 2 Hydroelectric Project (PG&E 1986, 2001).

American shad in Millerton Lake are sexually mature at 3 to 4 years of age (PG&E 1986). Spawning begins in May, but peaks from mid-June through mid-July, when water temperatures are between 52°F and 63°F (Moyle 2002). Spawning occurs at night, between the hours of 9:00 p.m. and 7:00 a.m., with peak activity between 11:00 p.m. and 4:00 a.m. (PG&E 1986). The fish spawn near the water surface over deep shoreline eddies (PG&E 1990). The eggs are slightly heavier than freshwater, so flow velocities of about 1 to 2 feet per second are required to keep the eggs suspended as they are transported downstream. Flows in the uppermost, riverine portion of Millerton Lake are turbulent, which may cause favorable conditions for American shad eggs, allowing them to remain in the river for a much longer time than they would in straight flow-through conditions (PG&E 1990). Dissolved oxygen (DO) levels of at least 5 milligrams per liter (mg/L) are required for egg survival. The eggs hatch in approximately 8 to12 days at 52°F to 59°F, 6 to 8 days at 63°F, and 3 days at 75°F (Moyle 2002).

Within 2 days of hatching, larvae begin feeding on small zooplankton. Older American shad typically feed on large zooplankton and other invertebrates, but Millerton Lake shad also feed on threadfin shad (Moyle 2002). Growth of American shad in Millerton Lake is slower than that of anadromous populations.

As previously indicated, the Millerton Lake American shad population has been intensively studied in connection with FERC licensing studies for the PG&E Kerckhoff No. 2 Hydroelectric Project (PG&E 1986, 1990, 2001). These studies focused primarily on effects of flow releases from the Kerckhoff or Kerckhoff No. 2 powerhouses on shad spawning. Kerckhoff Powerhouse discharges into the San Joaquin River approximately 2 miles upstream from Kerckhoff No. 2 Powerhouse, and Kerckhoff No. 2 Powerhouse discharges either into the San Joaquin River or directly into Millerton Lake, depending on the surface elevation of the reservoir. The studies demonstrated that shad need uninterrupted, steady discharges from the powerhouses for successful spawning. Uninterrupted discharges provide the water surface velocities that stimulate spawning behaviors and continuous flows in the lotic portion of the reservoir that keep eggs suspended until hatching occurs.

Before the Kerckhoff No. 2 Powerhouse started operations in 1983, large numbers of adult American shad were recruited in years when stream flows in the San Joaquin River were consistently high, but no American shad were recruited during drought years 1976 and 1977 when flow in the bypass reach dropped to as low as 21 cfs. After Kerckhoff No. 2 Powerhouse was brought into operation, backwater from Kerckhoff No. 2 Powerhouse affected hydraulic conditions in the spawning areas. The results of PG&E studies have led to FERC-mandated minimum flow release requirements from Kerckhoff No. 2 Powerhouse and/or Kerckhoff Powerhouse during the American shad spawning season (PG&E 2001).

*Spotted Bass* Alabama spotted bass (*Micropterus punctulatus*) were introduced to Millerton Lake in 1974 and 1975 from the Elk Grove Fish Hatchery and from Lake Perris, Riverside County (Moyle 2002, Wang 1986). Alabama spotted bass are native to the southeastern United States, but have been widely introduced into reservoirs because of their ability to spawn successfully in highly fluctuating water levels. In the primary study area, spotted bass are found in Millerton Lake and the upper San Joaquin River, where they may prey on native fishes (Wang 1986, Mitchell 2006).

Spotted bass begin spawning in Millerton Lake as early as late March, and peak spawning occurs in late May and early June (Wang 1986). Nesting areas include portions of the shoreline of Millerton Lake. Males construct nests in colonies at depths of 3 to 20 feet (Wang 1986). The males guard the nests and newly hatched larvae from predators such as bluegills (*Lepomis macrochirus*) (Aasen and Henry 1980). The larvae typically disperse from the nest 8 days after hatching (Vogele 1975). Spotted bass reach maturity at the age of 2 or 3 years (Moyle 2002), and the maximum total length is about 20 inches (McKechnie 1966). Few live longer than 4 to 5 years (Moyle 2002).

Spotted bass in reservoirs are most often found along steep, rocky shores (Vogele 1975). The adults tend to live at moderate depths (3 to 13 feet), often just above the thermocline, but may seek out deeper water (100 to 130 feet) following fall mixing. In some reservoirs, adults may move up into tributary rivers in summer, where they occupy deep, slow pool and run habitat (Moyle 2002). Juvenile spotted bass generally inhabit more shallow water than the adults. In Millerton Lake during summer, juveniles are often observed near the boat ramps (Wang 1986). Young-of-year bass usually swim in small schools, while larger fish tend to be solitary. Adult spotted bass frequently remain in the same area for most of the year (Moyle 2002).

Spotted bass are warm-water fish, preferring water with summer temperatures of 75°F to 88°F (Moyle 2002). Growth is maximized at about 75°F (McMahon et al. 1984). Spawning begins in spring when the water temperature rises to 59°F to 65°F and continues until temperatures reach 71°F to 73°F (Moyle 2002). They generally spawn in coves and on steeply sloped shorelines with large rock, rubble, or gravel, preferring sites near cover. The eggs hatch in 5 days at a water temperature of 58°F to 60°F and in 2 days at 70°F (Vogele 1975). DO levels greater than 6 mg/L are optimum for spotted bass survival and growth (McMahon et al. 1984). Spotted bass generally survive best in deep reservoirs with clear water and steep, rocky shorelines (Vogele 1975).

Spotted bass are better adapted to fluctuating reservoirs than other black bass species because their preferred spawning depths range from about 8 to 14 feet, which is deeper than the preferred spawning depths for largemouth and smallmouth bass (Moyle 2002, Aasen and Henry 1980). Nevertheless, large and rapid declines in water level may dewater spotted bass nests or increase their vulnerability to near-surface disturbances such as wave action and nest predation. Large increases in water level also may expose the nests to water temperatures so low as to cause males to abandon their nests and cease egg development.

*Largemouth Bass* Largemouth bass (*Micropterus salmoides*), native to the Mississippi River drainage and the southeastern United States, were first introduced into California in 1891 and have since spread to most suitable habitats in the State (Moyle 2002). They are normally found in warm, quiet waters with low turbidity and beds of aquatic plants. Largemouth bass provide an important sport fishery to many of the Central Valley reservoirs and are one of the most sought after warm-water sport fish in California. Largemouth bass, together with green sunfish (*Lepomis cyanellus*) and bluegill, were the first fish species planted in Millerton Lake when the reservoir was constructed in 1942 (Dill 1946). In the primary study area, largemouth bass essentially occur only in Millerton Lake, but their abundance is currently low (Mitchell 2006). The upper portion of Millerton Lake is a good spawning area for largemouth bass and other black bass fishes when the reservoir water level is high enough to inundate low-gradient shoreline habitat that borders the old river channel (Mitchell 2006).

Largemouth bass begin spawning in Millerton Lake in March and may spawn through June (Mitchell 1982). They typically build their nests on sand, gravel, or debris-littered substrates, often selecting sites next to logs or boulders that provide cover (Moyle 2002). Largemouth bass generally spawn at shallower depths than spotted bass, with most nests constructed between about 3 and 6 feet in depth. The larvae rise from the nest and begin exogenous feeding about 5 to 8 days after hatching (Emig 1966). The males guard the nests and newly hatched larvae from predators, including bluegill and threadfin shad (Mitchell 1982).

Largemouth bass typically inhabit clear, relatively shallow water, particularly in areas with abundant aquatic plants or other cover. In reservoirs, they tend to remain near shore in water 3 to 10 feet deep. Young-of-year bass usually swim in small schools, while larger fish tend to be solitary (Moyle 2002).

Largemouth bass are predators on fish, frogs, invertebrates, and other prey. Threadfin shad, sunfish, and crayfish are typical food items. The fry feed on zooplankton and switch to small insects and fish fry, including smaller bass fry, as they grow. Juveniles feed on crustaceans, aquatic insects, and fish (Moyle 2002).

Largemouth bass are warm-water fish, with optimal water temperatures for growth ranging from 77°F to 86°F (Moyle 2002). Juveniles prefer somewhat higher water temperatures than adults. During 1973, spawning by largemouth bass in Millerton Lake began when the water temperature reached 60°F and continued until it rose to about 76°F (Mitchell 1982). Incubation time for largemouth bass eggs is inversely related to water temperature, such that eggs hatch in about 6 days at 60°F and in about 2 days at 76°F (Jackson and Noble 2000). The time from hatching to dispersal of larvae from the nest may be similarly related to water temperature (Mitchell 1982). Growth of largemouth bass is reduced at DO levels below about 8 mg/L, and levels below 5 mg/L may produce stress (Stuber et al. 1982).

Threadfin shad and largemouth bass often have complex interactions in reservoirs. Threadfin shad are important prey of juvenile and adult largemouth bass, but are predators of largemouth bass eggs and fry. Threadfin shad also compete with largemouth bass fry for zooplankton. The relative timing of hatching for the two species potentially affects their relative success in reservoirs (Jackson and Noble 2000). The relationship between threadfin shad and largemouth bass in Millerton Lake is uncertain, but it is possible that the introduction of threadfin shad to the reservoir in 1959 has caused more harm than good to the largemouth bass population (Miller 1970).

The overall quality of largemouth bass fishing in most California reservoirs has declined since the reservoirs were constructed because of three main factors: overfishing, reservoir aging, and competition from threadfin shad and other plankton-feeding fishes (Von Geldern and Mitchell 1975). Largemouth bass are extremely vulnerable to angling, and at least half the population of legal-size fish are caught annually in many reservoirs. Over time, the catch rates and average size of the fish have declined. Reservoir aging reduces cover and forage fish, which reduces largemouth bass populations. Competition between young bass and other plankton-feeding fish, primarily threadfin shad, also reduces largemouth bass populations.

Large water-level fluctuations in many reservoirs inhibit production of largemouth bass populations. As previously noted for spotted bass, rapid declines in water level may dewater largemouth bass nests or increase their vulnerability to near-surface disturbances such as wave action and nest predation. Large increases in water level may also expose the nests to water temperatures so low as to cause males to abandon their nests and stop egg development.

*Smallmouth Bass* Smallmouth bass (*Micropterus dolomieui*) are native to the upper and middle Mississippi River drainage. They were first introduced into California in 1874 and have since been widely distributed throughout the State (Moyle 2002). They have become established in many reservoirs and are normally found in cool waters, often near the upstream end of the impoundments. They also concentrate in narrow bays or areas along shores where rocky shelves project under water (Moyle 2002). Smallmouth bass are a popular sport fish, but their value as a fishery is generally less important than those of largemouth or spotted bass. In the primary study area, smallmouth bass are primarily found in upper Millerton Lake and the San Joaquin River upstream from the reservoir (Wang 1986).

Spawning activity usually begins in spring when water temperatures reach 59°F to 61°F and ceases when temperatures reach about 78°F (Wang 1986, Cooke et al. 2003). Spawning behavior of smallmouth bass is generally similar to that of largemouth bass, except that they sometimes migrate from lakes and reservoirs a short distance up a stream to spawn. The male guards the nest until the eggs hatch, which occurs between 3 and 10 days, depending on water temperature. The male herds and guards the fry for an additional 1 to 3 weeks until the fry disperse into shallower water. Fluctuations in reservoir water levels often interfere with success of smallmouth bass nests, as previously discussed for largemouth bass and spotted bass nests.

Although smallmouth bass are typically found in cooler water than largemouth and spotted bass, optimum temperatures for growth and survival are similar, approximately 77°F to 81°F (Moyle 2002).

### *Millerton Lake Below RM 274*

**Aquatic Habitat** Millerton Lake, formed by Friant Dam, is the largest reservoir on the San Joaquin River. The lake is set in the lower foothills of the Sierra Nevada, is fairly open, and is mostly surrounded by low hills. Millerton Lake includes a relatively broad open portion of the reservoir near Friant Dam, and a long, narrow reach that grades upstream into the upper San Joaquin River. The reservoir facilities are part of the Friant Division of the CVP, and reservoir facilities operation substantially 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.

Inflow to Millerton Lake comes primarily from the upper San Joaquin River, and is largely influenced by the operation of several upstream hydropower generation projects. The reservoir typically fills during late spring and early summer when snowmelt in the watershed results in high San Joaquin River flows. Annual water allocations and release schedules are developed with the intent of drawing reservoir storage to minimum levels by the end of September. The reservoir has a maximum volume of 524 TAF and a maximum surface area of 4,905 acres at top of active storage. Median water level, simulated using current reservoir operating conditions based on 1922 through 2003 hydrology data, ranges from elevation 564 feet msl in late spring to elevation 497 feet msl in late summer. At the top of active storage, the reservoir has a maximum depth of 287 feet.

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 responsible for many fishery management issues such as limited cover habitat, limited littoral habitat, and shoreline erosion. Reservoirs in the Sierra Nevada operate to store water during winter and spring and release water in summer and fall into the Central Valley. Basin hydrology, and the pattern of storage and releases, results in highly variable seasonal availability of water from reservoirs in the upper San Joaquin River Basin. Under current reservoir operations, Millerton Lake water levels change by a foot or more per day almost 50 percent of days and change by 2 feet or more about 10 percent of days.

Because of the large changes in water levels and eroded soils, shoreline habitat in Millerton Lake is vegetated only in spring and early summer of wetter years, when the reservoir inundates terrestrial plants that have colonized nearshore environments. Arms of the reservoir that inundate mouths of tributary streams generally have the best protected shallow-water habitat in the reservoir. These tributaries include Fine Gold and Winchell creeks in the open, downstream portion of the reservoir, and Big Sandy Creek in the narrow, upstream portion.

Some modest attempts have been made to improve shallow-water habitat in Millerton Lake. These efforts include construction of shoreline subimpoundments in 1949 to allow continued inundation of bluegill nests that would otherwise be exposed when water levels in the reservoir dropped (Fisher 1950). In 1958, 50 brush shelters were suspended 5 to 10 feet below the surface in Winchell Cove, and in 1976 and 1977, bundles of willow cuttings were planted in several coves to stabilize shorelines and provide cover for fish (USFWS 1983). The brush shelters attracted fish, which made their capture easier, but no evidence exists that these or other efforts had any considerable effect on fish populations.

Most of Millerton Lake becomes thermally stratified during spring and summer and, therefore, potentially supports a two-stage fishery, with cold-water species residing in deeper water and warm-water species inhabiting surface waters and shallow areas near shore.

Selected water temperature and DO profiles from 2005, classified as a Wet year, indicate that the reservoir began stratifying in spring and varied little in water temperatures by late fall and winter (see the Physical Resources Appendix). A strong thermocline developed at approximately 25 feet deep in late March. The thermocline moved up about 10 feet during early summer and began moving down again in late summer and fall. Complete mixing of the water column likely occurs during winter. Most of the year, DO levels were high throughout the water column, but DO concentrations were less than 2.5 mg/L below 175 feet deep in November. November of the previous year had similarly low DO levels in the lower part of the water column. DO levels below 2.5 mg/L are stressful to most species of fish, but Millerton Lake fish could easily avoid this hypoxic water layer (i.e., low DO level), particularly because water temperatures throughout the water column are mild in November. Shallow shoreline areas, particularly in protected coves, likely 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 high.

**Fish Species** Most of the commonly occurring species in Millerton Lake are the same as the reservoir fishes described in the Temperance Flat Reservoir Area (including reservoir fish that spawn in riverine habitat as well as fully riverine fish species). Most of the native species have been extirpated from Millerton Lake in recent years (Mitchell 2006).

*Hitch* Hitch is a native minnow whose abundance has declined, and some San Joaquin River Basin populations have been extirpated (Moyle 2002). The species has no formal listing status. Hitch are widespread in warm, low-elevation lakes, sloughs, and slow-moving stretches of river, and in clear, low-gradient streams. Hitch have been found in Millerton Lake, but their current status in the reservoir is uncertain (Mitchell 2006).

Young hitch are often found in aquatic vegetation associated with run habitat, while older fish are found in pools. Hitch feed omnivorously, and include algae, zooplankton, and aquatic and terrestrial insects in their diet (Moyle 2002). In reservoirs, the adults are usually pelagic and migrate into the lower reaches of low-gradient tributary streams to spawn. Like most native cyprinids, hitch are weaker swimmers than salmonids and are more easily obstructed by migration barriers. Spawning occurs in fine- to medium-sized gravel bottoms that are swept clean by water movement, either from wave action or stream currents. They may also spawn in reservoirs.

Hitch mature in their second or third year, and spawn between March and July when water temperatures reach about 57°F to 64°F. Hitch eggs are demersal, absorbing water to help lodge them into the interstices of the gravel. Eggs hatch within 10 days, and larvae become free-swimming 10 days after hatching.

Habitat preferences for hitch include warm-water temperatures (about 80°F to 85°F) and slow water velocities, although they require somewhat higher flow velocities for spawning. They are omnivorous feeders, consuming algae, zooplankton, and insects (Moyle 2002).

*White Sturgeon* White sturgeon (*Acipenser transmontanus*), the largest freshwater or anadromous fish species in North America, can reach record sizes over 1,300 pounds. Historically, white sturgeon populations ranged from Alaska to Central California; however, the major spawning populations are now limited to the Fraser River (British Columbia, Canada), the Columbia River (Washington), and the Sacramento-San Joaquin River system. Habitat use varies among populations. Portions of populations are considered anadromous, using fresh, brackish, and marine waters during different phases of their life history. After construction of Friant Dam, some white sturgeon became landlocked in Millerton Lake. The status of these fish is unknown, but it is unlikely that the remnant population is spawning in the San Joaquin River, which means it is not a self-sustaining population.

## Extended Study Area

### *San Joaquin River from Friant Dam to Merced River*

**Aquatic Habitat** Aquatic habitat conditions vary spatially and temporally throughout the San Joaquin River between Friant Dam and the Merced River and in the flood bypasses in this area (collectively referred to as the Restoration Area in the SJRRP). This is because of differences in habitat availability and connectivity, water quantity and quality, channel morphology, and predation risks. Significant structures in the Restoration Area that are current impediments to both upstream and downstream fish movement are shown on Figure 5-1 and include the following:

- Seasonally deployed weir located at Hills Ferry (Hills Ferry Barrier) just upstream from the confluence with the Merced River that directs migrating adult salmonids into the Merced River and limits them from entering the San Joaquin River (the Hills Ferry Barrier has been operated by CDFW since 1992; however, through the SJRRP, adult Chinook salmon captured at the Hills Ferry Barrier are being transported upstream to just below Friant Dam)

- Drop structure on the Eastside Bypass near its confluence with the San Joaquin River (a drop structure is a manmade structure that passes water to a lower elevation while controlling the energy and velocity, often to prevent erosion impacts)

- Drop structure on the Mariposa Bypass near its confluence with the San Joaquin River
- San Joaquin River Headgate Structure at the Sand Slough Control Structure
- Sack Dam, a diversion dam for Arroyo Canal
- Mendota Dam, delivery point of the DMC and diversion point for several irrigation canals and pumps
- Radial gates and control structure on the Chowchilla Bypass Bifurcation Structure
- Friant Dam, primary storage dam on the San Joaquin River and upper limit of potential anadromous salmonid migration

Some of the above impediments are included as site-specific projects in the SJRRP for fish passage improvements. In addition to barriers, false migration pathways may impede fish movement in the Restoration Area. False migration pathways lead fish away from habitats that would support survival and growth. False pathways affect both upstream and downstream fish movement. During upstream movement, flow may attract fish into drains and bypasses that do not provide habitat because spawning substrate or cover, food availability, water temperatures, DO concentrations, salinity, and other environmental conditions are unsuitable.

Bypasses may not have environmental conditions that support movement of fish to downstream habitat, especially if flow entering the bypass becomes discontinuous and fish are stranded. Canals generally do not provide habitat that can sustain populations of most fish species, and frequently end in irrigated agricultural fields. Potential false pathways created by the bypass and canal systems are Salt Slough, Mud Slough, Bear Creek, Ash Slough, Berenda Slough, Dry Creek, Fresno River, Lone Willow Slough, Mariposa Bypass, Eastside Bypass, Arroyo Canal, Main Canal, other canals, and Little Dry Creek. Gravel mining ponds downstream from Friant Dam may also be minor false pathways that can confuse downstream and upstream migrating fish and delay migration.

Most aquatic habitat in the bypasses is temporary, and its duration depends on the frequency and magnitude of flood flows. The bypasses are largely devoid of aquatic and riparian habitat because of hydraulic conveyance maintenance efforts that involve vegetative clearing (McBain & Trush 2002). Portions of the Eastside Bypass near Merced National Wildlife Refuge (NWR) are reportedly wet year-round, but it is unknown whether these areas support fish. Although the bypasses provide very little perennial aquatic habitat, fish and other aquatic species may be present in the bypasses during wet conditions, including high-flow periods when a portion of the San Joaquin River flow is routed into the bypass system.

The San Joaquin River within the Restoration Area has been broken down into five distinct reaches:

- **Reach 1** – Friant Dam to Gravelly Ford
- **Reach 2** – Gravelly Ford Mendota Dam
- **Reach 3** – Mendota Dam to Sack Dam
- **Reach 4** – Sack Dam to the Sand Slough Control Structure
- **Reach 5** – Sand Slough Control Structure to the Merced River confluence

These reaches are shown in Figure 5-1.

Figure 5-1. San Joaquin River Reaches and Flood Bypass System in Restoration Area

Many changes have occurred to channel morphology in the Restoration Area over the last century, producing the conditions found there today. The most pronounced changes are as follows.

- **Reach 1** – In-channel and floodplain pits and exposed gravel bars and floodplains created by instream gravel mining in Reach 1 have impeded coarse sediment routing, reduced native fish habitat, increased river water temperatures, and increased habitat for nonnative species. As has been demonstrated on the Tuolumne River, these pits, which converted stream habitat to more pond-type habitat, provide habitat conducive to nonnative predatory fish species such as largemouth and smallmouth bass (EA Engineering 1991). In addition, in Reach 1, riparian encroachment has occurred, channels have been incised, mobilization of bed material is less frequent, and filling of gravel interstices with fine sediment has likely occurred.

- **Reaches 2 through 5** – Habitat conditions for fish in Reaches 2 through 5 have been substantially modified by levee/dike construction, agricultural encroachment, and water diversions. These changes have reduced the quantity of floodplain habitat, as well as reducing main channel habitat complexity and the quantity and quality of off-channel habitat in these reaches. Much of this floodplain habitat has been isolated from the river by dikes and levees, and the remaining floodplain habitat is rarely inundated under current hydrologic conditions.

**Fish** Fish assemblages currently found in the San Joaquin River are the result of substantial changes to the physical environment, combined with more than a century of nonnative species introductions, both accidental and intentional. Areas where unique and highly endemic fish assemblages once occurred are now inhabited by assemblages composed primarily of introduced species. The San Joaquin River provides a migratory corridor for salmonids to its major tributary rivers, the Stanislaus, the Tuolumne, and the Merced rivers.

The San Joaquin River from the end of Reach 1 to the Merced River confluence currently does not support spawning anadromous salmonids; however, with the ongoing implementation of the Settlement, self-sustaining populations of spring-run Chinook salmon and steelhead are expected to be reestablished. The estimated time frame for reintroduction is as follows: (1) a Reintroduction Period between the present and December 31, 2019; (2) an Interim Period between January 1, 2020, and December 31, 2024; (3) a Growth Population Period between January 1, 2025, and December 31, 2040; and (4) a Long-term Period beyond January 1, 2041.

Of the approximately 21 native fish species historically present in the San Joaquin River, at least eight are now uncommon, rare, or extinct, and an entire native fish assemblage (e.g., Sacramento splittail (*Pogonichthys macrolepidotus*), Sacramento blackfish) has been largely replaced by nonnative warm-water fish species (e.g., catfish) (Moyle 2002). Warm-water fish assemblages, comprising many nonnative species such as black bass species and sunfish species, appear better adapted to current, disturbed habitat conditions than native assemblages. However, habitat conditions in Reach 1 (slightly higher gradient, cooler water temperatures, and higher water velocities) seem to have restricted many introduced species from colonizing. The occurrence of fish species within the Restoration Area is described below by reach.

*Reach 1* Studies conducted from 2003 through 2005 by CDFW and Reclamation inventoried recent fish distributions in the Restoration Area (DFG 2007). Native fish species captured in Reach 1A included rainbow trout, Sacramento sucker, threespine stickleback (*Gasterosteus aculeatus*), lamprey species, sculpin species, and Sacramento pikeminnow (DFG 2007). No native fish species were captured in Reach 1B during the CDFW/Reclamation inventory. Although these species were not detected in Reach 1 from 2003 through 2005, earlier investigations report occurrence in Reach 1 of riffle sculpin (Brown and Moyle 1993), prickly sculpin (*Cottus asper*) (Saiki 1984, Brown and Moyle 1993, Moyle 2002), hardhead (Saiki 1984, Brown and Moyle 1993), tule perch (*Hysterocarpus traski*) (Saiki 1984, Brown and Moyle 1993, Moyle 2002), and fall-run Chinook salmon (Yoshiyama et al. 1998, Moyle 2002).

The following introduced fish species were captured in Reach 1A: green sunfish, western mosquitofish (*Gambusia affinis*), largemouth bass, redear sunfish (*Lepomis microlophus*), brown bullhead (*Ameiurus nebulosus*), black crappie (*Pomoxis nigromaculatus*), bluegill, channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), golden shiner (*Notemigonus crysoleucas*), kokanee (*Oncorhynchus nerka*), and spotted bass. The introduced fish species captured in Reach 1B were bluegill, green sunfish, redear sunfish, and spotted bass (DFG 2007).

Chinook salmon are currently being introduced in this reach through implementation of the SJRRP. Adult fall-run Chinook salmon are captured at the Hills Ferry Barrier and transported upstream to just below Friant Dam. Additionally, juveniles are brought in from the Feather River hatchery and tagged to monitor their movements. In 2011, 596 Chinook were released below Friant Dam (RM 266) and 631 were released at San Mateo Crossing (RM 211). A subsample of these fish (192) was tagged, and 71 of the tagged fish were later detected at the lower end of the Restoration Area (Reclamation 2011). These fish may come back as adults in later years; however, there is currently no self-sustaining population of Chinook salmon in the San Joaquin River upstream from the Merced River confluence. A Chinook salmon hatchery below Friant Dam to support a self-sustaining population is scheduled to be constructed during 2015 to enable the facility to be on-line by fall 2015. It is anticipated that the first hatchery year of Chinook salmon will be delivered to the San Joaquin River by 2016 (Reclamation 2013a).

*Reach 2* In general, species diversity increases downstream, while species composition shifts from native species to nonnative species (DFG 2007). Historically, much of Reach 2 was typically dry; thus, fish populations were confined to the upper part of Reach 2 upstream from Gravelly Ford, and to Mendota Pool in the lower part of Reach 2, with restricted fish migration between these habitats. All native species known to occur historically in Reach 1 were also known to persist in Reaches 2 through 5, with the exception of rainbow trout and perhaps riffle sculpin. The current nonnative species composition in Reach 2 is the same as that in Reach 1, with the addition of white crappie (*Pomoxis annularis*), threadfin shad, fathead minnow (*Pimephales promelas*), white catfish (*Ameiurus catus*), and striped bass (Saiki 1984, Moyle 2002, DFG 2007).

*Reach 3* Recent accounts document the presence in Reach 3 of the following native fish species: prickly sculpin, hitch, Sacramento blackfish, and tule perch (Saiki 1984, Brown and Moyle 1993, Moyle 2002, DFG 2007). Nonnative fish species present in Reach 3 include all of those documented in Reaches 1 and 2, as well as inland silverside (*Menidia beryllina*) and red shiner (*Cyprinella lutrensis*) (Saiki 1984, Brown and Moyle 1993, Moyle 2002, DFG 2007).

*Reach 4* Historically Reach 4 was dry much of the time, and only a single fish species (inland silverside) has been documented in this reach in the past 25 years (Saiki 1984, DFG 2007).

*Reach 5* Native species recently documented in Reach 5 include Sacramento sucker, prickly sculpin, hitch, Sacramento blackfish, Sacramento pikeminnow, Sacramento splittail, and tule perch. All nonnative species present upstream from Reach 5 are also present in this reach. Pumpkinseed (*Lepomis gibbosus*) and spotted bass have also been detected recently in Reach 5 (Saiki 1984, Brown and Moyle 1993, Moyle 2002, DFG 2007).

The current distributions of white sturgeon, green sturgeon, river lamprey (*Lampetra ayresii*), Kern brook lamprey, and western brook lamprey (*L. richardsoni*) within the Restoration Area are unknown.

*Bypass System* The occurrence of fish in the bypasses depends on the routing of flood flows through the bypass system. When water is present, fish of all life stages may enter the bypasses from upstream diversion points such as the Chowchilla Bypass Bifurcation Structure and Sand Slough Control Structure. Information on fish species that may use temporary aquatic habitat in the bypasses is not available. However, it is assumed that any species present near the diversion points could be routed into the bypasses along with flood flows.

#### *San Joaquin River from Merced River to the Delta*

Aquatic habitat and fish presently found in the San Joaquin River from the confluence with the Merced River to the Delta are discussed below.

**Aquatic Habitat** The San Joaquin River downstream from Reach 5 has a physical habitat and water quality conditions similar to those found in Reach 5, with increased flows provided by major tributaries, including the Merced, Tuolumne, Stanislaus, and Calaveras rivers. Water management in the San Joaquin River focuses on diversion of water out of streams and rivers into canals for agricultural use, with some of the applied water returned as agricultural drainage (Brown and May 2006). Flood control levees closely border much of the river but are set back in places, creating some off-channel aquatic habitat areas when inundated.

**Fish** Fish species presently inhabiting the San Joaquin River from the confluence with the Merced River to the Delta, including anadromous salmonids, other native species, and nonnative species, are discussed in the following sections.

*Anadromous Salmonids* Currently, the San Joaquin River downstream from the Merced River confluence provides transitory habitat for migrating fall-run Chinook salmon and steelhead, both as adults and juveniles, as they move upstream to tributaries, or downstream toward the Delta. Both fall-run Chinook salmon and steelhead spawn and rear in the Merced, Tuolumne and Stanislaus rivers. Their life stage timing is shown in Table 5-2.

## Table 5-2. Temporal Occurrence of Each Life Stage of Fall-Run Chinook Salmon and Steelhead in the San Joaquin River and Major Tributaries (Merced, Tuolumne, and Stanislaus Rivers)

| **Life Stage** | **Month** | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | | **Feb** | | **Mar** | | **Apr** | | **May** | | **Jun** | | **Jul** | | **Aug** | | **Sep** | | **Oct** | | **Nov** | | **Dec** | |
| **Chinook Salmon (Fall-Run)** | | | | | | | | | | | | | | | | | | | | | | | | |
| Adult migration | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ |
| Spawning | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ▒ | ■ | ■ | ▒ | ▒ |
| Incubation and emergence | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Juvenile rearing | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ |
| Juvenile migration | ▒ | ▒ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ |
| **Chinook Salmon (Spring-Run)** | | | | | | | | | | | | | | | | | | | | | | | | |
| Adult migration | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ |
| Spawning | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ■ | ■ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ |
| Incubation and emergence | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Juvenile rearing | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Juvenile migration | ▒ | ▒ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ |
| **Steelhead** | | | | | | | | | | | | | | | | | | | | | | | | |
| Adult migration | ■ | ■ | ■ | ■ | ■ | ■ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ | ▒ | ▒ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Spawning | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ▒ | ▒ | ▒ | ■ | ■ |
| Incubation and emergence | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ▒ |
| Juvenile rearing | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Juvenile migration | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ⬜ | ▒ | ▒ |

*Source: SJRRP 2012*

KEY:

| | |
|---|---|
| ⬜ | No presence |
| ▒ | Some presence |
| ■ | Peak presence |

*Native Fish Species* Brown and May (2006) summarized presence/absence of fish species in the San Joaquin River downstream from the Merced River confluence using spring seining data collected from 1994 through 2002 by the Interagency Ecological Program (IEP) and by the Turlock and Modesto irrigation districts (ID). Native species present in the San Joaquin River included Sacramento sucker, Sacramento pikeminnow, Sacramento splittail, tule perch, prickly sculpin, Sacramento blackfish, and hardhead (Brown and May 2006). Splittail are listed as a California State species of special concern largely because of the reduction in valley floor habitat once occupied by this species. Splittail move into the mainstem San Joaquin River during Wet years, but today are mostly resident in the Delta and San Francisco Estuary (Moyle 2002). Hardhead are also listed as a California State species of special concern primarily because of their reduced numbers and increasingly isolated populations throughout California streams. Historical records indicate that they were once present in most streams in the San Joaquin drainage but today a number of the populations have disappeared (Brown and Moyle 1993). Additionally, fall-run Chinook salmon, steelhead, California roach (*Hesperoleucus symmetricus*), threespine stickleback, lamprey, and hitch are also known to occur. The fall-run Chinook salmon population is supported in part by hatchery stock in the Merced River. In addition, California roach, threespine stickleback, lamprey, and hitch are likely inhabitants of this portion of the river, although they were not detected during the springtime monitoring efforts summarized by Brown and May (2006). Each of these native species is also present in the Restoration Area.

Moyle and Light (1996) suggested that nonnative piscivorous (fish-eating) fish are most likely to alter fish assemblages. Largemouth bass are documented predators of outmigrating juvenile anadromous salmonids (Turlock ID/Modesto ID 1992). They may also play the role of keystone predator (i.e., species that may increase biodiversity by preventing any one species from becoming dominant) in many aquatic environments because of broad environmental tolerances and their ability to forage on a wide variety of prey under many conditions. Smallmouth bass may primarily affect hardhead through competition for food resources, and may prey on juvenile cyprinids. Striped bass may be an important predator on immature life stages of river lamprey and Sacramento splittail. Inland silversides may feed on eggs and larvae of Sacramento splittail and other fish species in floodplain spawning areas. Native species expected to be the most sensitive to predation by nonnative predators include juvenile hardhead and Sacramento splittail.

Changes in predator success due to increased abundance and vulnerability of prey may occur at newly constructed or altered diversion intakes or passage structures. Many predatory fish may be more successful at locations where prey fish are artificially concentrated or stressed, such as at dams or salvage and hatchery release sites (Buchanan et al. 1981, Pickard et al. 1982). High predation rates are known to occur below small dams, such as the Sack Dam in the Restoration Area. As they pass over small dams, fish are subject to conditions that may disorient them, making them highly susceptible to predation by fish or birds. In addition, deep-pool habitats tend to form immediately downstream from such dams, creating conditions that promote congregation of Sacramento pikeminnow, striped bass, and other predators. For example, Tucker et al. (1998) showed high rates of predation by Sacramento pikeminnow and striped bass on juvenile salmon immediately below the Red Bluff Diversion Dam.

Vegetation or other cover may provide optimal habitat for vulnerable fish life stages while reducing capture rates of predators. Aquatic vegetative cover as low as 15 percent has been reported to limit largemouth bass foraging success in experimental trials (Savino and Stein 1982).

*Nonnative Fish Species* Nonnative fish reported in the San Joaquin River between the Merced River confluence and the Delta include red shiner, inland silverside, threadfin shad, western mosquitofish, fathead minnow, black bass species, bigscale logperch (*Percina macrolepida*), bluegill, white crappie, striped bass, redear sunfish, common carp, goldfish, black bullhead (*Ameiurus melas*), channel catfish, and green sunfish (Brown and May 2006). Golden shiner, black crappie, white catfish, and warmouth (*Lepomis gulosus*) are also likely in the main stem San Joaquin River downstream from the Merced River confluence.

### San Joaquin River Tributaries

Aquatic habitat and fish presently found in the three main San Joaquin River tributaries, the Merced, Tuolumne, and Stanislaus rivers, are discussed below.

**Aquatic Habitat** The Merced River is accessible to anadromous fish for the first 51 river miles upstream from the San Joaquin River confluence, with access terminating at

Crocker-Huffman Dam (USFWS 2001). Most spawning occurs within a few miles of the dam. Aquatic habitats in the Tuolumne River downstream from LaGrange Dam are influenced by several factors, many of them related to former gold mining activities and gravel mining (McBain & Trush 2000). In the Stanislaus River, fall-run Chinook salmon spawn in a 23-mile stretch of the Stanislaus downstream from Goodwin Dam, but most spawning occurs in the first 10 miles below the dam.

**Fish** Fall-run Chinook salmon inhabit the Merced, Tuolumne, and Stanislaus rivers, supported in part by hatchery stock in the Merced River. The average annual spawning escapement (1952 through 2013) for the three major San Joaquin River tributaries was an estimated 13,400 adults (river and hatchery combined) (CDFW 2014a). Since 1952, fall-run Chinook salmon populations in the San Joaquin River Basin have fluctuated widely, with a distinct periodicity that generally corresponds to periods of drought and wet conditions. In 2007, Chinook salmon experienced a population decline that occurred throughout the Central Valley, presumably unrelated to drought, with a near-record low escapement in 2007; however, numbers have been increasing since 2010 (CDFW 2014a). There are indications that there may be small populations of spring-run Chinook salmon in the Tuolumne and Stanislaus rivers based on adult and juvenile field data (Franks 2012). Some of the juveniles may rear year-round. Steelhead are still present in low numbers in the Tuolumne, Stanislaus, and possibly the Merced river systems below the major dams (McEwan 2001, Zimmerman et al. 2008), but escapement estimates are not available.

### *Sacramento–San Joaquin Delta*

The aquatic habitat and fish presently found in the Delta are discussed below.

**Aquatic Habitat** The historical Delta consisted of low-lying islands and marshes that flooded during high spring flows. More than 95 percent of the original tidal marshes have been leveed and filled for agriculture and other uses, resulting in substantial loss of important shallow-water aquatic habitat (USGS 2007). The current Delta consists of islands, generally below sea level, surrounded by levees to keep out water. Inflow of freshwater into the Delta has been substantially reduced by upstream water diversions, mostly to support agriculture. Dredging and other physical changes have altered water flow patterns and salinity (USGS 2007). Numerous nonnative species are changing the Delta's ecology by altering its food webs (Grimaldo et al. 2009a). All of these changes have had substantial effects on the Delta's biological resources, including marked declines in the abundance of many native fish and invertebrate species (Greiner et al. 2007).

Delta flow refers to the timing, volume, and direction of water flowing through the Delta. The natural Delta flow patterns have been radically altered by dredging, construction of levees, storage reservoirs, and major diversions both upstream from and within the Delta (Kimmerer 2004). Current unnatural flow patterns change fish distributions and exacerbate low survival, especially in the central and south Delta. For example, the Jones and Banks pumping plants diversions in the south Delta export such large volumes of water at times that the tidally averaged flow of water in channels leading away from the pumps is often upstream (i.e., reversed). These reverse flows interfere with the natural downstream migrations from the south Delta of young fish of several important Delta species, including delta smelt, longfin smelt (*Spirinchus thaleichthyes*), Chinook salmon, and striped bass (Monsen et al. 2007, Kimmerer 2004). In addition, these reverse flows may increase fish salvage (Grimaldo et al. 2009b) and entrainment mortality (Kimmerer 2008) at the CVP and SWP export facilities in the south Delta, or prolong fish residence in the south Delta, which may have harmful indirect consequences resulting from increased predation, poor water quality, degraded physical habitat, and other factors (Feyrer and Healey 2003).

Delta outflow establishes the location in the Delta of the low salinity zone (LSZ), an area that historically has had high prey densities and other favorable habitat conditions for rearing juvenile delta smelt, striped bass, and other fish species (Kimmerer 2004). The LSZ is often referenced by X2, which is the distance upstream, in kilometers (km), from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand (ppt). X2 is largely determined by Delta outflow (Kimmerer 2004). The best combination of habitat factors is believed to occur when X2 is located downstream from the confluence of the Sacramento and San Joaquin rivers. When Delta outflow is low, X2 is located in the relatively narrow channel of these rivers, and at higher outflows, it moves downstream into more open waters.

The Jones and Banks pumping plants in the south Delta entrain millions of fish each year, most of which are nonnative fishes (Reclamation 2008). Fish screens at the facilities are used to salvage fish greater than a certain size (around 20 millimeters), but many of the salvaged fish are assumed not to survive their return to the Delta (Kimmerer 2004). The loss of fish at the facilities has been shown to contribute to recent declines of delta smelt (Kimmerer 2008). Other species are also affected by direct losses from entrainment or salvage-related mortality at these CVP and SWP facilities.

The Delta has large regional variations in habitat quality and quantity. For most fish species, habitat quality in the south Delta is believed to be poor (Feyrer 2004, Feyrer and Healey 2003, Feyrer et al. 2007, Monsen et al. 2007). Nobriga et al. (2008) showed that very low summer abundances of delta smelt in the south Delta are related to significantly higher water temperatures and water clarity in the south Delta than other areas of the Delta. Increased water clarity may increase predation risks and reduce feeding success of planktivorous fish such as delta smelt. Entrainment risk is much higher in the south Delta because of the large volumes of water exported by the Jones and Banks pumping plants (Kimmerer 2008). In experimental releases, survival of fall-run Chinook salmon smolts migrating from the San Joaquin River was lower for smolts moving through the Delta via the channels south of the San Joaquin River than for those remaining in the river channel (SJRGA 2001 through 2009, Brandes and McLain 2001). Because of these risks, hydrodynamic flow patterns that transport fish larvae into the south Delta or increase residence time of fish there are likely to adversely affect the populations.

San Joaquin River inflow and diversion rates at the Jones and Banks pumping plants strongly affect net flow patterns in the San Joaquin River side of the Delta, thereby influencing how fish are distributed with respect to the south Delta, and how long the fish remain there (NMFS 2009, Kimmerer and Nobriga 2008, Monsen et al. 2007, Feyrer and Healey 2003, Mesick 2001). The Delta is a tidal system, and water naturally flows upstream with the incoming tide. However, diversions at the Jones and Banks pumping plants can export such large volumes that the pumping changes the balance to a net upstream flow more frequently than under natural conditions, such as at Old and Middle rivers (USFWS 2008, Monsen et al. 2007). San Joaquin River inflow and reverse Old and Middle river flows generally have counteracting effects on the distribution of fish: (1) higher inflows tend to move fish larvae away from the south Delta and reduce passage time of smolts emigrating from the San Joaquin River, and (2) higher reverse flows tend to move fish toward the south Delta (NMFS 2009, USFWS 2008, Kimmerer and Nobriga 2008). These flows are also likely to indirectly affect upstream migrating adult fish, with high reverse flows leading to increased straying away from the main channel of the San Joaquin River toward the south Delta (USFWS 2008, Kimmerer and Nobriga 2008, Mesick 2001).

Delta flow patterns affect migration of adult salmonids to upstream spawning areas and tributaries as well as juvenile outmigration. River discharge is an important migration cue for adult salmonids attempting to enter their natal streams to spawn, and increases in discharge may improve water quality and habitat conditions in the Delta. Low DO concentrations may cause delays in the onset of upstream migration until later in the fall when DO concentrations improve (Hallock et al. 1970).

Increased water temperature in the Delta could adversely affect cold-water fish species, including Central Valley fall-run Chinook salmon, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley steelhead, and other special-status species that use the Delta, including white and green sturgeon, longfin smelt, and delta smelt. The San Joaquin side of the Delta (south Delta) currently often has poor water temperature conditions for the special-status fish species, especially during late summer and early fall (Nobriga et al. 2008, Feyrer 2004, Kimmerer 2004). DO levels in the San Joaquin River near the Stockton Deep Water Ship Channel are often low during late summer and early fall because of high water temperatures, algal biomass, and low river flow (Giovannini 2005, Lee and Jones-Lee 2003). Water temperatures are especially important for Chinook salmon and steelhead adults that migrate upstream in the San Joaquin River beginning in late summer and smolts that migrate downstream through the Delta in spring because these fish have lower temperature tolerances than other Delta fish species. Low DO levels may interfere with upstream migrations of adult fall-run Chinook salmon.

**Fish** The Delta contains freshwater fishes (e.g., hitch, Sacramento blackfish, pikeminnow), endemic fish that live nowhere else (e.g., delta smelt), anadromous fishes that spend part of their life cycle there (e.g., white sturgeon, Chinook salmon, steelhead, longfin smelt, Pacific lamprey), adult marine fishes and those that spend juvenile stages there (e.g., staghorn sculpin [*Leptocottus armatus*] and starry flounder [*Platichthys stellatus*]), and freshwater species that can tolerate high salinities (e.g., Sacramento perch, tule perch, Sacramento splittail, prickly sculpin) (Moyle 2002). The Delta also contains a large number of introduced species, including striped bass, largemouth bass, white catfish, and inland silverside.

Over the last decade, abundances of pelagic fishes in the Delta have markedly declined (Sommer et al. 2007). The abundance indices for 2007 through 2013 include record lows for delta smelt, longfin smelt, striped bass, American shad, and threadfin shad (CDFW 2014b). The Delta has become a suboptimal environment for native fishes because of diversions, pollution, physical modifications, and exotic species invasions (Moyle 2002). Introduced species have the potential to greatly alter the Delta ecosystem and threaten native species through competition for resources, direct predation, complex food web effects, hybridization, habitat interference, and the spread of new diseases (Moyle 2002). Losses of salmonids associated with CVP and SWP diversions from the south Delta result from a variety of mortality factors, including entrainment at the CVP and SWP pumps near Tracy, predation in pump forebays, predation within south Delta channels, and fish salvage operations at the pumping facilities.

### *CVP and SWP Water Service Areas*

No fisheries resources in the CVP and SWP water service areas would be affected by the project, so this region is not discussed further in this chapter.

## Environmental Consequences and Mitigation Measures

This section discusses environmental consequences on aquatic resources associated with implementation of the alternatives. It also describes potential mitigation measures associated with impacts on aquatic resources that are significant or potentially significant. The potential direct and indirect impacts to aquatic resources and associated mitigation measures are summarized in Table 5-3.

## Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-1: Loss of Riverine Habitat for Lotic Fish Species | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | S | None Available | SU |
| | | Alternative Plan 2 | S | | SU |
| | | Alternative Plan 3 | S | | SU |
| | | Alternative Plan 4 | S | | SU |
| | | Alternative Plan 5 | S | | SU |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| FSH-2: Short-term Degradation of Aquatic Habitat from Accidental Spills or Seepage of Hazardous Materials during Construction of Temperance Flat RM 274 Dam and Other Facilities | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| FSH-3: Short-term Degradation of Aquatic Habitat from Increased Turbidity or Sedimentation during Construction of Temperance Flat RM 274 Dam and Other Facilities | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |

## Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-4: Loss of Reservoir Fish Habitat Resulting from Changes in Water Temperature | Primary Study Area | No Action Alternative | LTS | None Required | LTS |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| FSH-5: Changes to Reservoir Fish Habitat Caused by Turbidity from Increased Surface Area of Exposed Shoreline | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |

**Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)**

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-6: Loss of Reservoir Fish Caused by Entrainment | Primary Study Area | No Action Alternative | LTS | None Required | LTS |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| FSH-7: Change in Shallow-Water Habitat for Largemouth Bass, Spotted Bass, Smallmouth Bass, and Other Sport Fish Species | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | Beneficial | | Beneficial |
| | | Alternative Plan 2 | Beneficial | | Beneficial |
| | | Alternative Plan 3 | Beneficial | | Beneficial |
| | | Alternative Plan 4 | Beneficial | | Beneficial |
| | | Alternative Plan 5 | Beneficial | | Beneficial |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |

## Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-8: Change in Open-Water Habitat for Striped Bass and American Shad | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | Beneficial | | Beneficial |
| | | Alternative Plan 2 | Beneficial | | Beneficial |
| | | Alternative Plan 3 | Beneficial | | Beneficial |
| | | Alternative Plan 4 | Beneficial | | Beneficial |
| | | Alternative Plan 5 | Beneficial | | Beneficial |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| FSH-9: Loss of Spawning Habitat of American Shad and Striped Bass | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | S | None Available | SU |
| | | Alternative Plan 2 | S | | SU |
| | | Alternative Plan 3 | S | | SU |
| | | Alternative Plan 4 | S | | SU |
| | | Alternative Plan 5 | S | | SU |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |

## Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-10: Change in Habitat Potential for Spring-Run Chinook Salmon | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | Beneficial | None Required | Beneficial |
| | | Alternative Plan 1 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 2 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 3 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 4 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 5 | PS | None Available | PSU |
| FSH-11: Change in Water Temperature Conditions Supporting Juvenile Salmon and Steelhead Migration | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | LTS | None Required | LTS |
| | | Alternative Plan 1 | S | None Available | SU |
| | | Alternative Plan 2 | S | | SU |
| | | Alternative Plan 3 | S | | SU |
| | | Alternative Plan 4 | S | | SU |
| | | Alternative Plan 5 | S | | SU |

## Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-12: Change to Habitat for Moderately Tolerant Native Fish Species from Altered Water Temperatures | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | LTS | None Required | LTS |
| | | Alternative Plan 1 | LTS and Beneficial | None Required | LTS and Beneficial |
| | | Alternative Plan 2 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 3 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 4 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 5 | LTS and Beneficial | | LTS and Beneficial |
| FSH-13: Changes to Habitat for Highly Tolerant Native Fish Species from Altered Water Temperatures | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | LTS | None Required | LTS |
| | | Alternative Plan 1 | LTS | None Required | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |

**Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)**

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-14: Changes to Spawning and Rearing Habitat from Changes to Flood Pulses and Floodplain Connectivity | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | PS and Beneficial | None Required | PSU and Beneficial |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| FSH-15: Change in Fish Habitat and Migratory Behaviors from Changes in Water Temperatures | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |

## Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-16: Change in Fish Habitat and Migratory Behaviors from Changes in Flows | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | LTS and Beneficial | None Required | LTS and Beneficial |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| FSH-17: Loss of Fish Habitat from Changes in Tributary Flows | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | LTS | None Required | LTS |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |

**Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)**

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-18: Effects on Delta Fish Habitat from Changes in Water Temperatures and Dissolved Oxygen Concentrations | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | PS | None Available | PSU |
| | | Alternative Plan 1 | PS | | PSU |
| | | Alternative Plan 2 | PS | | PSU |
| | | Alternative Plan 3 | PS | | PSU |
| | | Alternative Plan 4 | PS | | PSU |
| | | Alternative Plan 5 | PS | | PSU |
| FSH-19: Loss of Suitable Fish Habitat from Salinity Changes in the Delta | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | LTS | None Required | LTS |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |

### Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-20: Loss of Suitable Fish Habitat from Change in Flow Patterns in the South Delta | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | LTS | None Required | LTS |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |
| FSH-21: Reduction in Fish Abundance from Changes in Exports and Entrainment in the South Delta | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | PS | None Required | PSU |
| | | Alternative Plan 1 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 2 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 3 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 4 | LTS and Beneficial | | LTS and Beneficial |
| | | Alternative Plan 5 | LTS and Beneficial | | LTS and Beneficial |

## Table 5-3. Summary of Impacts and Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

| Impact | Study Area | Alternative | Level of Significance Before Mitigation | Mitigation Measure | Level of Significance After Mitigation |
|---|---|---|---|---|---|
| FSH-22: Loss of Suitable Fish Habitat Resulting from Changes in X2 | Primary Study Area | No Action Alternative | NI | None Required | NI |
| | | Alternative Plan 1 | NI | | NI |
| | | Alternative Plan 2 | NI | | NI |
| | | Alternative Plan 3 | NI | | NI |
| | | Alternative Plan 4 | NI | | NI |
| | | Alternative Plan 5 | NI | | NI |
| | Extended Study Area | No Action Alternative | PS | None Required | PSU |
| | | Alternative Plan 1 | LTS | | LTS |
| | | Alternative Plan 2 | LTS | | LTS |
| | | Alternative Plan 3 | LTS | | LTS |
| | | Alternative Plan 4 | LTS | | LTS |
| | | Alternative Plan 5 | LTS | | LTS |

Key:
LTS = less than significant
NI = no impact
PS = potentially significant
PSU = potentially significant and unavoidable
S = significant
SU = significant and unavoidable

### Methods and Assumptions

Impacts were evaluated based on the temporal and spatial presence of fish life stages (e.g., spawning adult, egg, juvenile). The methods used varied by geographic area, species, life stage, environmental conditions, and impact mechanism, and depended largely on the amount of available information. An important consideration in evaluating the potential impacts of the alternatives on fish species was that fish life stages vary greatly in their vulnerability to change in environmental conditions. Therefore, impacts were evaluated with respect to the life-cycle timing and spatial distribution of each life stage.

The impact assessment for fisheries is divided into six geographic areas:

- San Joaquin River upstream from Millerton Lake
- Millerton Lake and Temperance Flat RM 274 Reservoir
- San Joaquin River – Friant Dam to Merced River
- San Joaquin River – Merced River to the Delta
- San Joaquin River tributaries (Merced, Tuolumne, and Stanislaus rivers)
- Delta

Each geographic area includes a unique combination of existing representative species and environmental conditions. The following discussion provides an overview of representative species and environmental conditions, followed by a description of the specific methods that were used within each geographic area. As stated previously, there would be no impacts to aquatic resources in the CVP and SWP water service areas so this geographic area is not discussed further.

Three general categories of environmental conditions were used in this impact assessment: (1) water temperature and water quality, (2) physical processes/conditions, and (3) biological interactions. Each category consists of multiple environmental factors that can affect the aquatic ecosystem, and can result in direct and/or indirect impacts on the representative fish species and other fishes.

Impacts are described using three comparisons; the No Action Alternative to existing conditions: action alternatives to No

Action Alternative; and action alternatives to existing conditions.

### *San Joaquin River Upstream from Millerton Lake*

Effects of the alternatives on lotic (i.e., riverine or stream) habitat were evaluated by calculating the amount of stream habitat under current maximum reservoir storage conditions and how much stream habitat would be inundated at maximum reservoir storage conditions under each alternative. These physical effects were expressed as lengths of stream habitat lost from estimated reservoir inundation.

Streambed gradient (i.e., stream slopes) of all lotic reaches was estimated from contour maps and digital elevation models. Length of stream habitat with slopes less than and greater than 3 percent was estimated. The results generated for the length of stream under each gradient category are approximations and are meant to only be used for comparing alternatives.

Species evaluations for the alternatives relative to lotic habitat were considered with regard to their effects on important habitat elements of the evaluated species and their life-stage requirements. The length of useable stream habitat affected for each of the lotic species was calculated.

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 always a barrier to hardhead or to the Kern brook lamprey, the fishes are not likely present on a regular basis in higher gradient habitats, so the higher gradient reaches 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 the stream gradient is less than 3 percent in Big Sandy Creek. Kern brook lamprey were assumed to occur only in the San Joaquin River.

For the stream resident species, stream habitat was segregated by gradient into useable and not useable habitat. Useable habitat was defined as the principal habitat of a species. Habitat with a greater than 3 percent gradient was considered not useable by Kern brook lamprey, hardhead, Sacramento sucker, and Sacramento pikeminnow. All stream habitat was considered useable by rainbow trout. Useable habitat of each of the streams was allocated to the fish species based on known or potential presence of the species in that stream. Rainbow trout, hardhead, and Kern brook lamprey were all considered residents of the San Joaquin River. The effects of the alternative on each of the fish species was assessed by determining the length of useable habitat in streams potentially inhabited by the species that would be inundated by the predicted change in reservoir elevation.

#### *Millerton Lake and Temperance Flat RM 274 Reservoir*

The effects of the alternatives on Millerton Lake fish were evaluated by identifying expected environmental changes caused by the alternatives, and evaluating impacts of these changes on five key Millerton Lake sport fish species—largemouth, spotted, smallmouth, and striped bass, and American shad.

Many of the impacts on environmental conditions could not be directly quantified, but were inferred from quantifiable impacts on the following habitat factors: (1) surface area of shallow water, (2) surface area and volume of open-water habitat, (3) fluctuations in water levels, and (4) water temperatures. Risk of entrainment of fish through the reservoir outlets were evaluated by comparing elevations of the outlets at different times of year with the elevations of the reservoir epilimnion (i.e., top layer of a thermally stratified lake), which is where most of the vulnerable fish are expected to reside.

Operations modeling results were used with Millerton Lake bathymetric data to estimate changes in the surface area of open-water and shallow-water habitats, and changes in water-level fluctuations. Evaluation of changes in Millerton Lake was generally limited to the times of year that included the most active spawning, incubation, feeding, and growth period for the selected species. Changes in water temperatures were estimated for both shallow-water habitat and deep, open-water habitat based on water temperature modeling results.

Shallow-water habitat analyses were conducted for three black bass: largemouth bass, spotted bass, and smallmouth bass, which reside primarily in the shallow-water margins of reservoirs. Mean surface area between the reservoir surface and the 15-foot-depth contour, which is the approximate lower margin of the principal spawning and rearing habitat of largemouth bass (Mitchell 1982, Stuber et al. 1982), was computed for each alternative. The surface areas were computed for April through September, since most spawning for these species occurs from April through June, and the most critical months for successful rearing are April through September (Moyle 2002, Mitchell 1982, Aasen and Henry 1980).

Water-level fluctuations affect the spawning success of largemouth bass, spotted bass, and smallmouth bass because these species spawn in shallow water (O'Brien 1990, McMahon et al. 1984, Mitchell 1982, Stuber et al. 1982). Mean quarter-month increases and decreases in water levels were computed for the alternatives because the time required for hatching black bass eggs exposed to the water temperature conditions that typically occur during spring in Millerton Lake is approximately a quarter-month (Knoteck and Orth 1998, Mitchell 1982).

Results of the reservoir habitat analyses were combined with the known habitat requirements of the selected reservoir species to assess species-specific impacts of the alternatives. For striped bass and American shad, impact analyses were based on water temperature model results and reservoir operation projections for reservoir surface areas and inundation zones, including inundation of spawning habitat.

Impacts to spawning largemouth bass and spotted bass were determined using a spawning production model, which was developed to evaluate effects of reservoir surface-level fluctuations, shallow-water surface areas, and water temperatures for each alternative. The model simulated spawning production of these species under each alternative. The model outputs an index of total reservoir production rather than a true production estimate. Results for largemouth bass were used to determine likely impacts of the alternatives on smallmouth bass spawning because, except for water temperatures, the two species have similar spawning habitat requirements. A detailed description of the spawning production model is provided in the Modeling Appendix.

Water-level fluctuations can have both positive and negative effects on shallow-water habitat factors for fish (O'Brien 1990). Many of these effects are integrated in the Black Bass Spawning Production Model (see the Modeling Appendix) to estimate spawning production for largemouth bass and spotted bass. Effects incorporated in the model include nest dewatering, water temperature effects on development rates and egg and larvae survival, and substrate condition factors.

However, water-level fluctuations also affect important factors that are more difficult to quantify, including predation risk and food resource availability. Potential effects of water-level fluctuations on predation risk and trophic factors are summarized in Table 5-4.

**Table 5-4. Potential Effects of Increased Water-Level Fluctuations on Predation Risk and Food Resource Availability for Largemouth Bass, Spotted Bass, and Smallmouth Bass**

| **Increased water-level fluctuations increase predation risk** |
|---|
| Young largemouth, spotted, and smallmouth bass sheltering in inundated terrestrial vegetation and other nearshore refuges forced from shelter (falling water level) |
| Guard males forced from nests by risk of exposure to surface (falling water level) or intrusion of cold water (rising water level) |
| Nests near water surface exposed to predation by birds and other terrestrial predators (falling water level) |
| Development of eggs and larvae slowed by intrusion of cold water, increasing time of exposure to high predation risk (rising water level) |
| **Increased water-level fluctuations reduce predation risk** |
| Increased availability of inundated terrestrial vegetation used as shelter by young largemouth, spotted, and smallmouth bass (rising water level) |
| **Increased water-level fluctuations reduce food resources** |
| Unstable water levels interfere with development of diverse community of invertebrates (falling or rising water levels) |
| Muddy/silty substrates at lower reservoir depths have poor habitat quality for invertebrate prey species (falling water levels) |
| **Increased water-level fluctuations increase food resources** |
| Inundated terrestrial vegetation provides excellent food web support for all life stages of black bass (rising water level) |
| Small prey fish of older largemouth, spotted, and smallmouth bass that shelter in inundated terrestrial vegetation and other nearshore refuges forced from shelter (falling water level) |

*Source: Aasen and Henry 1980, O'Brien 1990, Kohler et al. 1993, Knoteck and Orth 1998, Garvey et al. 2000*

The effects of the habitat factors discussed above (shallow-water surface area, water-level fluctuations, and water temperatures) were integrated with additional factors using the Spawning Production Model to compute spawning production indices for largemouth bass and spotted bass for Millerton Lake.

### *San Joaquin River – Friant Dam to Merced River*

The effects of the alternatives on aquatic habitats and species between Friant Dam and the Merced River were evaluated by characterizing water quality and physical habitat changes anticipated to occur under the alternatives, and evaluating the likely range of resulting effects on fish species of interest. All water year types are based on the Restoration Year Type index.

Future conditions include full Restoration Flows and Settlement implementation, which will benefit Chinook salmon as well as other native anadromous fish and resident fish species. All action alternatives described in this Draft EIS would affect restoration of the San Joaquin River, as follows:

- The reduced frequency, magnitude, and duration of Friant Dam releases greater than Restoration Flows would:
    - Reduce the risk of damage to SJRRP instream and floodplain investments
    - Reduce river continuity with some gravel pits
    - Increase flexibility for managing riparian recruitment flows and flexible flow periods
    - Reduce the potential for riparian zone/bank erosion
    - Reduce the rate of unmanaged migration of gravel from spawning areas and potentially reduce the required rate of gravel augmentation
    - Reduce the rate of downstream unmanaged sand migration and potentially reduce the rate/frequency of required sand removal at flow control structures
- Reduce the frequency, magnitude, and duration of floodplain habitat inundation, affecting rearing habitat
- Potential to increase primary productivity in waters released to the San Joaquin River at Friant Dam associated with increased residence time of water in Temperance Flat RM 274 Reservoir
- Improve flexibility in management of Restoration Flows with no effect on water deliveries, including increased operational flexibility for providing buffer flows, and pulse flows for gravel mobilization

The effects of the alternatives on fish and aquatic habitat in the San Joaquin River between Friant Dam and the Merced River were assessed using six different impact indicators. These indicators and the methods used to evaluate their effects are described in the following sections. Many of these impact indicators are evaluated based on the river reaches as defined in the Settlement and further subdivided for this analysis, as listed in Table 5-5.

**Table 5-5. San Joaquin River Flow Capacity by Reach, Friant Dam to Merced River**

| Reach | Location | Reach Length (miles) | Flow Capacity (cfs) | Average Gradient |
|---|---|---|---|---|
| **1A** | Friant Dam to Highway 99 | 23.7 | 8,000 | 0.07 |
| **1B** | Highway 99 to Gravelly Ford | 14.2 | 8,000 | 0.04 |
| **2A** | Gravelly Ford to Chowchilla Bypass Bifurcation | 12.9 | 8,000 | 0.04 |
| **2B1** | Chowchilla Bifurcation to Fresno Slough Obstruction | 10.2 | 1,300 | 0.01 |
| **2B2** | Fresno Slough Obstruction to Mendota Dam | 0.65 | 1,300 | 0.02 |
| **3** | Mendota Dam to Sack Dam | 22.3 | 4,500 | 0.02 |
| **4A** | Sack Dam to Sand Slough Control Structure | 13.5 | 4,500 | 0.02 |
| **4B** | Sand Slough Control Structure to Bear Creek | 32.3 | 475 | 0.02 |
| **5** | Bear Creek to Merced River | 16.6 | 26,000 | 0.02 |

Note: Flow capacity is as assumed for this analysis, as described in the Modeling Appendix.

Key:
cfs = cubic feet per second

**Habitat Potential for Spring-Run Chinook Salmon** The effect of the alternatives on spring-run Chinook salmon habitat potential was evaluated quantitatively using the EDT model (see the Modeling Appendix). The EDT model was previously used to evaluate the anticipated effects of the SJRRP on habitat potential for spring-run Chinook salmon in the year 2030. The descriptions provided in the SJRRP PEIS/R were also used to describe the physical habitat and water quality conditions under existing and future conditions for the No Action Alternative when high-flow events are not taking place (Reclamation 2012a). The simulated SJRRP effects are representative of anticipated future conditions under the No Action Alternative.

Additional EDT scenarios were modeled to evaluate the effects of each action alternative relative to the No Action Alternative. EDT model scenarios for each alternative were developed using San Joaquin River flow and water temperature inputs derived from SRJ5Q and CalSim II model outputs for each alternative (see the Modeling Appendix).

EDT model outputs included:

- Habitat productivity: The density-independent habitat productivity, or habitat quality, expressed in terms of the number of returning adults per original spawning adult
- Habitat capacity: The ultimate capacity, or quantity, of available habitat capable of supporting the modeled species, or, the number of fish that can be supported by the available habitat
- Equilibrium abundance (Neq): The theoretical population size that habitat of a given quantity and quality (capacity and productivity) can support

Habitat potential was modeled using the EDT model as described in the Modeling Appendix. The results are shown with high SAR and low SAR conditions. The SAR variations assume different adult and juvenile survival rates during migration through the lower San Joaquin River (i.e., downstream from the Merced River) and the Delta, and in the ocean. Juvenile and adult Chinook through-Delta survival rates are variable and uncertain, so the high SAR and low SAR scenarios are intended to provide upper and lower bounds for modeling habitat performance.

The EDT modeling is performed for a single representative year for each water year type. The average is an average of the water year type results, weighted by the frequency of each water year type during the simulation period. Details on the EDT model and modeling process are included in the Modeling Appendix.

**Water Temperatures Supporting Pre-Spawn Holding Adults and Juvenile Chinook Salmon and Steelhead Migration** San Joaquin River temperature conditions were modeled from Friant Dam to the Merced River and a threshold temperature of 55°F was used to describe water temperatures suitable for adult pre-spawn holding and spawning temperatures in reaches 1A and 1B. This threshold is also useful as an upper bound for suitable water temperatures for transformation to the smolt life history stage during juvenile migration for Chinook salmon and steelhead. These water temperature effects are incorporated into the EDT model for spring-run Chinook, but additional analysis is useful to characterize potential effects on specific Chinook life history strategies and on other anadromous species including steelhead which could recolonize the San Joaquin River.

EPA (1999) and Richter and Kolmes (2005) summarized the scientific literature on water temperature effects on salmonids and found that temperatures approaching and exceeding 55°F can inhibit and even reverse smoltification in steelhead and Chinook salmon. The extent and significance of these effects are dependent on the duration of exposure and the prevalence of smolt transformation before migration. Juvenile steelhead and Chinook salmon that outmigrate as yearlings transform to the smolt phase before or in the early stages of migration. As the extent and duration of water temperatures above 55°F increases, conditions become less favorable for this life history strategy. By extension this would favor the subyearling migrant life history strategy, potentially limiting the life history diversity of the affected population. Sauter et al. (2001a) found that water temperature exposures during rearing influence temperature preferences during smolting; temperature preferences decline as age at smolting increases; and yearling spring-run Chinook preferred water temperatures below 52°F while early-migrant fall-run Chinook could tolerate higher temperatures.

On this basis, even small increases in the duration of water temperatures above the 55°F threshold could potentially restrict the period during which successful smolt transformation can occur in the San Joaquin River migration corridor. Any habitat alterations that reduce the range of potential life history expression are considered to have a negative effect on spring-run Chinook and other salmonids.

San Joaquin River temperature conditions under the No Action Alternative and action alternatives from Friant Dam to the Merced River were modeled using the SJRQ5 model (see the Modeling Appendix). SJRQ5 was developed specifically to support the SJRRP. Model outputs include projected daily minimum, maximum, and average water temperatures calculated from simulated flow conditions for the years 1922 to 2003.

For this analysis, the simulated daily mean water temperatures were processed into a 7-day running average, as a parameter reflective of the biological benefit of both temperature magnitude and duration, and the 10 percent, 50 percent, and 90 percent exceedence values for each day of the year computed. Figure 5-2 displays the results of this process for the No Action Alternative at Reach 1A (see the Modeling Appendix for additional figures).

The number of days during specific periods of interest for the fishery analysis that were below specific thresholds for each exceedance level were counted and divided by 7 to get weeks for use as an indicator of the biological impact of water temperature. A reduction in the number of week between the baseline and action alternative is considered a significant impact and an increase beneficial.

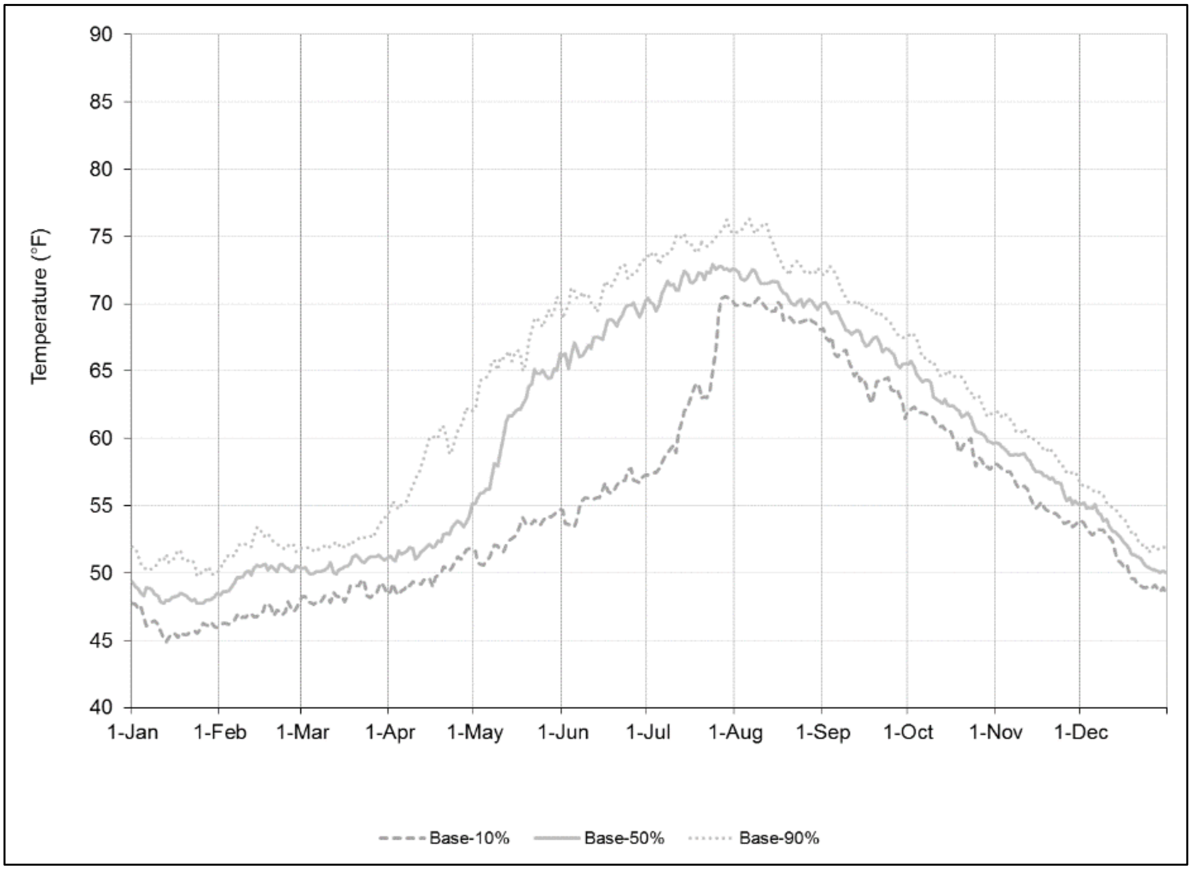


**Figure 5-2. The 10th, 50th, and 90th Percentile San Joaquin 7-Day Mean Daily Running Average San Joaquin River Water Temperature for Reach 1A Under the No Action Alternative**

**Water Temperatures Supporting Moderately Tolerant Native Fish Species** The methods for evaluating effects of the alternatives on the temperature regime of the San Joaquin River relative to the thermal requirements of several native fish species that have slightly higher water temperature preferences than salmonids are described below. The species covered under this analysis include hitch, splittail, Sacramento blackfish, and tule perch, species belonging to the deep-bodied assemblage as defined by Moyle (2002), as well as Sacramento pikeminnow, and prickly and riffle sculpin.

The upper limit of optimal growth water temperatures for species in this assemblage ranges from 75°F to 84°F, with splittail, tule perch, and pikeminnow having lower optimal temperature ranges and hitch and blackfish the highest. Splittail are more temperature sensitive overall, having a maximum water temperature tolerance of 84°F (Reclamation 2012a). A water temperature threshold of 77°F provides a useful basis for evaluating a change in habitat conditions for this assemblage, as it marks a transition point between lower and higher optimal water temperature ranges across these four species. The same process described above was used to compute the number of weeks where the 7-day running average was below the 77°F threshold. Any reduction of the number of weeks is considered a significant impact and an increase beneficial.

**Water Temperatures Supporting Highly Tolerant Native Fish Species** The effects of the alternatives on the temperature regime of the San Joaquin River relative to the thermal requirements of native fish species with the highest water temperature tolerance ranges were evaluated using the methods described below. The species included were Sacramento sucker and hardhead, members of the pikeminnow-hardhead-sucker assemblage as defined by Moyle (2002). The upper limit of optimal growth water temperatures for these two species ranges from 83°F to 86°F (Reclamation 2012a). Both species can tolerate much higher water temperatures, but a threshold of 84°F provides a reasonable upper bound for optimal conditions and a useful basis for evaluating the effects of the alternatives on these species. SJRQ5-simulated temperature conditions for the San Joaquin River from Friant Dam to the Merced River were used to characterize water temperature conditions relative to this threshold.

The same process described above under Water Temperatures Supporting Juvenile Salmon and Steelhead Migration was used to compute the number of weeks where the 7-day running average was below the 84°F threshold. Any reduction of the number of weeks is considered a significant impact and an increase beneficial.

**Flood Pulses and Floodplain Connectivity** The relationship between floodplain inundation and aquatic ecosystem health has been documented in numerous studies. Flood pulses provide a connection between aquatic and terrestrial ecosystems that promotes beneficial changes in physical habitat conditions, provides spawning and rearing habitat for floodplain-adapted fish species, and supports high food web productivity (Benke 2001; Junk et al. 1989; Matella and Merenlender 2014; Middleton 2002; Sommer et al. 2002, 2004a, 2004b). These concepts have been integrated into ecosystem management and habitat restoration efforts in the Sacramento and San Joaquin River systems, including the SJRRP (Matella and Merenlender 2014; USACE and Reclamation Board 2002, Reclamation 2012a).

A central component of these concepts is the maintenance and/or reestablishment of normative flow patterns, which include regular (i.e., interannual), low-magnitude flood pulses punctuated by larger floods (e.g., 5- to 10-year recurrence interval) to support healthy ecological processes (Poff et al. 1997). In the case of the San Joaquin River ecosystem, changes in flood peaks could affect phytoplankton and zooplankton production, limits establishment of native riparian vegetation, and fragments key habitats used by native fish species (Opperman 2012). Matella and Merenlender (2014) conclude that the successful restoration of native fish habitat in the San Joaquin River system will depend on simulation of natural flood pulse regimes that make effective use of the available floodplain. The background studies supporting the SJRRP identified 8,000 cfs releases at Friant Dam as the functional equivalent of a 10-year recurrence interval event for the purpose of floodplain activation (Reclamation 2002).

The SJRRP Restoration Flow Schedule was designed to provide flood peaks of sufficient size and frequency to support ecological functions beneficial to Chinook salmon in reaches with sufficient flow capacity to support them. All action alternatives meet the SJRRP Restoration Flow Schedule, with full Exhibit B Schedule flow releases in all simulations of future conditions. The addition of Temperance Flat RM 274 Reservoir would allow for the capture and use of flood flows above the SJRRP Restoration Flow Schedule. This analysis evaluates the potential impacts of changes to the flood flows on ecological functions. Daily operation modeling was performed for the period from 1922 to 2003 for all scenarios (see the Modeling Appendix). The peak daily release from Millerton Reservoir for each year is used as an indicator of flood peak impacts of the alternatives. Figure 5-3 shows the annual peak flows for the future condition scenarios.

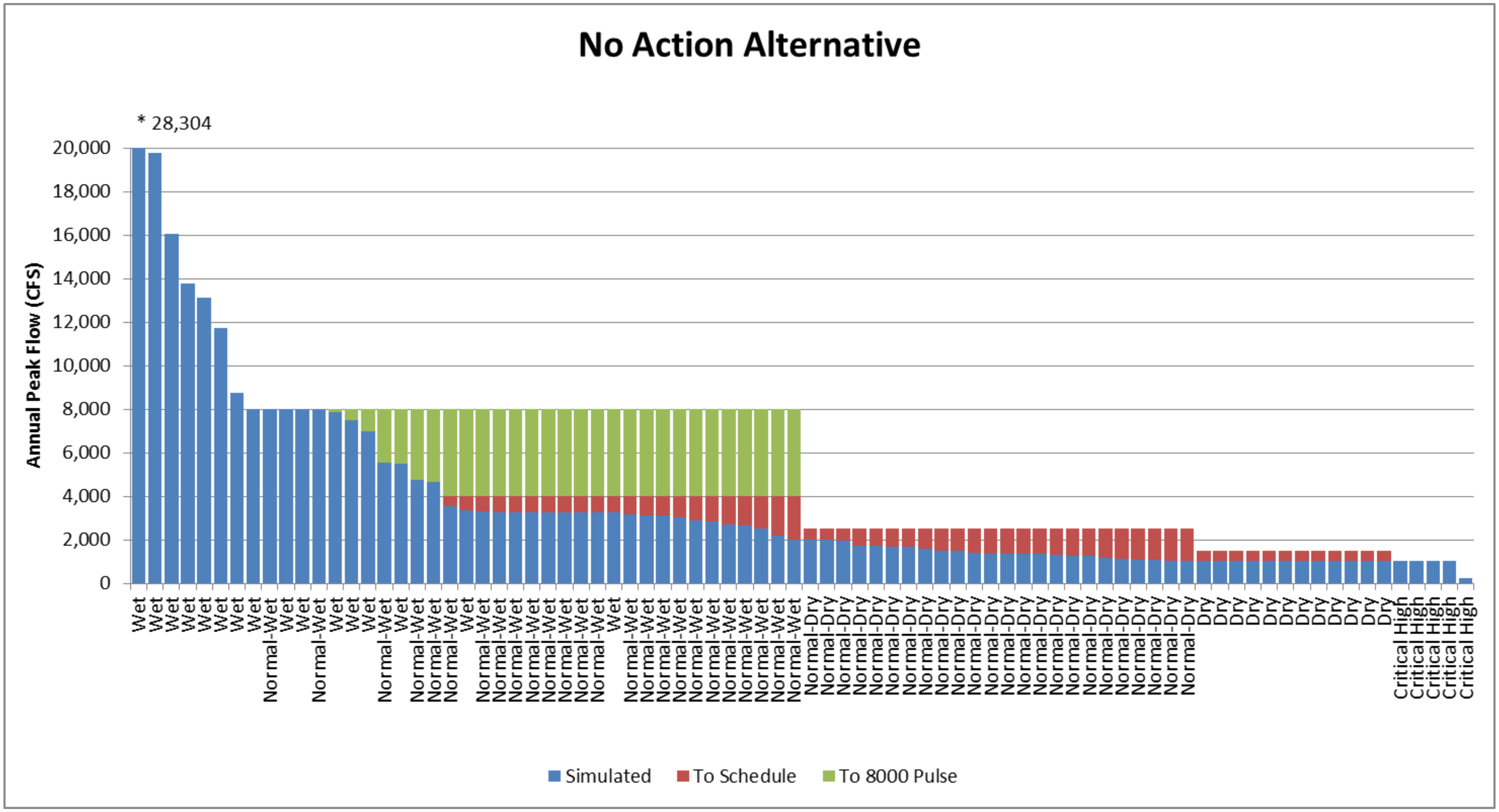


**Figure 5-3. Annual Peak Release from Friant Dam to San Joaquin River for the No Action Alternative**

### San Joaquin River – Merced River to Delta

The San Joaquin River between the Merced River confluence and the Delta is used primarily as a migratory corridor for both juvenile and adult fish, including Chinook salmon and steelhead. Migration could be affected in the lower San Joaquin River through changes in water temperature or flow. These changes could affect the timing or duration of migration, or even the direct survival of individual fish as they move upstream or downstream.

Simulated San Joaquin River monthly flows from the CalSim II simulation results downstream from the Merced River confluence and near Vernalis were compared to the baselines for each alternative. Downstream from the Merced River a flow reduction of 10 percent or greater, when the baseline flow is below 6,000 cfs, is considered significant. Downstream from Vernalis a flow reduction of 10 percent or greater, when the baseline flow is below 10,000 cfs, is considered significant.

### San Joaquin River Tributaries

The Merced, Tuolumne, and Stanislaus rivers are the three main tributaries to the lower San Joaquin River. Each tributary supports self-sustaining populations of fall-run Chinook salmon and Central Valley steelhead.

Criteria for determining impacts to tributary fish were based on the flows in each tributary expected to provide the maximum habitat for each life stage of Chinook salmon and Central Valley steelhead. Optimal flows were identified based on several sources, including two instream flow incremental methodology (IFIM) studies conducted to calculate maximum weighted usable area of habitat for each life stage, studies conducted for FERC relicensing projects, and from CDFW modeling (USFWS 1993, 1995, and 1997; DFG 2005; NMFS 2009). In the evaluation, all years were first combined, and then separated by water year type based on the San Joaquin Valley Index. Resulting average flows are presented for each time frame for the life stages provided in Table 5-6.

## Table 5-6. Tributary Flows Assumed to Provide Maximum Salmon and Steelhead Habitat

| Time Frame | Life Stage | Flow (cfs) |
|---|---|---|
| **Merced River Chinook Salmon/Steehead[1]** | | |
| October 1–December 31 | Spawning | 400 |
| January 1–March 15 | Incubation/Fry Rearing | 400 |
| March 16–June 15 | Juvenile Rearing/Migration | 1,500 |
| June 15–October 31 | Juvenile Rearing/Adult (steelhead) | 250 |
| **Tuolumne River Chinook Salmon[2]** | | |
| October 1–April 30 | Spawning/Incubation/Fry Rearing | 275 |
| January 1–December 31 | Juvenile Rearing | 150 |
| January 1–June 30 | Juvenile Migration | 1,100 |
| **Tuolumne River Steelhead[2]** | | |
| January 1–December 31 | All Life Stages | 275 |
| March 15–June 30 | Juvenile Migration | 1,100 |
| **Stanislaus River Chinook Salmon[3]** | | |
| October 15– December 31 | Spawning | 300 |
| January 1–February 28 | Incubation/Fry Rearing | 300 |
| January 1–December 31 | Juvenile Rearing | 200 |
| March 15–June 30 | Juvenile Migration | 2,000 |
| **Stanislaus River Steelhead[3]** | | |
| November 1–February 28 | Spawning | 200 |
| January 1–March 31 | Incubation/Fry Rearing | 200 |
| January 1–December 31 | Juvenile Rearing | 150 |
| March 15–June 30 | Juvenile Migration | 2,000 |

Sources: USFWS 1993, 1995, and 1997; DFG 2005; NMFS 2009
Notes:
[1] Because information is limited on steelhead, flows needed for Chinook salmon and steelhead are combined.
[2] Flows are based on USFWS 1995 and from results of the DFG Chinook model.
[3] Flows are based on USFWS 1993, and from the 2009 Operations Criteria and Plan Biological Opinion for Below-Normal years
Key:
cfs = cubic feet per second

### *Delta*

The effects of the alternatives on aquatic habitats and species in the Delta were evaluated by characterizing water quality and physical habitat changes anticipated to occur under the alternatives and evaluating the likely range of resulting effects on Delta fish species of interest. The alternatives are expected to have virtually no effect on environmental conditions in most of the Delta, but they are expected to affect conditions in the south Delta because of changed flows in the San Joaquin River entering the south Delta during wet hydrologic periods. Therefore, the impact analysis focuses on anticipated changes and effects on fish in the south Delta.

The effects of the alternatives on fish and aquatic habitat in the Delta were assessed using five different impact indicators. Many of the effects analyses were based on mean results for different water year types, using the water year types of the Sacramento Valley Index. These five impact indicators and the methods used to evaluate their effects are described in the following sections.

**Water Temperature and Dissolved Oxygen Concentration**
Exposure to water temperatures exceeding the upper limits of suitable temperature ranges for the fish species of interest, during the time of year when the species is expected to occur in the south Delta, is considered significant. The upper water temperature limits for Chinook salmon and steelhead are 55°F and 70°F for the juvenile and adult life stages, respectively. Justification for these temperature limits is provided above in methods descriptions for the San Joaquin River—Friant Dam to Merced River. The upper limit for other species of interest is 77°F for delta smelt (Sommer and Mejia 2013), 64°F for longfin smelt (Moyle 2002), and 66°F for both white sturgeon (Israel et al. 2010) and green sturgeon (Israel and Kimley 2008). However, changes in Delta water temperatures resulting from the project are highly unlikely because by the time Friant Dam releases reach the Delta, water temperatures would be directly affected by air temperature and tributary water temperatures.

Effects of the alternatives on DO concentrations in the Delta were not estimated directly, but were assessed from their effects on San Joaquin River inflow. The most important issue concerning DO in the Delta is periodic depletions of DO in the San Joaquin River near the Stockton Deep Water Ship Channel. The low DO levels often occur in late summer and fall and are believed to delay the upstream migration of adult fall-run Chinook salmon (Lee and Jones-Lee 2003). DO levels are at times directly affected by San Joaquin River inflow, with low inflow resulting in reduced DO concentration (Lee and Jones-Lee 2003). The relationships between San Joaquin River inflow and DO concentrations, and between the DO concentrations and fall-run salmon migration delay have not been well quantified, but Lee and Jones-Lee (2003) found that DO depletion occurred only at flows below about 2,000 cfs. Therefore, for this analysis, San Joaquin River inflow below

2,000 cfs during late summer and fall (defined here as September through November) is considered to have potentially adverse effects on DO levels encountered by upstream migrating adult fall-run salmon. To evaluate the potential effect of changes in San Joaquin River inflow on fish habitat in the south Delta, and considering the inherent uncertainty within the hydrologic model, it was assumed that changes that were less than 5 percent (plus or minus) relative to the basis of comparison in the frequency of months with mean flows less than 2,000 cfs would not result in a significant (detectable) effect on DO concentration to which adult fall-run salmon were exposed. Therefore, an alternative is considered to have a significant impact if its implementation would result in an increase of 5 percent or more in the percentage of months per water year type with mean San Joaquin River inflow less than 2,000 cfs during September through November.

**Salinity** Elevated salinity levels adversely affect special-status Delta fish species, including delta smelt and longfin smelt, both of which spawn in the freshwater portions of the Delta. The egg and larval stages are particularly vulnerable.

The State Water Board Water Right Decision 1641 (D-1641) for Delta salinity objectives and X2 standards are designed to protect sensitive Delta species such as delta smelt. Any changes to salinity or X2 resulting in violation of any of the objectives and standards is considered a significant impact.

**Delta Flow Patterns** Hydrodynamics in the south Delta influence distributions of Delta fish species and thereby affect their risk of exposure with respect to preexisting adverse environmental conditions. As previously noted, habitat conditions in the south Delta are considered to be particularly poor. The expected effects of the alternatives on south Delta hydrodynamics were quantified using CalSim II simulations of San Joaquin River flow at Vernalis (inflow), Old and Middle river flows, and combined diversions (exports) of the Banks and Jones export facilities. San Joaquin River inflow affects the movement of fish into and out of the south Delta. Reversed flows in Old and Middle rivers are believed to affect fish by altering their natural migration behaviors and increasing time of exposure to entrainment risk and other adverse conditions. Reverse flows in Old and Middle rivers, resulting from low San Joaquin River inflows and increased exports to the CVP and SWP, have been identified as a potential cause of increased delta smelt mortality at the CVP and SWP fish facilities within recent years (Simi and Ruhl 2005, Wanger 2007). Results of analyses of the relationship between the magnitude of reverse flows in Old and Middle rivers and salvage of adult delta smelt in the late winter shows a substantial increase in salvage as reverse flows exceed approximately -5,000 cfs. Concerns regarding reverse flows in Old and Middle rivers have also focused on planktonic egg and larval stages of splittail and on Chinook salmon smolts, in addition to delta smelt and, while these species do not spawn to a significant extent in the south Delta, eggs and larvae may be transported into the area by reverse flows in Old and Middle rivers. The ratio of San Joaquin River inflow to total exports (inflow:export [I:E] ratio) has been used to evaluate the net effect of these factors on emigrating fall-run Chinook salmon (NMFS 2009). Increases in the ratio are considered to reduce the probability of fish entering or remaining in the south Delta.

The significance criteria used in this analysis for determining a significant impact of the alternatives on Delta flow patterns, based on the RPAs of the NMFS 2009 and USFWS 2008 BOs, employ Old and Middle rivers reverse flows and the I:E ratios as follows:

- A comparison of reverse flows within Old and Middle rivers under the basis of comparison and proposed alternative project operations was prepared for the seasonal period extending from January through June. Per the RPAs in the USFWS 2008 and NMFS 2009 BOs, any reduction in Old and Middle River reverse flows (i.e., flows that are more negative) that result in flows greater than (i.e., flows that are more negative) -5,000 cfs are considered to be a significant impact. Additionally, a 5 percent reduction in Old and Middle river flows making them more negative is also considered a significant impact.

- An alternative is considered to have a significant impact if its implementation would result in an increase of 5 percent or more in the percentage of months with a mean I:E ratio less than 4:1 in Wet and Above-Normal years, less than 3:1 in Below-Normal years, less than 2:1 in Dry years and less than 1:1 in Critical years, during the April and May period of Chinook salmon and steelhead emigration (NMFS RPA Action IV.2.1)(NMFS 2009).

For purposes of evaluating the potential effect of changes in Old and Middle river flows and I:E ratios on fish habitat in the south Delta, and considering the inherent uncertainty within the hydrologic model, it was assumed that changes that were less than 5 percent (plus or minus) relative to the basis of comparison in the frequency of the above-described conditions would not result in a significant (detectable) effect on habitat quality or availability. Therefore, an alternative is considered to have a significant impact if its implementation would result in an increase of 5 percent or more in the frequency of Old and Middle river flows less than -2,000 cfs or -5,000 cfs, respectively, or in the frequency of low I:E ratios, as defined above.

**Entrainment** Sensitive Delta fish species, including fall-run, spring-run, and winter-run Chinook salmon, steelhead, longfin smelt, and delta smelt, are regularly entrained with white and green sturgeon entrained less frequently at the Banks and Jones export facilities (Williams 2006, NMFS 2009, Harvey and Stroble 2013, DWR 2013a). Assuming the fish are present in the south Delta, increases in diversions at the Banks and Jones facilities increase their risk of entrainment and exposure to other adverse conditions, including increased predation, reduced water quality, and migration delays. Young life stages are especially at risk. The period of the year that presents an increased risk of entrainment and related effects encompassing all the special-status Delta species is December through June (USFWS 2008, NMFS 2009). For evaluating the potential effect of changes in entrainment and related effects on fish abundance, these factors are assumed, on an average basis, to be directly proportional to the diversion level. Considering the inherent uncertainty of this relationship and of the hydrologic model used to estimate diversion levels, it was assumed that changes in mean monthly diversions that were less than 5 percent (plus or minus) relative to the basis of comparison would not result in a significant (detectable) effect on entrainment and related effects. Therefore, increases in the mean monthly Banks and Jones combined diversion rates, by water year type, of more than 5 percent that occur during the December-through-June period of increased risk are considered to have a significant impact on Delta fishes.

**X2** Shifts in X2 provide a measure of changing habitat conditions resulting from changes in flow downstream from the south Delta. The CalSim II model was used to simulate the location of X2. Except under extreme high-flow conditions, reductions in X2 generally provide improved habitat conditions for special-status species such as delta smelt and longfin smelt. Also, reductions in X2 reflect increased Delta outflow, which is considered important in dispersing fish larvae, especially longfin smelt, into habitats downstream from the Delta. Historically, X2 has varied between San Pablo Bay (River Kilometer 50) during high Delta outflow and Rio Vista (River Kilometer 100) during low Delta outflow. X2 has typically been located between approximately Honker Bay and Sherman Island (River Kilometer 70 to 85). Upstream shifts that move X2 from downstream to upstream from the confluence of the Sacramento and San Joaquin rivers (81 km) may be especially deleterious for fish habitat because the surface area and quality of habitat are substantially reduced upstream from the confluence (Unger 1994, USFWS 2008).

X2 is controlled directly by the volume of Delta outflow, although changes in X2 lag behind changes in outflow. Minor modifications in outflow do not greatly alter X2. Operations of upstream storage reservoirs have the potential to affect the location of X2 as a result of changes in freshwater flows from the upstream tributaries through the Delta. For purposes of evaluating changes in habitat quantity and quality for estuarine species, a significance criterion of an upstream change in X2 location within 1 km of the basis-of-comparison condition was considered to be less than significant. The criterion was applied to a comparison of hydrologic model results for basis-of-comparison conditions and action alternatives, by month and water year, for the months from February through May and September through November, based on the X2 requirements identified in the USFWS 2008 BO.

### Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect of the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

Significance criteria (sometimes called thresholds of significance) used in this analysis are based on the checklist presented in Appendix G of the State CEQA Guidelines; factual or scientific information and data; and regulatory standards of Federal, State, and local agencies. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of the context and the intensity of its effects.

For the assessment of impacts on fisheries and aquatic ecosystems, habitat indicators for project operations, such as water temperature, flows, and important ecological processes, have been used to evaluate whether the alternatives would have an adverse effect on the species and/or species' habitat. For example, changes in river flows and water temperatures during certain periods of the year have the potential to affect spawning, fry emergence, and juvenile emigration. Therefore, changes in monthly mean river flows and water temperatures during certain times of the year (during spawning, incubation, and initial rearing) have also been used as habitat impact indicators for species of primary management concern.

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on fisheries and aquatic ecosystems would be significant if project implementation would do any of the following:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW, USFWS, or NMFS.

- Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved State, regional, or local habitat conservation plan or policies or ordinances protecting biological resources.

- Interfere substantially with the movement of any native resident or migratory fish species or with established habitat, or impede the use of native fish nursery/rearing sites.

- Conflict with a local policy or ordinance that protects aquatic and fishery resources.
- Substantially reduce the habitat of a fish species, cause a fish species to drop below self-sustaining levels, threaten to eliminate a fish or macroinvertebrate community, or substantially reduce the number or restrict the range of an endangered, rare, or threatened fish species.

Significance statements are relative to both the existing conditions and future conditions, unless stated otherwise.

## Topics Eliminated from Further Consideration

Because implementing any of the action alternatives would not result in land use changes or other physical consequences in the CVP and SWP water service areas that would affect existing habitat for biological resources, their implementation would not create an impact on biological resources within these service areas. This portion of the extended study area is not discussed further in this analysis.

## Direct and Indirect Effects

### *Impact FSH-1: Loss of Riverine Habitat for Lotic Fish Species*

#### Primary Study Area – San Joaquin River Upstream from Millerton Lake

*No Action Alternative* Under the No Action Alternative, no change to the reservoir elevation would occur, and no riverine habitat upstream from Millerton Lake would be inundated. Therefore, there would be no loss of riverine habitat for lotic fish species in the upper San Joaquin River.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* The San Joaquin River between Millerton Lake and Kerckhoff Dam currently provides roughly 9 miles of riverine habitat, about 6 miles of which has gradients of 3 percent or less. These lower gradient habitats are necessary for Kern brook lamprey, hardhead, Sacramento sucker, and Sacramento pikeminnow, as habitat gradients higher than 3 percent are typically difficult for these fishes to pass. Rainbow trout are able to pass these higher gradient habitats.

When full, Temperance Flat RM 274 Reservoir would affect all useable habitat for the riverine fish species. Within the riverine habitat, assuming rainbow trout, Kern brook lamprey, hardhead, Sacramento sucker, and Sacramento pikeminnow all inhabit the San Joaquin River; all lotic habitat for these fishes would be affected by all the action alternatives. The action alternatives would frequently eliminate all riverine habitat for these fish, potentially including during the reproductive season. A portion of Big Sandy Creek would also be inundated, however, it is not likely to contain suitable habitat for Kern brook lamprey, hardhead, or Sacramento pikeminnow. More evaluations would be required to determine the quality of habitat for these species. Rainbow trout and Sacramento sucker may move upstream and inhabit Big Sandy Creek.

Striped bass may be less affected because their spawning success in the riverine habitat analysis area is already questionable, and stocking is necessary to propagate the Millerton Lake population. American shad would also lose the required habitat conditions necessary for spawning. Neither of these species is likely to use Big Sandy Creek.

Of the fishes that currently occupy the riverine segment during all or portions of their life stage, rainbow trout, hardhead, pikeminnow, striped bass and American shad can all also live in reservoirs. Kern brook lamprey, however, require stream conditions, and cannot transition into a reservoir habitat condition.

This impact would be **significant** under all the action alternatives. No feasible avoidance or minimization measures are available to reduce this impact below the level of significance. Mitigation for this impact is not proposed because no feasible mitigation is available to reduce the impact to a less-than-significant level.

### *Impact FSH-2: Short-term Degradation of Aquatic Habitat from Accidental Spills or Seepage of Hazardous Materials during Construction of Temperance Flat RM 274 Dam and Other Facilities*

#### Primary Study Area – Millerton Lake and Temperance Flat Reservoir Area

*No Action Alternative* Under the No Action Alternative, no construction activities would occur in the primary study area. Therefore, there would be no potential spills of hazardous materials related to construction in Millerton Lake that would adversely affect fish populations in the reservoir.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* As described in Chapter 15, "Hydrology – Surface Water Quality," construction-related activities in the reservoir basin could discharge waste petroleum products or other construction-related substances containing metals that could enter waterways in runoff. In addition, chemicals associated with operating heavy machinery would be used, transported, and stored on site during construction activities. Concentrations of hazardous materials could become especially elevated in shallow-water embayments, where dilution mixing from other parts of the reservoir would be limited. These materials would be potentially harmful to fish in Millerton Lake and in the Temperance Flat Reservoir Area.

As described in Chapter 2, "Alternatives," Reclamation would prepare and implement a SWPPP before construction, identifying BMPs to prevent or minimize the discharge of sediments and other contaminants with the potential to affect beneficial uses or lead to violations of water quality objectives of surface waters. These measures are expected to protect all life stages of fish in Millerton Lake and the Temperance Flat Reservoir Area and their tributaries. The accidental release of chemicals, fuels, lubricants, and non-storm-drainage water into water bodies would be prevented to the extent feasible.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### *Impact FSH-3: Short-term Degradation of Aquatic Habitat from Increased Turbidity or Sedimentation during Construction of Temperance Flat RM 274 Dam and Other Facilities*

#### Primary Study Area – Millerton Lake and Temperance Flat Reservoir Area

*No Action Alternative* Under the No Action Alternative, no construction activities would occur in the primary study area. Therefore, there would be no short-term increases in turbidity or suspended sediment in Millerton Lake that would adversely affect fish population in the reservoir.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* As described in Chapter 15, "Hydrology – Surface Water Quality," construction-related activities in the reservoir basin would result in short-term increases in the amount of exposed shoreline area subject to erosion. The erosion would raise levels of turbidity and suspended sediments in the reservoir, which could result in thickening of the gills, potentially causing the loss of respiratory function; in clogging and abrasion of gills; and in increased stress levels, which in turn could reduce tolerance to disease and toxicants. Prolonged exposure to high levels of suspended sediment would create a loss of visual capability in fish in aquatic habitats within the primary study area, leading to reduced feeding and growth rates.

Levels could become especially elevated in shallow-water bays, where dilution mixing from other parts of the reservoir would be limited. Activities that could lead to erosion include construction of the Temperance Flat RM 274 Dam and associated structures, which would require the excavation, transport, stockpiling, grading, drilling, blasting, and use of bedrock, alluvium, and soil obtained from the aggregate quarry. Other activities producing erosion would include the demolition and removal of existing facilities within the inundation zone, installation of support structures, construction of permanent access roads and temporary haul roads, and use of staging areas. Additionally, about 3,580 acres of vegetation in parts of the new inundation area would be partially or completely removed. Removal of vegetation would reduce the amount of effective ground cover (both live and dead material), thereby increasing the potential for short-term erosion and sedimentation along the shoreline. Soils disturbed by these activities as well as materials stockpiled for use during construction would be susceptible to erosion.

Temporary construction-related erosion will be avoided and minimized via implementation of the erosion and sediment control plans and SWPPPs (i.e., erosion and sediment control plans, including site revegetation) that are a part of the environmental commitments common to all action alternatives. The plans would include site-specific structural and operational BMPs to prevent and control short- and long-term erosion and sedimentation effects, stabilize soils and vegetation in areas affected by construction activities, and prevent and control impacts on runoff quality. Types of BMPs may include, but would not be limited to, earth dikes and drainage swales, stream bank stabilization, silt fencing, sediment basins, fiber rolls, sandbag barriers, straw bale barriers, storm drain inlet protection, hydraulic mulch, and stabilized construction entrances.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### *Impact FSH-4: Loss of Reservoir Fish Habitat Resulting from Changes in Water Temperature*

### Primary Study Area – Millerton Lake and Temperance Flat Reservoir Area

*No Action Alternative* Under the No Action Alternative, water temperatures would be expected to be slightly different that existing conditions. The increased releases for full Restoration Flows could deplete the existing cold-water pool slightly, resulting in slightly higher temperatures at deeper depths in Millerton Lake during the fall months.

This impact would be **less than significant** under the No Action Alternative.

*Action Alternatives* Implementing any of the action alternatives is expected to have an effect on water temperatures in Millerton Lake under existing and future conditions because of the increased surface area and increased area of shallow shoreline habitat. Increased water temperatures are expected in Millerton Lake and the Temperance Flat Reservoir Area for both shallow depths (less than 25 feet) where black bass spawn and at greater depths where striped bass and American shad may reside.

The open water in Millerton Lake and the Temperance Flat Reservoir Area would be warmer under the action alternatives especially in deep water (greater than 150 feet) during October and January (see Figure 5-4 and additional water temperature figures in the Modeling Appendix). The highest water temperatures under any of the alternatives could be as high as 79°F, which slightly exceeds the lowest warm-water temperature found stressful for striped bass (Moyle 2002).

The open water of both Millerton Lake and Temperance Flat RM 274 Reservoir would provide a wide range of water temperatures during July because of temperature stratification (see results in the Modeling Appendix), so striped bass and American shad would be able to find suitable temperatures in the reservoirs. For the March through June period, future action alternatives would create reservoir water temperatures greater than the No Action Alternative and existing conditions for Millerton Lake at the same depth. The expected water temperatures are somewhat greater for Millerton Lake than for the Temperance Flat RM 274 Reservoir, especially for the 11- to 15-foot and 16- to 22-foot depth intervals (see Figure 5-5 and Figure 5-6 and additional water temperature figures in the Modeling Appendix). Depth ranges of 3 to 6 feet and 8 to 13 feet are considered optimal for largemouth bass and spotted bass spawning, respectively (Moyle 2002). Differences among the five action alternatives in these shallow depths during spring are small.

Black bass spawning production could benefit from increasing rates of egg and larval development at warmer water temperatures. However, spotted bass and largemouth bass cease spawning when water temperatures exceed about 72°F (Moyle 2002) and 76°F (Mitchell 1982), respectively. These water temperatures are exceeded more frequently under the action alternatives in Millerton Lake, but Temperance Flat RM 274 would add additional areas of suitable temperatures to somewhat offset this effect (see the Modeling Appendix).

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

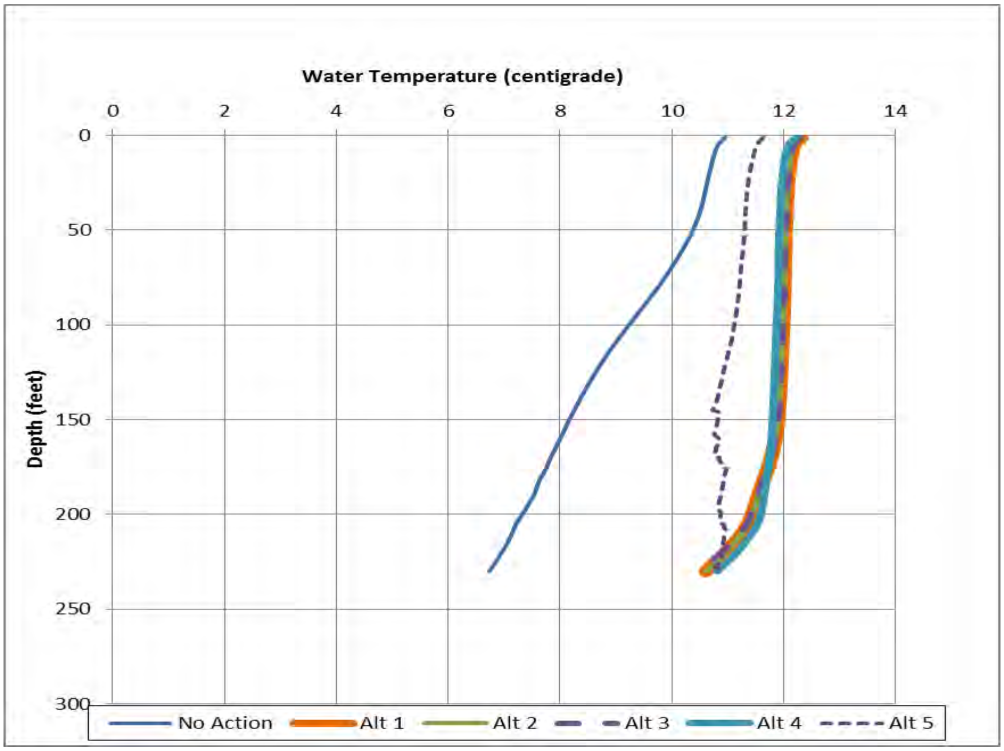


**Figure 5-4. Average January Water Temperatures in Millerton Lake Under Future Conditions**

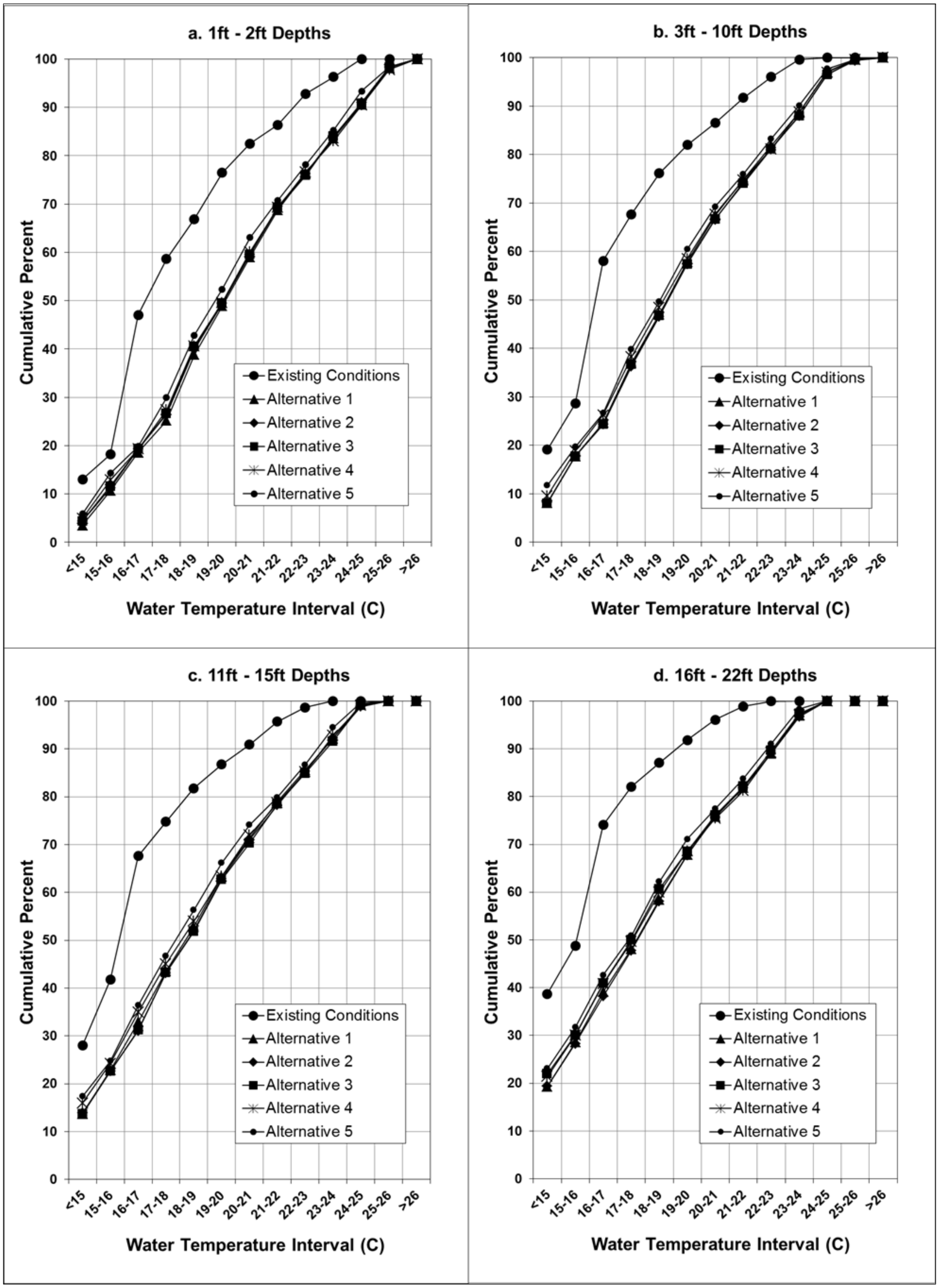


Figure 5-5. Cumulative Frequency of March-Through-June Water Temperatures in Millerton Lake Under Existing Conditions

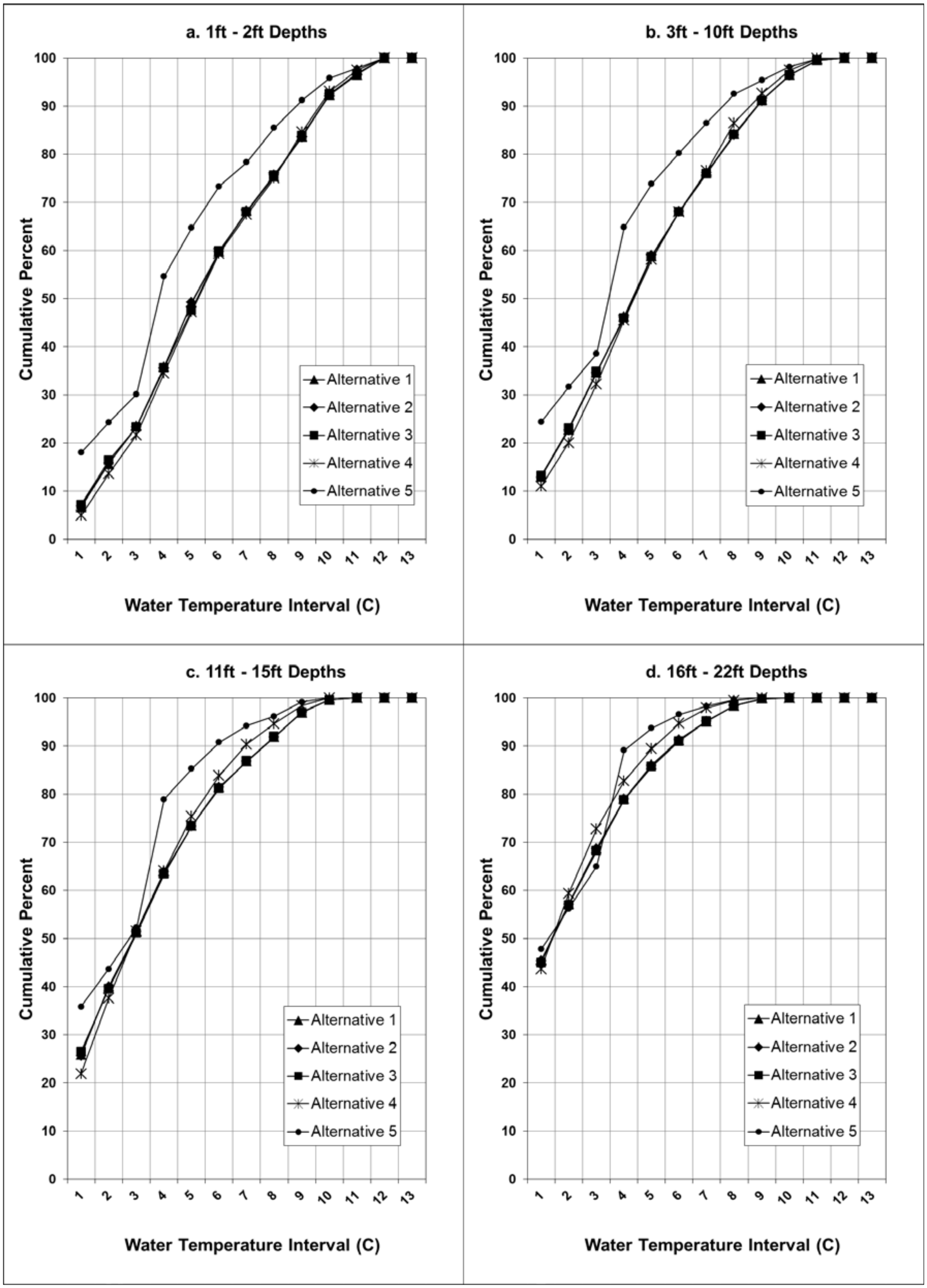


Figure 5-6. Cumulative Frequency of March-Through-June Water Temperatures in Temperance Flat Reservoir Under Existing Conditions

### *Impact FSH-5: Changes to Reservoir Fish Habitat Caused by Turbidity from Increased Surface Area of Exposed Shoreline*

#### Primary Study Area – Millerton Lake and Temperance Flat Reservoir Area

*No Action Alternative* Under the No Action Alternative, variation in reservoir levels of Millerton Lake due to reoperating Friant Dam under the SJRRP would continue within the range of reservoir water surface elevations under existing conditions, with little change in the average conditions. No changes are expected in upslope vegetation, in streams tributary to Millerton Lake, or to the San Joaquin River upstream from Millerton Lake. Therefore, no long-term changes are expected in exposure of shorelines to erosion or to turbidity and suspended sediment runoff from surrounding slopes and tributaries under the No Action Alternative.

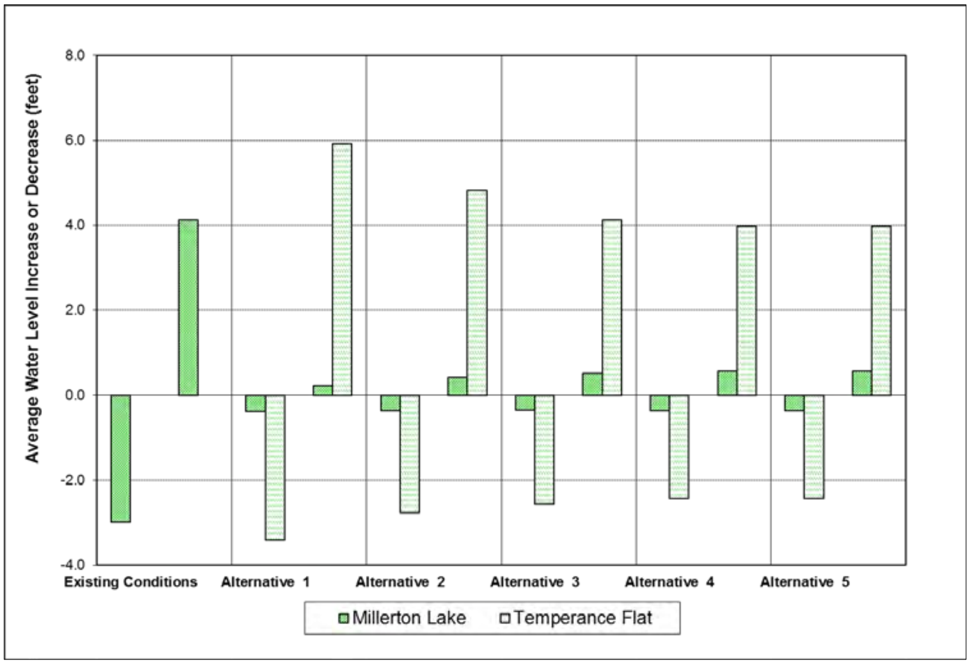
There would be **no impact** under the No Action Alternative.

*Action Alternatives* Once Temperance Flat RM 274 Dam is constructed and the reservoir filled, shoreline erosion would occur along the zone of reservoir-elevation fluctuation between the top-of-active-storage capacity (985 TAF) and the top of minimum carryover storage capacity (200 TAF under Alternative Plans 1, 2, and 3, 325 TAF under Alternative Plan 4, and 100 TAF under Alternative Plan 5). Average water-level fluctuations in the Temperance Flat RM 274 Reservoir during the April-to-June black bass spawning period would be similar to those currently in Millerton Lake under Alternative Plans 2, 3, 4, and 5 and somewhat greater than those currently in Millerton Lake under Alternative Plan 1 (Figure 5-7 and Figure 5-8). As described in Chapter 11, “Geology and Soils,” substantial soil erosion and loss of topsoil would occur in the area of shoreline subject to fluctuating water levels. This shoreline area comprises about 4,300 acres under Alternative Plans 1, 2, and 3, about 3,700 acres under Alternative Plan 4, and about 5,000 acres under Alternative Plan 5. The amount of sediment that could be delivered is not quantifiable because of the size of the reservoir and the number of variables that influence sediment transport and delivery. As discussed in Chapter 15, “Hydrology – Surface Water Quality,” the action alternatives would result in an incremental increase in the delivery of suspended sediment and turbidity to Temperance Flat RM 274 Reservoir. The sediment would be largely retained within the reservoir, and therefore have essentially no effect on Millerton Lake or the San Joaquin River downstream.

The rate of shoreline erosion would be greatest during the first several years after construction, and would reduce over time as the new shoreline stabilized.

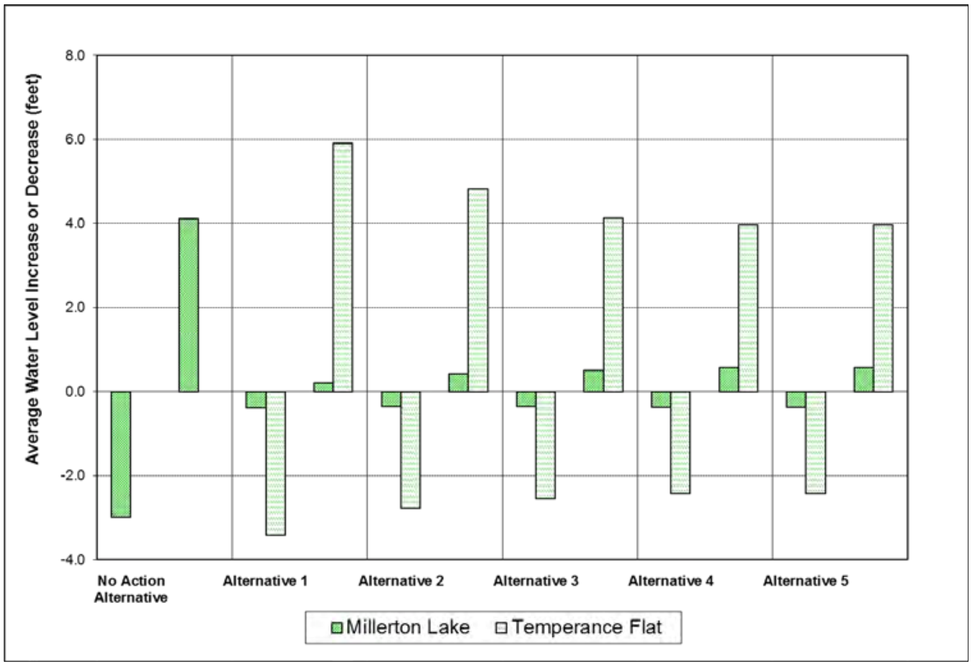
High turbidity and sedimentation have a number of potentially adverse effects on fish, including smothering of eggs, injury to gills, impairment of visual feeding, and reduced food web production (Kerr 1995). However, while these effects would potentially suppress fish production in Temperance Flat RM 274 Reservoir, any such suppression would be offset by improved habitat conditions in Millerton Lake and an overall increase in habitat availability (see also Impact FSH-7: Change in Shallow-Water Habitat for Largemouth Bass, Spotted Bass, Smallmouth Bass and other Sport Fish Species; and Impact FSH-8: Change in Open Water Habitat for Striped Bass and American Shad). Spring (April through June) water level fluctuations in Millerton Lake under all action alternatives are substantially reduced, which would minimize turbidity and erosion levels. This impact would be less than significant and beneficial in Millerton Lake.

Overall, this impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.



Note: Averages include zero change value.

**Figure 5-7. Change in Reservoir Water Levels During April Through June Under Existing Conditions**



Note: Averages include zero change value.

**Figure 5-8. Change in Reservoir Water Levels During April Through June Under Future Conditions**

#### *Impact FSH-6: Loss of Reservoir Fish Caused by Entrainment*

### Primary Study Area – Millerton Lake and Temperance Flat Reservoir Area

*No Action Alternative* Under the No Action Alternative, seasonal variations in surface elevation of Millerton Lake are expected to vary similar to those of the reservoir under existing conditions, so the depth of fish with respect to the outlet would remain unchanged (Figure 5-9 and additional figures in the Modeling Appendix). However, reoperation of Friant Dam under the No Action Alternative could potentially change the reservoir storage release and diversion schedule and affect fish entrainment rates, but this effect is expected to be small and not a substantial change from existing conditions.

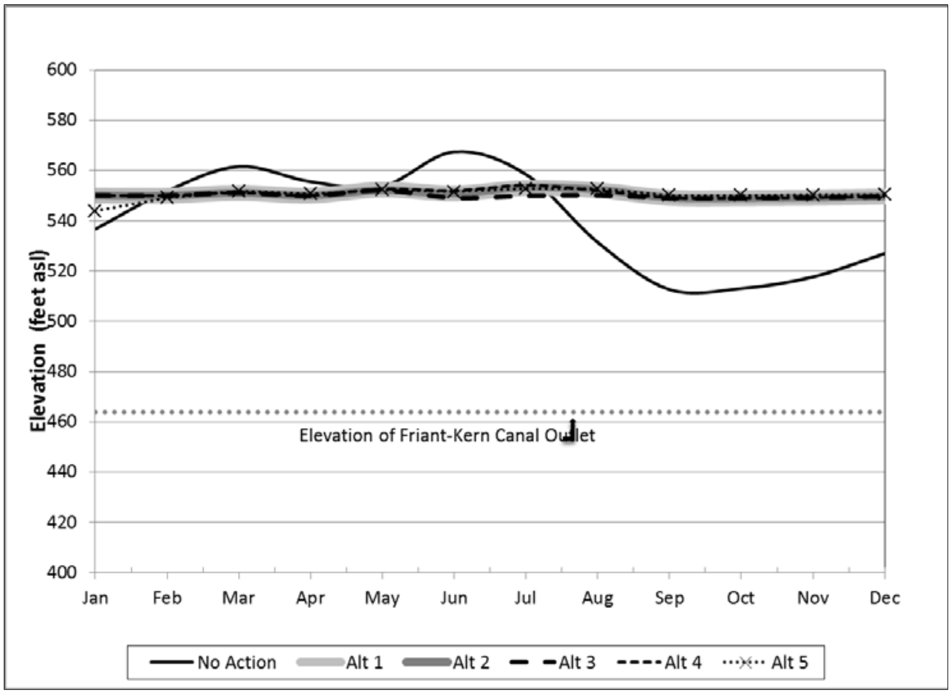


**Figure 5-9. Average Water Surface Elevations of Millerton Lake Relative to the Friant-Kern Canal Outlet Elevation in Wet and Above-Normal Water Years**

Outlets of large dams may adversely affect the reservoir fish both by entrainment of fish and by washout of food web resources, especially plankton, that support the fish populations (CH2M Hill 2003, Marotz et al. 1996). Rapid washout of the reservoir's food web resources could affect growth and survival of many species in Millerton Lake. However, the average flushing rate for Millerton Lake, which is the average time required for the reservoir's total storage volume to pass through the reservoir, is roughly 4 months. This far exceeds the replacement time needed for the plankton to regenerate. Under average growth conditions, algae generally require no more than a week or two to double in population (Jassby 2008, Kimmel et al. 1990). Growth of zooplankton populations is slower than this, but rapid enough for regeneration. It is therefore concluded that washout of food resources does not affect fish in Millerton Lake.

No studies have been conducted on entrainment of fish at Friant Dam, but it is likely that small, open-water species, particularly threadfin shad, do experience entrainment at the dam. Juvenile striped bass and American shad could also be affected. Small-sized open-water fish species, such as threadfin shad and the young life stages of striped bass and American shad, are the most vulnerable to entrainment because they are most likely to reside in the vicinity of the reservoir outlets and because, relative to larger fish, they are unable to swim against the currents drawing them to an outlet. Threadfin shad are the primary prey species for striped bass. Fish are most at risk of entrainment when they reside at the same reservoir depth from which water is released. In Millerton Lake, the depth of the epilimnion likely determines the depth at which the open-water fish species reside, because the epilimnion is where food production rates are highest. During spring and summer, when the young, vulnerable life stages of fish are most abundant and when fish are most actively feeding, the epilimnion of Millerton Lake is less than 50 feet deep. Threadfin shad are rarely found at depths greater than about 60 feet (Moyle 2002). Operations modeling indicates that much of the time the outlet from the reservoir to the Friant-Kern Canal, which is the shallowest outlet of the reservoir, is more than 50 feet below the surface (see the Modeling Appendix for additional figures). At such times, fish entrainment rates are likely to be relatively low. However, in late summer and fall of Dry and Critical years, the reservoir surface approaches the depth of the outlet, and increased entrainment would be likely. Under the No Action Alternative, seasonal variations in water surface elevation of Millerton Lake and depth of the fish are expected to vary similar to those of the reservoir under existing conditions,

This impact would be **less than significant** under the No Action Alternative.

*Action Alternatives* The average flushing rate of the proposed Temperance Flat RM 274 Reservoir would be lower than that of Millerton Reservoir, requiring about 9 months to replace the full volume of the reservoir. Therefore, washout of food resources would not affect fish in Temperance Flat RM 274 Reservoir.

Implementation of any of the action alternatives is expected to result in a large and consistent separation of the upper water layers of Millerton Lake, where most fish are expected to reside, from the Friant-Kern outlet under both existing and future conditions (see the Modeling Appendix for figures). This change is expected to result in a reduction in fish entrainment rates.

The depth of the epilimnion in Temperance Flat RM 274 Reservoir during spring and summer, like that in Millerton Lake, is expected to be less than 50 feet under both existing and future conditions. In all months and water year types, the low-level gates, which are the main outlet structures for all five of the action alternatives, are expected to lie more than 100 feet below the average expected surface elevation of Temperance Flat RM 274 Reservoir (see the Modeling Appendix for additional figures). At this depth, fish entrainment is expected to be small relative to the sizes of the fish populations in the reservoir. The low-level gates are the only outlet structures for Alternative Plans 1, 2, 3, and 5, and entrainment of fish is not expected to significantly affect the fish populations under these alternatives, except for Alternative Plan 5, whose average surface elevation approaches the low-level gates in the late summer and fall of Dry and Critical years.

Alternative Plan 4 includes an SLIS, with upper gates at elevations of 700 feet, 800 feet, and 900 feet above sea level. One of these gates lies close to the reservoir surface elevation at all times (see the Modeling Appendix for additional figures). The SLIS gates are operated primarily during late winter, spring, and early summer, when young life stages of threadfin shad, American shad, and striped bass are most abundant. Entrainment from Temperance Flat RM 274 Reservoir is likely to be relatively high under Alternative Plan 4. However, the higher entrainment at Temperance Flat RM 274 Reservoir under Alternative Plan 4 would be offset by the lower entrainment at Friant Dam, resulting in little overall net effect on fish entrainment. Relative to the size of the fish populations, it is unlikely that the change in entrainment in either reservoir would have more than a minor effect.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

#### ***Impact FSH-7: Change in Shallow-Water Habitat for Largemouth Bass, Spotted Bass, Smallmouth Bass, and Other Sport Fish Species***

##### Primary Study Area – Millerton Lake and Temperance Flat Reservoir Area

*No Action Alternative* Under the No Action Alternative, the reservoir surface-level fluctuations (see Figure 5-10 and Figure 5-11) and the surface area of shallow-water habitat would be similar to those under existing conditions. Results of the Black

Bass Spawning Production Model show very little difference between existing conditions and the No Action Alternative, with a 0.3 percent reduction in the index for largemouth bass and a 1.5 percent increase for spotted bass. The Black Bass Spawning Production Model integrates effects of surface area, water temperature, surface-level fluctuations, and other habitat factors to produce an overall index of largemouth bass and spotted bass habitat quantity and quality. The No Action Alternative has little effect on shallow-water habitat in Millerton Lake.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* Implementation of any of the action alternatives is expected to result in increased surface area of shallow-water habitat and reduced surface-level fluctuations in Millerton Lake. These changes are expected to increase the availability and improve the quality of shallow-water habitat for black bass and other sport fish. Increases in water temperatures, as previously noted, could benefit or adversely affect habitat quality, depending on the time of year and the level of increase. Results of the Black Bass Spawning Production Model for the action alternatives show substantial increases in spawning production for largemouth bass and spotted bass compared to results for the reservoir under both existing and future conditions. These changes would benefit black bass and other sport fish species.

Changes in shallow-water habitat surface area for Millerton Lake and the Temperance Flat RM 274 Reservoir under the action alternatives are shown in Figure 5-10 and Figure 5-11. Shallow-water habitat is quantified as the mean surface area from the shoreline to a depth of 15 feet during April through September, the principal period of spawning and juvenile rearing for black bass. The action alternatives are expected to increase, relative to the No Action Alternative and existing conditions, in the total surface area (both reservoirs) of shallow-water habitat ranging from 16 to 19 percent. The net habitat increases would result from the increased storage upstream from the Temperance Flat RM 274 Dam. The gains in shallow-water habitat are substantial despite the relatively steep shoreline in most of the area of the basin upstream from the dam and the decreased shallow-water habitat in Millerton Lake under the action alternatives relative to the No Action Alternative.

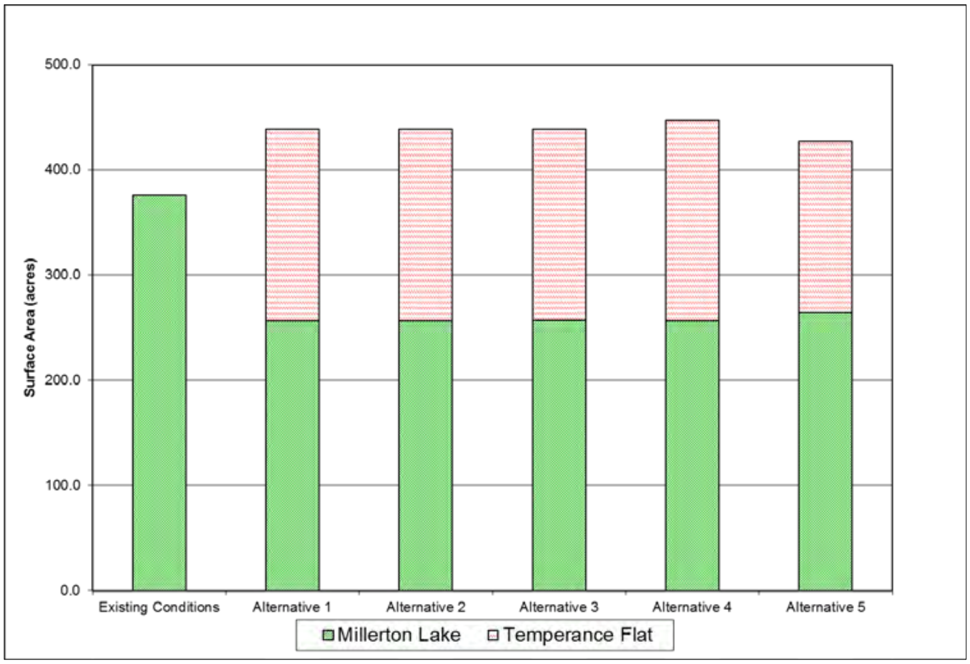


**Figure 5-10. Mean April to September Reservoir Shallow Water (0 to 15 feet) Surface Areas Under Existing Conditions**

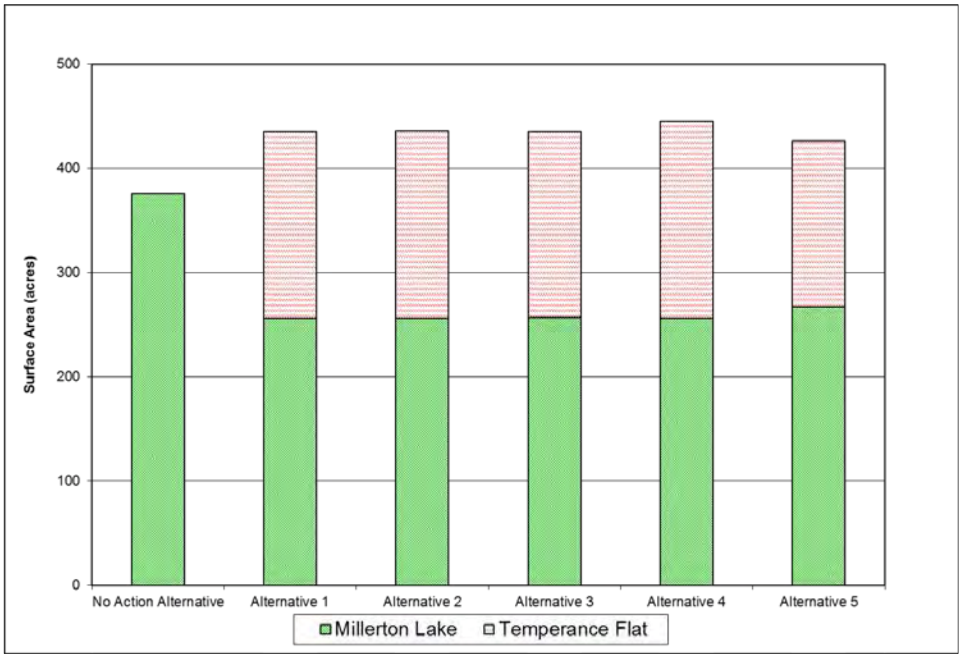


**Figure 5-11. Mean April to September Reservoir Shallow Water (0 to 15 feet) Surface Areas Under Future Conditions**

Figure 5-7 and Figure 5-8 show the mean expected increases and reductions in reservoir surface elevations over a quarter-month for Millerton Lake and the action alternatives under existing and future conditions, respectively. The means were determined for the March-through-June period of black bass spawning. Water-level fluctuations following implementation of the action alternatives would be much smaller for Millerton Lake, compared to the No Action Alternative and existing conditions. Water level fluctuations in Temperance Flat RM 274 Reservoir are expected to be similar to those in Millerton Lake under the No Action Alternative and existing conditions. The net effect would be an overall reduction in water-level fluctuations during the primary black bass spawning months.

Spawning production indices were computed for largemouth bass and spotted bass for Millerton Lake under existing conditions and the No Action Alternative, and for Millerton Lake and Temperance Flat RM 274 Reservoir under the five action alternatives (Figure 5-12 through Figure 5-15). The model results show substantial increases in overall spawning production for the action alternatives in comparison to the No Action Alternative and existing conditions, especially for spotted bass. For both species, Alternative Plan 4 consistently shows the highest spawning production. For largemouth bass, production in Millerton Lake would be reduced from that of the No Action Alternative and existing conditions (Figure 5-12 and Figure 5-13), which results from the loss of the Millerton Lake shallow-water habitat in the basin upstream from the Temperance Flat RM 274 Dam at RM 274. However, the loss of spawning production in Millerton Lake would be more than offset by the production in the new Temperance Flat RM 274 Reservoir. For spotted bass, production in Millerton Lake under the action alternatives would be similar to the No Action Alternative and existing conditions (Figure 5-14 and Figure 5-15), despite the substantial loss of Millerton Lake shallow-water habitat in the basin upstream from the Temperance Flat RM 274 Dam. The large reduction in reservoir surface-level fluctuations is likely largely responsible for the increased habitat value per area of Millerton Lake under the action alternatives. The increases in spawning production of largemouth bass and spotted bass would be beneficial. Effects of the action alternatives on production of smallmouth bass and other warm-water sport fishes (e.g., crappie and sunfish) would be similar to the results predicted by the model simulations for largemouth and spotted bass. Smallmouth bass, in particular, have very similar reservoir habitat requirements to those of largemouth bass.

This impact would be **beneficial** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

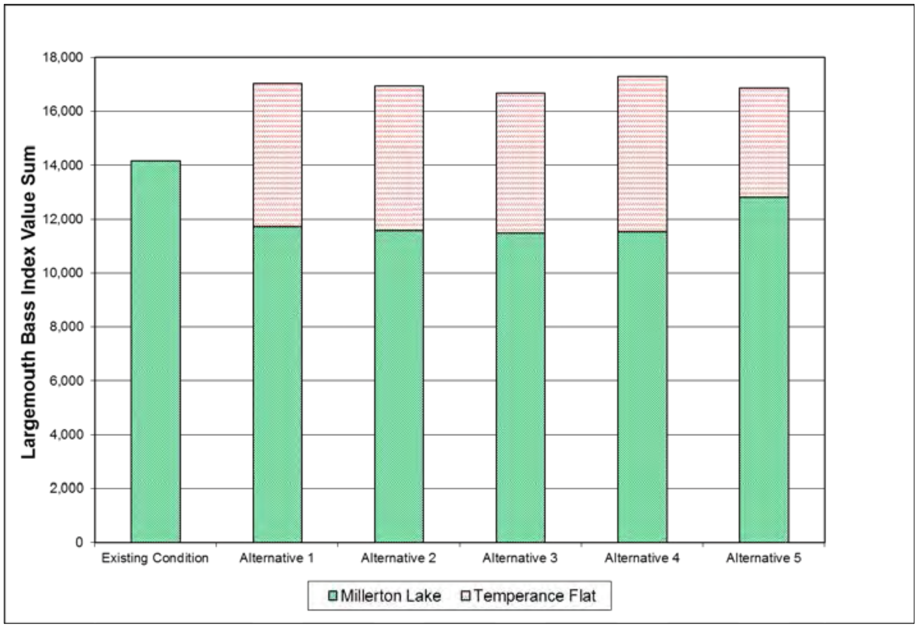


**Figure 5-12. Largemouth Bass Spawning Production Indices Under Existing Conditions**

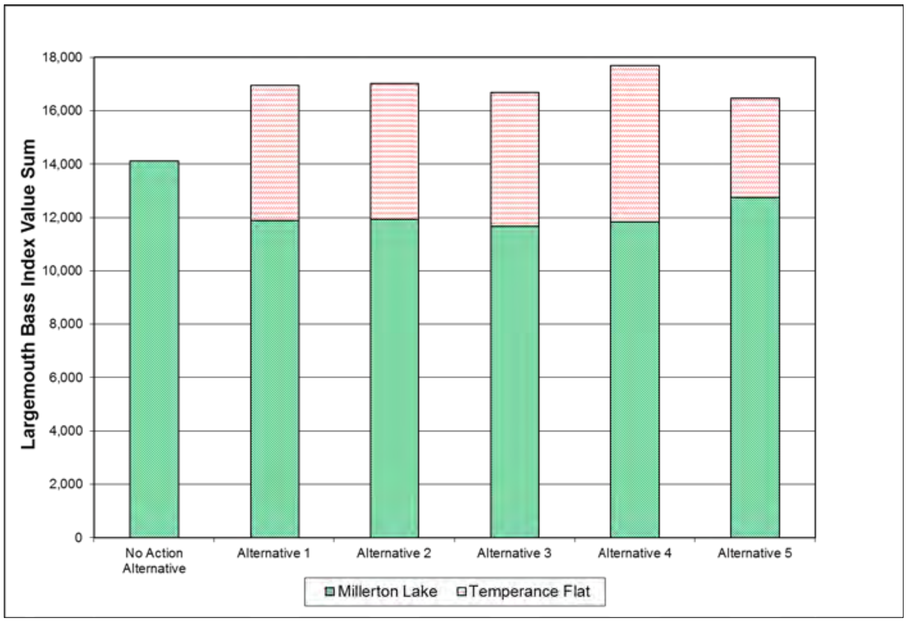


**Figure 5-13 Largemouth Bass Spawning Production Indices Under Future Conditions**

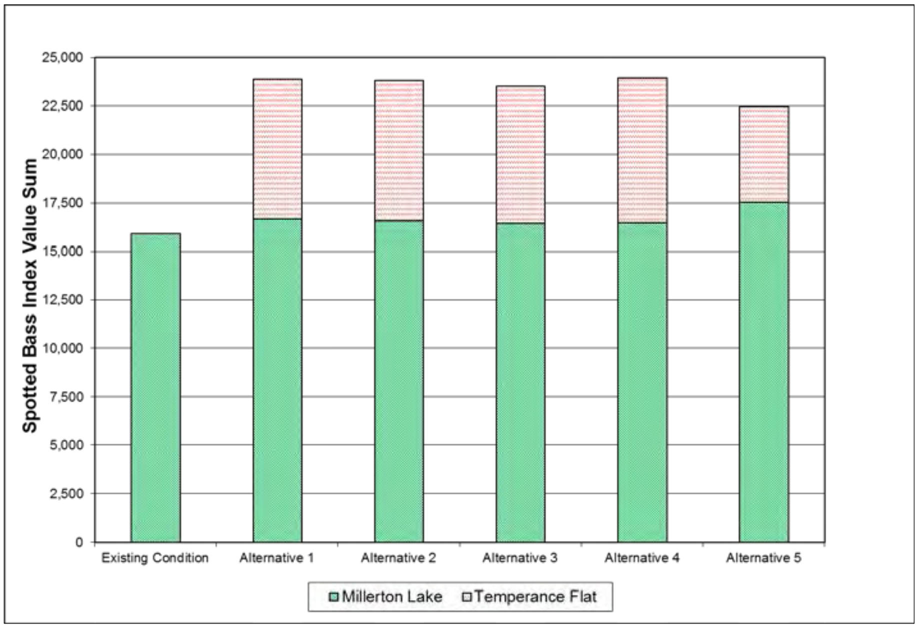


Figure 5-14. Spotted Bass Spawning Production Indices Under Existing Conditions

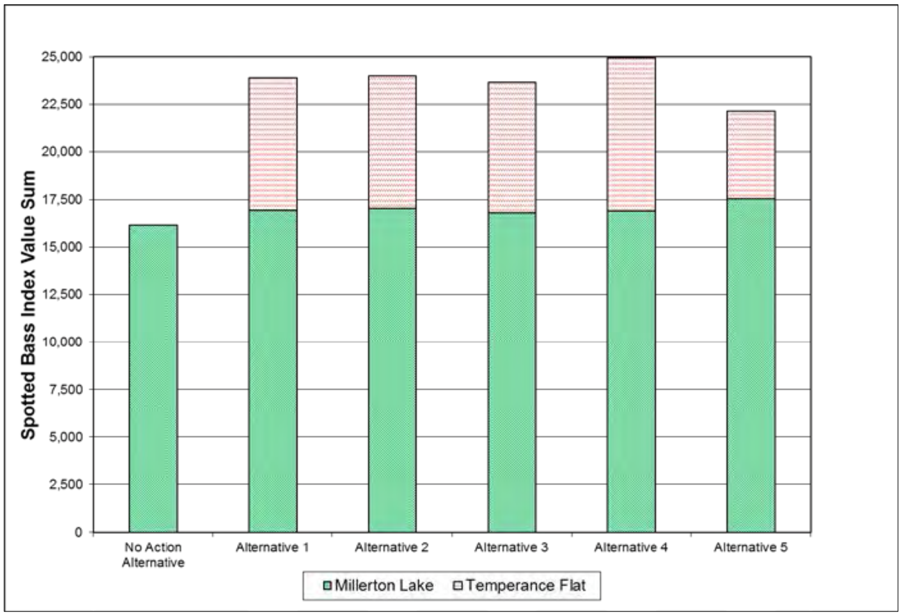


Figure 5-15. Spotted Bass Spawning Production Indices Under Future Conditions

### *Impact FSH-8: Change in Open-Water Habitat for Striped Bass and American Shad*

#### Primary Study Area – Millerton Lake and Temperance Flat Reservoir Area

*No Action Alternative* The No Action Alternative would not result in any change in the volume or surface area of open-water habitat for striped bass or American shad.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* The action alternatives would result in about a threefold increase in the volume and twofold increase in surface area of deep, open-water reservoir habitat as compared to the No Action Alternative and existing conditions. Striped bass and American shad both forage in the open water of Millerton Lake. Increasing the volume and surface area of this foraging habitat is likely to result in increased food resources, leading ultimately to larger populations of both species.

This impact would be **beneficial** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### *Impact FSH-9: Loss of Spawning Habitat of American Shad and Striped Bass*

#### Primary Study Area – Millerton Lake and Temperance Flat Reservoir Area

*No Action Alternative* The upper portion of Millerton Lake and its confluence with the San Joaquin River are currently used for spawning by American shad and may be sporadically used by striped bass. Because Temperance Flat RM 274 Dam would not be constructed under the No Action Alternative, there would be no change in the access of American shad or striped bass (if used) to their current spawning habitat.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* The action alternatives would eliminate American shad spawning habitat in the upper portion of Millerton Lake and its confluence with the San Joaquin River. Construction of Temperance Flat RM 274 Dam would prevent American shad within Millerton Lake from spawning upstream.

The loss of potential spawning habitat for striped bass would not significantly affect the striped bass population because this population is almost completely sustained by stocking. However, American shad are not stocked and the loss of upstream spawning habitat above Millerton Lake would likely eradicate the American shad population in Millerton Lake, which is a unique population because they are the only known self-sustaining inland population; further, stocking these fish would not be a viable option to maintain its unique value.

The action alternatives have the potential to create new spawning habitat for American shad in the upper portion of the Temperance Flat RM 274 Reservoir within the San Joaquin River channel below Kerckhoff Dam. Flows from Kerckhoff Dam into this reach might provide suitable spawning conditions. Even at full pool, the constrained character of this reach of the river would likely produce suitable riverine conditions in the reservoir. Therefore, as long as flow releases from Kerckhoff Dam were sufficient, the reservoir might sustain shad spawning over a broad range of reservoir levels and the Millerton Lake population could become reestablished in Temperance Flat RM 274 Reservoir. However, even if spawning habitat for American shad were available in Temperance Flat RM 274 Reservoir, the population remaining in Millerton Lake would be prevented from accessing this habitat by the presence of the Temperance Flat RM 274 Dam. Some shad might continue to occur in Millerton Lake as a result of entrainment from Temperance Flat RM 274 Reservoir, assuming they were able to survive passage through the power plants, but such shad would be excluded from the spawning population and would not be self-reproducing; any American shad in Millerton Lake would depend on successful shad reproduction and survival in Temperance Flat RM 274 Reservoir and entrainment from this new population into Millerton Lake.

The average surface area of the proposed Temperance Flat RM 274 Reservoir is similar to that of the existing Millerton Lake and the volume is about twice as large. Therefore, assuming the shad population was able to survive, grow, and reproduce successfully in the Temperance Flat RM 274 Reservoir, there is no reason to expect that the relocated population would be any smaller than the current population in Millerton Lake. However, the potential for American shad to be introduced into, and survive, grow, and reproduce successfully in the new reservoir is uncertain, so the loss of the Millerton Lake population creates a moderate risk of eliminating the American shad population upstream from Friant Dam.

This impact would be **significant** under the action alternatives. No feasible avoidance or minimization measures are available to reduce this impact below the level of significance. Mitigation for this impact is not proposed because no feasible mitigation is available to reduce the impact to a less-than-significant level.

### *Impact FSH-10: Change in Habitat Potential for Spring-Run Chinook Salmon*

#### Extended Study Area – San Joaquin River from Friant Dam to the Merced River

*No Action Alternative* Under existing conditions the extended study area does not support a spring-run Chinook salmon run. Under the No Action Alternative the SJRRP would be fully implemented, including a self-reproducing population of spring-run Chinook salmon.

This impact would be **beneficial** under the No Action Alternative.

*Alternative Plans 1 through 4* Alternative Plans 1 through 4 each have modest but variable effects on spring-run Chinook salmon habitat potential with the effects varying by water year type and SAR scenario. High and low SAR scenario results and the percent change relative to the No Action Alternative are included in Table 5-7 and Table 5-8. Alternative Plans 1 through 4 beneficially improve habitat potential during Dry years, producing increases in habitat productivity, capacity, and equilibrium abundance that exceed significance criteria. These beneficial effects offset scattered negative effects that exceed the habitat productivity significance criterion in Normal-Wet years. Collectively, the EDT model results suggest that the action alternatives will benefit spring-run Chinook because they significantly increase minimum habitat potential during the most extreme conditions.

The largest positive effects occur during Dry years under high SAR conditions. Alternative Plans 1 through 4 increase Dry year habitat capacity and productivity by as much as 10.6 percent to 13.1 percent and 7.6 percent to 9.0 percent, respectively. Dry year equilibrium abundance increases by as much as 13.2 percent to 15.9 percent (Table 5-7). Smaller increases in capacity, productivity, and abundance occur under all action alternatives in Normal-Dry years.

### Table 5-7. Modeling Results and Percent Change for High Smolt-to-Adult Survival Rate

| Alternative | Habitat Productivity[1] | | | | Habitat Capacity[2] | | | | Equilibrium Abundance[3] | | | | Weighted Average Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dry | Normal-Dry | Normal-Wet | Wet | Dry | Normal-Dry | Normal-Wet | Wet | Dry | Normal-Dry | Normal-Wet | Wet | |
| No Action Alternative | 4.32 | 5.27 | 5.62 | 6.6 | 3,179 | 4,247 | 4,911 | 7,851 | 2,443 | 3,441 | 4,037 | 6,661 | 3,895 |
| Alternative Plan 1 | 4.7 | 5.3 | 5.64 | 6.87 | 3,596 | 4,369 | 5,043 | 7,726 | 2,831 | 3,545 | 4,149 | 6,601 | 4,005 |
| | 8.8% | 0.6% | 0.4% | 4.1% | 13.1% | 2.9% | 2.7% | -1.6% | 15.9% | 3.0% | 2.8% | -0.9% | 2.8% |
| Alternative Plan 2 | 4.69 | 5.32 | 5.65 | 6.84 | 3,515 | 4,408 | 5,054 | 7,703 | 2,766 | 3,579 | 4,159 | 6,577 | 4,003 |
| | 8.6% | 0.9% | 0.5% | 3.6% | 10.6% | 3.8% | 2.9% | -1.9% | 13.2% | 4.0% | 3.0% | -1.3% | 2.8% |
| Alternative Plan 3 | 4.71 | 5.38 | 5.49 | 6.57 | 3,556 | 4,327 | 4,937 | 7,541 | 2,801 | 3,523 | 4,038 | 6,393 | 3,919 |
| | 9.0% | 2.1% | -2.3% | -0.5% | 11.9% | 1.9% | 0.5% | -3.9% | 14.7% | 2.4% | 0.0% | -4.0% | 0.6% |
| Alternative Plan 4 | 4.65 | 5.37 | 5.86 | 6.97 | 3,522 | 4,446 | 5,253 | 7,737 | 2,765 | 3,618 | 4,357 | 6,627 | 4,085 |
| | 7.6% | 1.9% | 4.3% | 5.6% | 10.8% | 4.7% | 7.0% | -1.5% | 13.2% | 5.1% | 7.9% | -0.5% | 4.9% |
| Alternative Plan 5 | 4.60 | 2.92 | 5.59 | 6.60 | 3,693 | 4,237 | 4,784 | 6,738 | 2,890 | 2,788 | 3,928 | 5,718 | 3,552 |
| | 6.5% | -44.5% | -0.6% | 0.1% | 16.2% | -0.2% | -2.6% | -14.2% | 18.3% | -19.0% | -2.7% | -14.2% | -8.8% |

Notes:

[1] Habitat productivity is the number of returning adults per original spawning adult.

[2] Habitat capacity is the number of fish that can be supported by the available habitat.

[3] Equilibrium abundance is the theoretical population size that habitat of a given quantity and quality (capacity and productivity) can support.

### Table 5-8. Modeling Results and Percent Change for Low Smolt-to-Adult Survival Rate

| Alternative | Habitat Productivity[1] | | | | Habitat Capacity[2] | | | | Equilibrium Abundance[3] | | | | Weighted Average Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dry | Normal-Dry | Normal-Wet | Wet | Dry | Normal-Dry | Normal-Wet | Wet | Dry | Normal-Dry | Normal-Wet | Wet | |
| No Action Alternative | 3.09 | 3.80 | 4.25 | 4.83 | 611 | 827 | 944 | 1,444 | 413 | 609 | 722 | 1,144 | 682 |
| Alternative Plan 1 | 3.29 | 3.74 | 4.15 | 4.96 | 677 | 833 | 943 | 1,417 | 471 | 610 | 716 | 1,131 | 686 |
| | 6.5% | -1.6% | -2.4% | 2.7% | 10.8% | 0.7% | -0.1% | -1.9% | 14.0% | 0.2% | -0.8% | -1.1% | 0.6% |
| Alternative Plan 2 | 3.28 | 3.76 | 4.15 | 4.94 | 649 | 840 | 945 | 1,413 | 451 | 616 | 717 | 1,127 | 685 |
| | 6.1% | -1.1% | -2.4% | 2.3% | 6.2% | 1.6% | 0.1% | -2.1% | 9.2% | 1.1% | -0.7% | -1.5% | 0.4% |
| Alternative Plan 3 | 3.29 | 3.79 | 4.09 | 4.77 | 672 | 832 | 937 | 1,389 | 468 | 613 | 707 | 1,098 | 678 |
| | 6.5% | -0.3% | -3.8% | -1.2% | 10.0% | 0.6% | -0.7% | -3.8% | 13.3% | 0.7% | -2.1% | -4.0% | -0.6% |
| Alternative Plan 4 | 3.25 | 3.78 | 4.29 | 5.04 | 663 | 848 | 984 | 1,417 | 459 | 624 | 754 | 1,136 | 701 |
| | 5.2% | -0.5% | 0.9% | 4.3% | 8.5% | 2.5% | 4.2% | -1.9% | 11.1% | 2.5% | 4.4% | -0.7% | 2.8% |
| Alternative Plan 5 | 3.23 | 2.07 | 4.14 | 4.79 | 696 | 813 | 902 | 1237 | 480 | 420 | 684 | 979 | 593 |
| | 4.5% | -45.5% | -2.6% | -0.9% | 13.9% | -1.7% | -4.4% | -14.3% | 16.3% | -31.0% | -5.2% | -14.4% | -13.1% |

Notes:

[1] Habitat productivity is the number of returning adults per original spawning adult.

[2] Habitat capacity is the number of fish that can be supported by the available habitat.

[3] Equilibrium abundance is the theoretical population size that habitat of a given quantity and quality (capacity and productivity) can support.

The effects of Alternative Plans 1 through 4 are more mixed in Normal-Wet and Wet water year types. Alternative Plans 1 through 4 negatively affect habitat capacity and productivity in Wet years (Table 5-7). These effects result primarily from a reduction in capacity as a result of smaller channel widths during winter and spring through the capture of flood peaks in Temperance Flat RM 274 Reservoir. Alternative Plans 1, 2, and 4 have comparable negative Wet year effects on capacity and equilibrium abundance, while Alternative Plan 3 has larger negative effects that extend into Normal-Wet years as well.

Under low SAR conditions, Alternative Plans 1 through 4 increase Dry year habitat capacity and productivity by 6.2 percent to 10.8 percent and 5.2 percent to 6.5 percent, respectively. Dry year equilibrium abundance increases from 9.2 percent to 14 percent (Table 5-8). As with the high SAR results, the EDT model predicts smaller increases in capacity and abundance to occur under Normal-Dry years for Alternative Plans 1 through 4. Effects on habitat potential are similarly mixed in Normal-Wet and Wet water year types, with Alternative Plans 1 through 4 having negative effects on habitat capacity and productivity in Wet years, relative to the No Action Alternative.

Alternative Plans 1 through 4 result in a modest increase in weighted average equilibrium abundance ranging from 0.6 percent to 4.9 percent, relative to the No Action Alternative under high SAR conditions (Table 5-7). The increase in equilibrium abundance realized during Dry, Normal-Dry, and Normal-Wet years offsets negative effects during Wet years. These weighted average results are below the significance criterion for equilibrium abundance. These beneficial effects are the result of decreases in water temperature conditions in Reaches 1 and 2. Alternative Plan 4 results in the largest weighted average increase in equilibrium abundance of 4.9 percent (see the Modeling Appendix for tables of results).

Low SAR weighted average abundance change by less than 1 percent under Alternative Plans 1 through 3; Alternative Plan 4 results in an increase of 2.8 percent (Table 5-8). The relatively large increases in equilibrium abundance, capacity, and productivity during Dry and Normal-Dry water year types offset smaller decreases during Wet and Normal-Wet years. Dry year effects exceed the criteria for equilibrium abundance, capacity, and diversity under each action alternative. Generally speaking, these beneficial effects on Dry year habitat potential are likely to outweigh any negative effects during Wet years, resulting in a net benefit to spring-run Chinook under all alternatives.

This conclusion is based on the assumption that increases in minimum population size during Dry years will support population resilience more than relatively small decreases in maximum population size. For example, under low SAR conditions, EDT results predicted Dry year equilibrium abundance under Alternative Plans 1 through 4 below the effective population size objective of 500 spawning adults specified in the SJRRP Fisheries Management Plan (Reclamation 2012a), but Alternatives 1 through 4 increase predicted equilibrium abundance by 9.2 to 14.0 percent (46 to 70 adult fish). In contrast, predicted Wet year equilibrium abundance decreased by only 0.7 to 4.0 percent (4 to 20 adult fish). While EDT abundance results should not be viewed as actual predictions of future population size, these results suggest that Alternative Plans 1 through 4 could improve habitat conditions in the San Joaquin River and enhance the potential population.

This impact would be **less than significant and beneficial** under Alternative Plans 1 through 4. Mitigation for this impact is not needed and thus not proposed.

*Alternative Plan 5* For Alternative Plan 5, the largest positive effects occur under the high SAR conditions, during Dry years, where the habitat capacity and productivity is 16.2 percent and 6.5 percent respectively (Table 5-7). In Normal-Dry years, the habitat capacity for Chinook salmon is essentially unchanged (-0.2 percent) but habitat productivity decreases by 44.5 percent (Table 5-7). This results in a decrease in high SAR equilibrium abundance of 19.0 percent. Alternative Plan 5 negatively affects habitat capacity and productivity in Wet years (Table 5-7). These effects result primarily from a reduction in capacity as a result of smaller channel widths during winter and spring as a result of the capture of flood peaks in Temperance Flat RM 274 Reservoir.

Under low SAR conditions, Alternative Plan 5 shows an increased Dry year habitat capacity and productivity by 13.9 percent and 4.5 percent, respectively (Table 5-8). However, in Normal-Dry years, Alternative 5 results in a decrease in habitat capacity by 1.7 percent and decreased habitat productivity by 45.5 percent, a large negative effect reflected in a decrease in equilibrium abundance of 31 percent (Table 5-8). Assuming an effective population size of 500 spawning adults, this would result in a decrease in 155 fish. Alternative Plan 5 also results in large negative effects on habitat productivity, capacity, and abundance that exceed significance criteria in Normal-Wet and Wet water years.

Alternative Plan 5 would have a **potentially significant** impact. No feasible avoidance or minimization measures are available to reduce this impact below the level of significance. Mitigation for this impact is not proposed because no feasible mitigation is available to reduce the impact to a less-than-significant level.

### *Impact FSH-11: Change in Water Temperature Conditions Supporting Juvenile Salmon and Steelhead Migration*

#### Extended Study Area – San Joaquin River from Friant Dam to the Merced River

*No Action Alternative* Under the No Action Alternative water temperatures would reflect conditions created by the full implementation of the Settlement in the year 2030.

Simulated conditions under the No Action Alternative vary by water year type through Reach 4A, where water temperatures have effectively reached thermal equilibrium. Water temperatures in Reach 1A immediately downstream from Friant Dam differ substantially from those likely to occur in the remaining 123 river miles from the upstream end of Reach 1B to the Merced River. Under the No Action Alternative, water temperatures remain below threshold throughout the entire January 1 to June 1 period in all water year types in Reach 1A, but threshold exceedence becomes more variable in downstream reaches. Figure 5-16 shows simulated No Action Alternative water temperatures at the downstream end of Reach 1A. As shown, the cooler 10th percentile water temperatures remain below threshold during the entire January 1 to June 1 period, but that period shrinks by approximately 4 to 8 weeks for the typical 50th and warmer 90th percentile temperatures.

It is important to note that the water temperatures shown are modeled daily average temperatures, not daily maximums. The daily maximums vary from about 1-2°F above the average daily water temperature in November to February to about 2-4°F above the daily mean water temperature in July to August. Figure 5-17 shows the distribution of the daily fluctuation at Gravely Ford for the No Action Alternative.

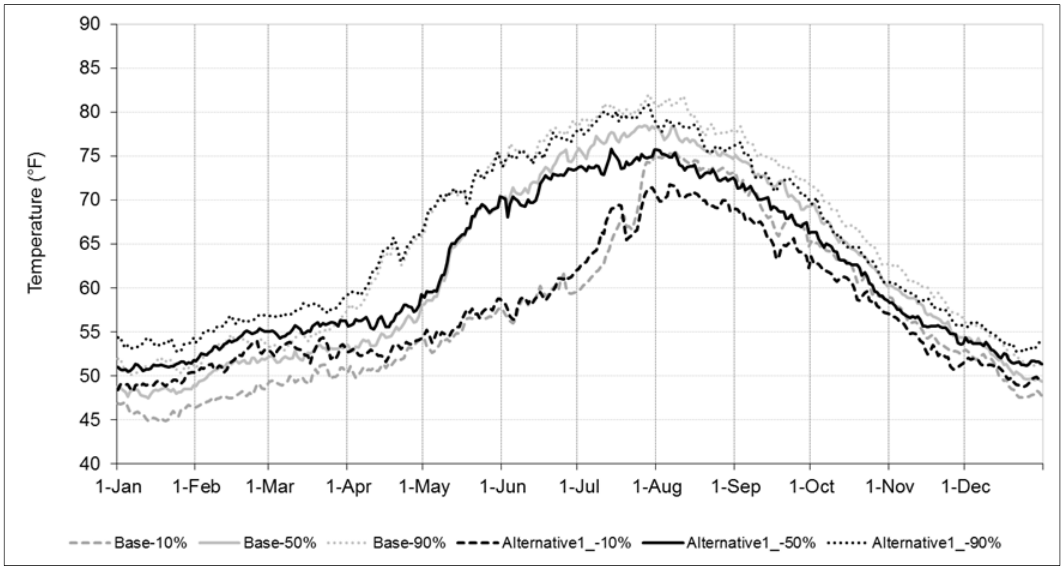


Figure 5-16. San Joaquin River Modeled Water Temperatures at the Upstream End of Reach 2A Under the No Action Alternative and Alternative Plan 1, 10th, 50th, and 90th Percentile Temperature Years

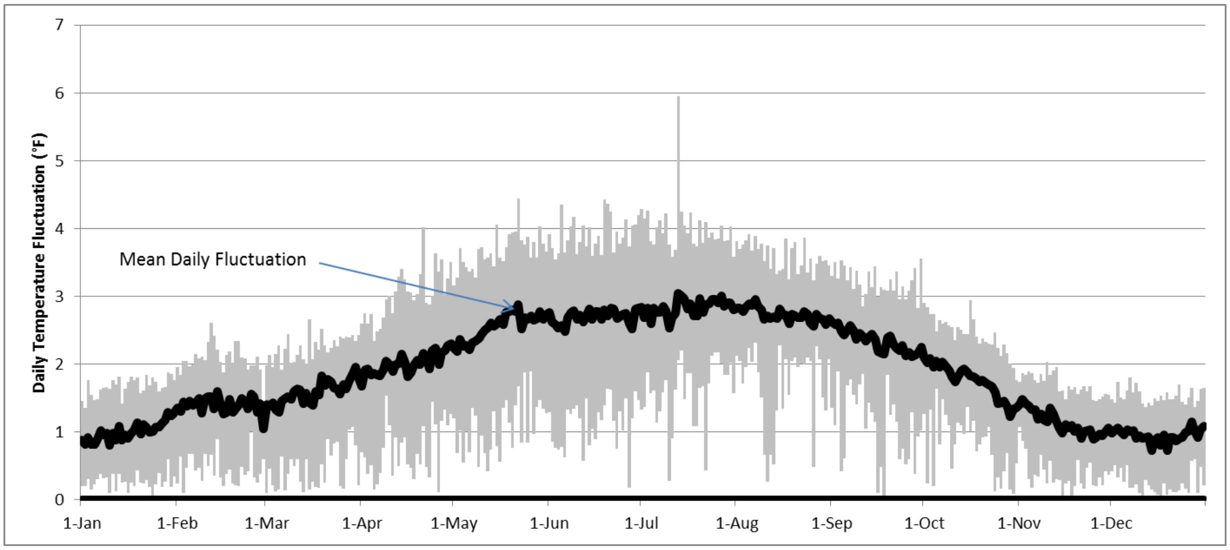


Figure 5-17. San Joaquin River Daily Water Temperature Fluctuation Around the Daily Mean at Gravelly Ford in the No Action Alternative

From Gravelly Ford downstream, water temperatures exceed 55°F over an increasingly large portion of the January 1 to June 1 period in all water year types. The pattern across water year types is similar to that for Reach 1A. For the warmer 90th percentile temperatures, the window with water temperatures below 55°F across the entire stretch of San Joaquin River from

Friant Dam to Merced River, lasts for only 5 weeks and ends in early February. These water temperatures represent a potential limitation on the duration of suitable temperature conditions for salmon and steelhead smolting and outmigration. The temperature conditions are very similar between existing conditions and the No Action Alternative.

This impact would be **less than significant** under the No Action Alternative.

*Action Alternatives* Each of the action alternatives would reduce the number of weeks between January 1 and June 1 with 7-day average water temperatures below the 55°F temperature threshold in at least one reach in all water temperature year types, at all exceedence levels, with the largest effects occurring between reaches 1B and 2B2. Simulated effects on threshold exceedence are negligible downstream from Reach 3. The action alternatives decrease the number of weeks below the 55°F water temperature threshold by 2 to 7 weeks at the 90th percentile water temperature in the 51 river miles in reaches 1B and 2A. The warming effect shifts downstream at the typical 50th percentile, with 55°F temperature threshold exceedence occurring from 1 to 7 weeks earlier in reaches 2B1 and 2B2. Weeks below the 55°F threshold decrease by 1 to more than 7 weeks under each action alternative at the cooler 10th percentile water temperature, extending as far downstream as Reach 3.

The action alternatives all increase simulated water temperatures between December and May and decrease temperatures in mid- to late-summer and fall which may improve spawning and holding habitat conditions for spring-run Chinook salmon. The effect on migratory corridor conditions is evident in modeled water temperature conditions, which are summarized in graph and tabular format in the Modeling Appendix. Figure 5-16 displays water temperature conditions in Reach 2A under the No Action Alternative and Alternative Plan 1 (see the Modeling Appendix for additional figures).

As shown, Alternative Plan 1 increases winter and spring water temperatures over baseline conditions. As a consequence, the 55°F 7-day average temperature threshold is exceeded 6 to 7 weeks earlier than the No Action Alternative at the typical 50th and warmer 90th percentile temperatures (see summary table of results in the Modeling Appendix). The effect is more muted at the cooler 10th percentile. However, the effects of Alternative

Plan 1 are small compared with the large differences in water temperature conditions that occur between water year types under the No Action Alternative. Water temperature effects become negligible downstream from Reach 3 where the river essentially meets thermal equilibrium with air temperatures. Small effects are apparent downstream from this point but do not exceed the significance criterion.

Each of the action alternatives produces similar simulated effects on the number of weeks below threshold throughout the 84-mile stretch of river extending from Reach 1A through Reach 3. This has the effect of altering the timing and distribution of water temperatures suitable for juvenile salmon and steelhead migration and smolting throughout a large component of the migratory corridor, increasing both the distance and duration of exposure to water temperatures that inhibit smolting transformation. For example, Alternative Plan 1 has a large effect on the distribution of 50th percentile temperatures below threshold between Reaches 1B and 2B2. Threshold exceedence occurs from 1 to 7 weeks earlier between Reaches 1B and 2B2 (see summary table of results in the Modeling Appendix). This effectively constrains the period of suitable migration water temperatures in these reaches to the first week of February, meaning that juveniles migrating later would face an additional 38 miles of water temperatures unsuitable for maintaining smolting physiology. The effects are similar at the 10th and 90th percentiles, but they are shifted farther upstream and downstream, respectively. Alternative Plans 2, 3, 4, and 5 have generally similar effects, although there are some important differences by reach (see summary table of results in the Modeling Appendix).

This impact would be **significant** under the action alternatives. No feasible avoidance or minimization measures are available to reduce this impact below the level of significance. Mitigation for this impact is not proposed because no feasible mitigation is available to reduce the impact to a less-than-significant level.

### ***Impact FSH-12: Change to Habitat for Moderately Tolerant Native Fish Species from Altered Water Temperatures***

#### Extended Study Area – San Joaquin River from Friant Dam to the Merced River

*No Action Alternative* Under the No Action Alternative water temperatures would reflect conditions created by the full implementation of the SJRRP.

Simulated temperature conditions for the No Action Alternative are summarized in the Modeling Appendix, including the number of weeks with 7-day average water temperatures below the 77°F threshold (also see the Modeling Appendix for related figures). Water temperatures above this threshold exceed optimal growth conditions for several moderately tolerant resident fish species, including hitch, splittail, Sacramento blackfish, tule perch, and Sacramento pikeminnow, and prickly and riffle sculpin. The extent and duration of temperatures above this threshold represents a limitation on the availability of suitable summer rearing habitat for these species.

The distribution of simulated water temperatures below 77°F varies by reach and water year type. Simulated water temperature conditions are suitable for summer rearing throughout Reaches 1A and 1B. Downstream from Reach 1B, the duration of suitable summer temperatures varies by temperature year. For example, simulated water temperatures in Reach 2A are below the temperature threshold at the cooler10th percentile. In contrast, the 77°F threshold is exceeded by over 4 weeks at the typical 50th percentile and by 3.4 to 5 weeks at the warmer 90th percentile. Downstream from Reach 2A, simulated water temperatures exceed the threshold over longer periods each year, ranging from 15 to 21 weeks in duration (see summary table of results in the Modeling Appendix). Water temperatures exceeding optimal growth ranges in fish typically lead to behavioral avoidance, effectively limiting the amount of habitat available during peak growth periods.

San Joaquin River temperatures are expected to be similar between the existing conditions and the No Action Alternative.

This impact would be **less than significant** under the No Action Alternative.

*Action Alternatives* The action alternatives would have a mixed effect on water temperature conditions for moderately tolerant fish species under most, but not all, circumstances (see the Modeling Appendix). Each action alternative increases the extent, duration, and annual frequency of suitable water temperatures for these species, particularly in Reach 2A. This constitutes a beneficial effect on water temperature conditions for certain native fish species.

Water temperatures exceed the 77°F threshold for over 4 weeks in Reach 2A at the 50th percentile. The action alternatives all reduce simulated water temperatures below the threshold for the entire year in this reach. At the warmer 90th percentile the action alternatives all result in a 3 to 5-week increase in the weeks below the threshold, but water temperatures would remain unsuitable for approximately 8 weeks a year.

The beneficial effects of the action alternatives extend downstream into Reaches 2B1 and 2B2 (see the Modeling Appendix). With the exception of Alternative Plan 3, the action alternatives result in year-round water temperatures below the 77°F threshold in Reach 2B1 at the 10th percentile, resulting in optimal growth conditions throughout the summer. Under Alternative Plan 3, peak water temperatures would exceed the threshold for approximately 1 week. The effects of the action alternatives are less pronounced at the 50th percentile and negligible at the 90th percentile years in Reach 2B1. The effects of Alternative Plans 1, 2, and 4 are similar but less pronounced in Reach 2B2. Alternative Plan 3 has a negligible effect on the number of weeks below the threshold in this reach. In contrast, Alternative Plan 5 has a large positive effect on water temperature conditions in Reaches 2B1 and 2B2, increasing the number of weeks below threshold by 1.7 to 5.1 weeks at the 90th and 50th percentile, respectively.

The action alternatives have variable effects downstream from Reach 2B. Alternative Plans 1, 2, and 3 each result in a 1- to 1.6-week decrease in the number of weeks below the threshold in Reach 3 at the 10th percentile, while Alternative Plan 5 results in a 3.6-week increase.

In Reach 4A, the action alternatives result in decreases of 1.3 to 3.6 weeks below the threshold at the 10th percentile. In Reach 4B, all action alternatives result in 1.9- to 2.3-week decreases in weeks below the threshold at the 10th percentile. The effects of the action alternatives are negligible in these reaches at the 50th and 90th percentile. The action alternatives have negligible effects on water temperatures in Reach 5, with the exception of Alternative Plan 5, which decreases the number of weeks below threshold by 3.7 to 4.3 weeks across all year types (see tables in Modeling Appendix).

When averaged across all years, Alternative Plans 1, 2, 3, and 4 either maintain or modestly improve temperature conditions in each reach. In contrast, Alternative Plan 5 negatively affects temperatures in Reaches 4A and 5, resulting in a decrease of

1.4 to 4.0 weeks below 77°F averaged across all water years. When the duration of suitable water temperatures is averaged across all reaches, Alternative Plan 5 temperatures are similar to the No Action Alternative. Therefore, these negative impacts may be offset by the large increases in the number of weeks below threshold in Reaches 2A, 2B1, and 2B2.

This impact would be **less than significant and beneficial** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### *Impact FSH-13: Change to Habitat for Highly Tolerant Native Fish Species from Altered Water Temperatures*

#### Extended Study Area – San Joaquin River from Friant Dam to the Merced River

*No Action Alternative* Under the No Action Alternative water temperatures would reflect conditions created by the full implementation of the Settlement.

Simulated water temperature conditions for the No Action Alternative are shown in figures and summarized in tabular form in the Modeling Appendix. The tabular summary identifies the change in the number of 7-day periods with average water temperatures below the 84°F threshold under each action alternative relative to the No Action Alternative. Water temperatures above this threshold exceed optimal growth conditions for highly tolerant native fish species, including the Sacramento sucker and hardhead.

Simulated 7-day average water temperatures remain below the 84°F threshold throughout the San Joaquin River from Friant Dam to the Merced River confluence at the cooler 10th percentile, and all but Reach 5 at the typical 50th percentile. At the warmer 90th percentile r temperatures), water temperatures exceed threshold from Reach 2B1 through Reach 4B from 6 to 11 weeks per year. The extent and duration of 7-day average temperatures above 84°F represent a potentially significant limitation on the availability of suitable summer rearing habitat for highly tolerant fish species while providing beneficial conditions for nonnative predator and competitor species.

Based on projected water temperature conditions under the No Action Alternative, there would be a limitation in the extent of suitable water temperature conditions for highly tolerant native fish species in specific reaches at the warmer 90th percentile.

Water temperatures remain below this threshold in all reaches in at the typical 50th percentile and cooler 10th percentile levels.

Temperatures near 84°F typically occur in the downstream reaches of the San Joaquin River where the water temperature is at or near the equilibrium temperature. Little if any differences in these temperatures would be expected between the existing conditions and the No Action Alternative.

This impact would be **less than significant** under the No Action Alternative.

*Action Alternatives* The action alternatives are projected to have small but potentially beneficial effects on water temperature conditions for highly tolerant native fish species in specific years and specific reaches. At the 50th percentile, the action alternatives would reduce 7-day average water temperatures to below the 84°F threshold for almost the entire year in Reach 4A, limiting water temperatures above the threshold to less than 2 weeks per year. This would effectively extend suitable summer rearing water temperatures for highly tolerant species throughout the majority of the extended study area downstream from the cold-water habitats used by salmon and trout.

At the warmer 90th percentile, the action alternatives decrease the number of weeks exceeding the threshold (see the Modeling Appendix for additional results) by:

- 1.7 to 4.4 weeks in Reach 2B1 – all action alternatives
- 3.1 to 6.7 weeks in Reach 2B2 – all action alternatives
- 2.1 weeks in Reach 4B – all action alternatives
- 1 week in Reach 3 – Alternative Plan 4
- 7.9 weeks in Reach 5 – Alternative 5

In summary, the action alternatives would produce a mix of water temperature effects that could influence the extent of suitable habitat conditions for highly tolerant fish species at the warmer 90th percentile water temperatures improving conditions in some reaches, and degrading them in others. When averaged across all reaches, the net water temperature effect of each action alternative is small, decreasing the number of 7-day periods with average water temperatures below 84°F by less than 1 week.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

#### *Impact FSH-14: Changes to Spawning and Rearing Habitat from Changes to Flood Pulses and Floodplain Connectivity*

##### Extended Study Area – San Joaquin River from Friant Dam to the Merced River

*No Action Alternative* Under the No Action Alternative, flow, flood pulse, and restored floodplain habitat inundation would occur consistent with implementation of the Settlement.

Flood pulses at different locations on the San Joaquin River are influenced by operations of various flood control facilities and by flood inflows from other tributaries such as the James Bypass. The influences are not under the control of the project and influence the actual flood flow peaks at various locations. This analysis uses changes to the Friant release to the San Joaquin River as an indicator of change attributable to the project.

Flood pulse conditions under the No Action Alternative were determined by the Restoration Flow schedule and, under certain conditions, by additional spill from Friant Dam. Table 5-9 summarizes the total storage volume allocated to the Restoration Flow schedule by water year type in TAF, average daily flows by season, and the average daily releases required to meet the flow schedule in TAF. The Settlement specifies that the water budget can be flexibly managed across each flow period to mimic the rise, peak, and gradual fall of a natural hydrograph. The Settlement includes provisions for the release of pulse flows in Normal-Wet and Wet Years to perform several geomorphic functions, such as floodplain activation and flushing spawning gravels, unless the Secretary, in consultation with the RA, determines that such flows are not needed. Flushing flows would be accomplished with a quantity of water based on an average flow of 4,000 cfs from April 16 to 30, and include a peak release as close to 8,000 cfs as possible for several hours, within the constraints of then-existing channel capacity (Reclamation 2012b).

The annual Restoration Flow release schedule for the San Joaquin River ranges from 673.5 TAF for Wet years to 116.9 TAF in Critical-Low years (Table 5-9). These represent the minimum amount of water storage available for instream flow releases in each respective water year type. In some years, annual inflow will exceed the storage capacity of Millerton Lake, requiring spill. These spill events would add additional flow volume during the spring flexible flow period and perhaps other periods during the year. This would in turn result in larger flood pulses with their size determined by channel capacity and the ability to manage the additional flows using the extensive network of existing flood control bypass channels.

**Table 5-9. SJRRP Settlement Agreement Restoration Flow Schedule by Period with Estimated Daily Release Equivalents**

| Flow Allocation Period | Wet cfs (TAF) | Normal-Wet cfs (TAF) | Normal-Dry cfs (TAF) | Dry cfs (TAF) | Critical-High cfs (TAF) | Critical-Low cfs (TAF) |
|---|---|---|---|---|---|---|
| March 1 – 15 (15 days) | 500 (0.98) | 500 (0.98) | 500 (0.98) | 500 (0.98) | 500 (0.98) | 130 (0.26) |
| March 16–31 (16 days) | 1,500 (2.95) | 1,500 (2.95) | 1,500 (2.95) | 1,500 (2.95) | 1,500 (2.95) | 130 (0.26) |
| April 1–15 (15 days) | 2,500 (4.95) | 2,500 (4.95) | 2,500 (4.95) | 350 (0.7) | 200 (0.4) | 150 (0.3) |
| April 16–30 (15 days) | 4,000 (7.85) | 4,000 (7.85) | 350 (0.7) | 350 (0.7) | 200 (0.4) | 150 (0.3) |
| May 1–Jun 30 (61 days) | 2,000 (3.94) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 215 (0.42) | 190 (0.38) |
| July 1–August 30 (62 days) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 255 (0.5) | 230 (0.46) |
| September 1–30 (30 days) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 260 (0.51) | 210 (0.42) |
| October 1–31 (31 days) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 160 (0.31) | 160 (0.31) |
| November 1–6 (6 days) | 700 (1.4) | 700 (1.4) | 700 (1.4) | 700 (1.4) | 120 (0.24) | 120 (0.24) |
| November 7–10 (4 days) | 700 (1.4) | 700 (1.4) | 700 (1.4) | 700 (1.4) | 400 (0.79) | 130 (0.26) |
| November 11–December 31 (51 days) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 120 (0.24) | 120 (0.24) |
| January 1–February 28 (59 days) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 350 (0.7) | 110 (0.22) | 110 (0.22) |
| Annual Flow Allocation (TAF) | 673.5 | 473 | 365. | 279 | 187 | 116.9 |

Notes:
* Critical-High and Critical-Low water years are grouped with Dry years for CalSim II modeling.
Key:
cfs = cubic feet per second
TAF = thousand acre-feet

The San Joaquin River Flood Control Project Agency (2013) determines channel capacities for managing flood flows. San

Joaquin River channel capacities in the Friant Dam-to-Merced River component of the extended study area are summarized by reach in Table 5-5.

Reaches 1A and 1B are incised in the alluvial fan of the San Joaquin River and they have an accessible floodplain that is largely unconfined by artificial structures, providing sufficient capacity to contain the largest likely flood events. Reach 5 is located downstream from the major flood bypasses. It is relatively unconfined by levees and a large amount of accessible floodplain provides significant channel capacity. These unconfined reaches would experience the greatest flood pulse variability and presumably realize the largest habitat benefits, particularly in those areas targeted for floodplain restoration under the SJRRP. The remaining reaches are confined by levees, have limited available floodplain, and have less flow capacity than upstream and downstream reaches. Flood pulses in excess of capacity are diverted into flood control bypasses. The controlled flows and relative lack of floodplain habitat limit the extent to which flood pulses can influence and enhance aquatic habitat conditions.

Given existing constraints in the San Joaquin River from Friant Dam to Merced River, the ability to achieve Restoration Flow releases at Friant Dam is assumed to provide the flexibility necessary for managing ecologically beneficial floodplain functions in areas with suitable conditions. Any change in the ability to achieve those Restoration Flows would constitute an adverse effect.

Figure 5-3 shows the distribution of projected peak flow releases under the No Action Alternative. Effectively, Figure 5-3 displays what implementation of the Restoration Flow schedule would look like over an 82-year period with water year conditions similar to those from 1922 through 2003. As shown, the 4,000-cfs flow objective with capacity to achieve peak flows of 8,000 cfs would be achieved 50 percent of the time, consistent with the Settlement. Millerton Lake storage capacity would be exceeded in 7 of those years, requiring controlled or uncontrolled spill exceeding 8,000 cfs. Flood pulses of 2,500 cfs would be achieved in 24 of the remaining 41 years, and lower flows would be allowed in drier years consistent with the Settlement. This represents a substantial improvement over existing conditions. Simulated peak flows under current conditions would exceed 4,000 cfs in only 21 of 82 model years and 2,500 cfs in only 24 of those years. These results indicate that the No Action Alternative would substantially increase the number of years with flood pulse flows sufficient to manage for desired floodplain habitat functions.

This impact would be **potentially significant and beneficial** under the No Action Alternative.

*Action Alternatives* The proposed Temperance Flat RM 274 Reservoir is designed to capture peak flood flows and store this water primarily for consumptive use. Because this would allocate storage volume for purposes other than instream flows, it is necessary to determine if the action alternatives would have any effect on the ability to meet the Restoration Flow schedule. Any change in the ability to meet the flow schedule would infer a change in the ability to manage for ecologically desirable floodplain functions. Flood pulses in excess of the Settlement may also have beneficial ecological functions in reaches with adequate flow capacity. However, these beneficial effects may be offset in other areas by damaging floods that degrade floodplain conditions and potentially strand focal fish species behind overtopped levees, and by increases in low flows due to deliveries under the action alternatives.

As discussed in the Methods and Assumptions section, several of the native fish species considered in this analysis are dependent on floodplain habitats to varying degrees. For example, juvenile Chinook salmon exhibit higher growth rates and greater survival when they have access to inundated floodplain habitat. This effect is reflected in EDT model results developed to analyze the effects of specific floodplain restoration alternatives in Reach 2B under the SJRRP (Reclamation 2013b). These results found that floodplain restoration anticipated under the SJRRP would increase habitat potential for spring-run Chinook, but the benefits were constrained by the limiting effects of high water temperatures on survival. These benefits would presumably extend to fall-run Chinook salmon, which also make extensive use of floodplain habitats during rearing and migration (Sommer et al. 2001). Splittail are obligate floodplain spawners, and juveniles rear in floodplain habitats for extended periods. The other non-salmonid fish species occurring in this component of the extended study area are also dependent on floodplain habitats to varying degrees, and all species benefit from increased food web productivity associated with flood pulses (Matella and Merenlender 2014; Sommer et al. 2004a, 2004b).

The action alternatives are designed to capture flood flows, resulting in a reduction in peak and annual average spill rates relative to the No Action Alternative. Because each action alternative captures flood peaks, each affects both the size and frequency of extreme flow events exceeding 8,000 cfs at Friant Dam, and the size and frequency of flow peaks between the Restoration Flows and 8,000 cfs. The Restoration Flows would be met under any of the action alternatives.

Projected peak flow releases under Alternative Plan 1 provide a useful example. Figure 5-18 displays projected flow releases under this action alternative over the same modeled period. As noted previously, modeled peak flows exceeding 8,000 cfs occur in 7 of 82 years under the No Action Alternative, with a projected peak of 28,304 cfs in the highest flow year. Under Alternative Plan 1, they would occur in only 4 of 82 years with a maximum flow peak of 19,586 cfs (Figure 5-18). However, the action alternatives would alter the duration of peak flows above 4,000 cfs because they would reallocate a portion of the total volume of available water to uses other than streamflows. Therefore, while the ability to achieve desired flood pulse and peak flows would be retained, the duration of peak flows would change. All flood peaks exceeding 8,000 cfs are functionally similar from the standpoint that this threshold marks the upper limit of downstream channel capacity in Reaches 1A, 1B, and 2A and exceeds the downstream channel capacity by a minimum of 6,700 cfs in all reaches except Reach 5 (Table 5-5).

Figure 5-18 provides an example of flow effects likely to occur under Alternative Plan 1 relative to the No Action Alternative. Figure 5-18 includes the assumption that restoration flows in Wet and Normal-Wet years would not be manipulated to produce the 8,000 cfs peak flows during the spring flexible flow period. Flood pulse flows under Alternative Plans 2 and 4, including flows exceeding 8,000 cfs, are essentially identical to those under Alternative Plan 1. Peak flows exceeding 8,000 cfs are slightly (40 to 550 cfs) lower under Alternative Plan 3. Alternative Plan 5 has the largest effect, producing peak flows in excess of 8,000 cfs in only 3 out of 82 years. The maximum peak flow under Alternative Plan 5 would remain effectively the same but the frequency of large flood events would decrease.

Figure 5-19 shows how Friant Dam releases would change under Alternative Plan 1 relative to the No Action Alternative. As shown, sustained pulse flows between 4,000 and 8,000 cfs would occur more frequently under the No Action Alternative. This suggests that the duration of peak flows between 4,000 and 8,000 cfs would be reduced under Alternative Plan 1, but the ecological significance of changes in flood pulse frequency exceeding this threshold is unclear. The effects of the remaining action alternatives on flood pulse volumes and, by extension, the duration of flood pulses larger than 4,000 cfs, are similar to those described for Alternative Plan 1.

Reach 5 has a flow capacity of 26,000 cfs, suggesting that reducing the frequency of peak flows in excess of 8,000 cfs could affect floodplain conditions in this reach. However, this reach also receives inflows from regional flood bypasses and from the Kings River via the San Joaquin River that must also be managed to remain within the capacity limitations of the system.

This impact would be minimal under the action alternatives on the basis that, at minimum, the restoration flow requirements in the Settlement would be achieved in all years under each of the action alternatives. Some effects on the duration of flow volumes between 4,000 and 8,000 cfs may occur.

This impact would be **less than significant** under the action alternatives.

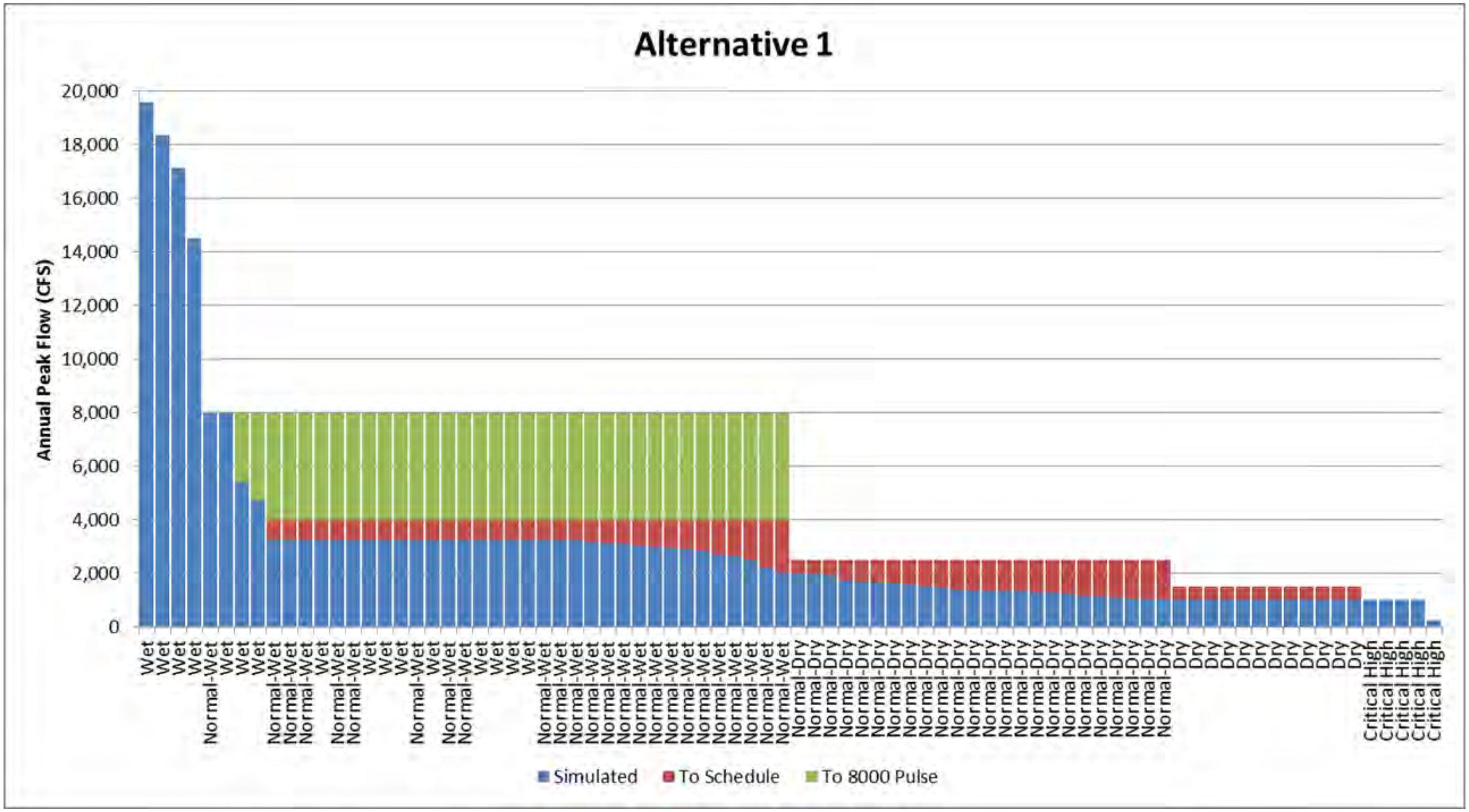


**Figure 5-18. Achievable San Joaquin River Peak Flow Releases at Friant Dam under Alternative Plan 1, Including Sustained and Peak Flood Pulse Flows Under the SJRRP Restoration Flow Schedule**

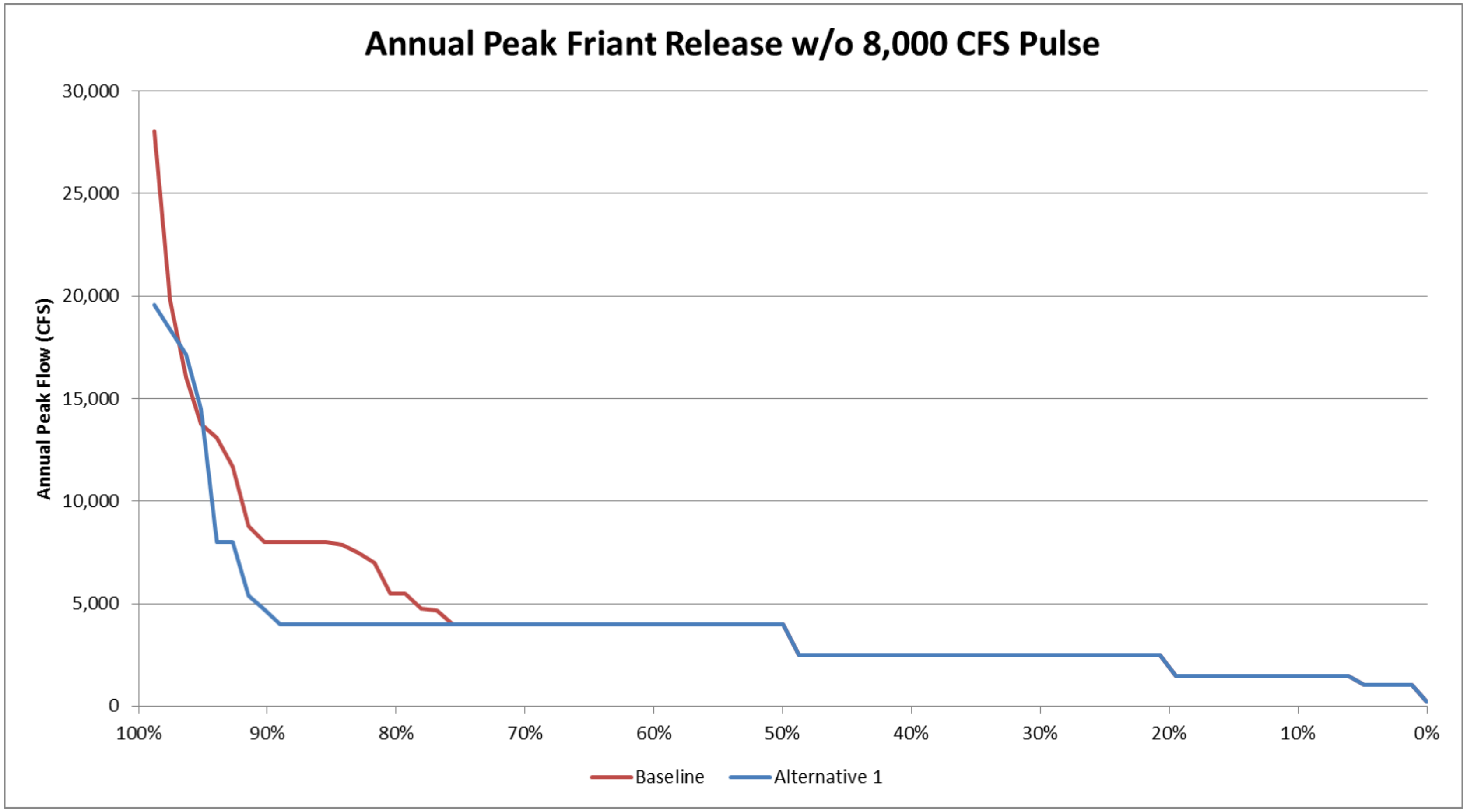


**Figure 5-19. Percentile Distribution of San Joaquin River Annual Peak Flow Releases at Friant Dam Under Alternative Plan 1 Excluding 8,000 cfs Peak Flow**

### *Impact FSH-15: Change in Fish Habitat and Migratory Behaviors from Changes in Water Temperatures*

#### Extended Study Area – San Joaquin River from Merced to Delta

*No Action Alternative* Water temperature in the San Joaquin River between the Merced River and the Delta is typically in equilibrium with air temperature during the hottest summer months, but not at other times of the year, such as spring and fall. Under the No Action Alternative, water temperatures are often warmer than is optimal (often over 70°F between May and October at Patterson, based on California Data Exchange Center [CDEC] gage data) for migratory species; however, steelhead and fall-run Chinook salmon do migrate through the lower San Joaquin River to and from the tributaries.

There is no anticipated change in the water temperatures in this reach of the San Joaquin River between the existing conditions and the No Action Alternative.

There would be **no impact** under the No Action Alternative.

*Action Alternatives* As mentioned under the No Action Alternative, San Joaquin River water temperature is strongly affected by air temperatures. Additionally, the SJR5Q water temperature model results indicate that the action alternatives would not affect water temperatures in the San Joaquin River immediately downstream from the confluence with the Merced River under both existing and future conditions (see Figure 5-16, Figure 5-17 and the Modeling Appendix for additional figures). Therefore, it is reasonable to conclude that water temperatures in the San Joaquin River downstream from the Merced River would not be affected by the action alternatives.

There would be **no impact** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### *Impact FSH-16: Change in Fish Habitat and Migratory Behaviors from Changes in Flows*

#### Extended Study Area – San Joaquin River from Merced to Delta

*No Action Alternative* Under the No Action Alternative, Friant Dam and downstream flow control structures would be operated to meet the full Restoration Flow targets. The change in flows in this reach between the existing conditions, and the No Action Alternative would be relatively small.

This impact would be **less than significant and beneficial** under the No Action Alternative.

*Action Alternatives* In the San Joaquin River below the Merced River confluence, project-related flow reductions would generally be greatest in winter and spring, when flood flows are being captured and stored by the project. Similarly, in the San Joaquin River at Vernalis, project-related flow reductions are generally greatest in late winter and spring. However, for all months at both locations, flow reductions greater than 5 percent to 10 percent only occur in years when river flows are well above average, with essentially no change at times when flows are at or below the median monthly flow.

Juvenile Chinook salmon, both fall-run and spring-run, as well as steelhead, use spring pulse flows for juvenile outmigration. They also require flows high enough to allow them to track and then migrate through to their natal stream as an adult to spawn. As shown in Figure 5-20 and in additional figures in the Modeling Appendix, large reductions in San Joaquin River flows relative to the No Action Alternative would occur primarily during the highest flow events. The action alternatives have few monthly incidences where they result in flow reductions when flows are less than 10,000 cfs at Vernalis, or less than 6,000 cfs at the Merced River confluence.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

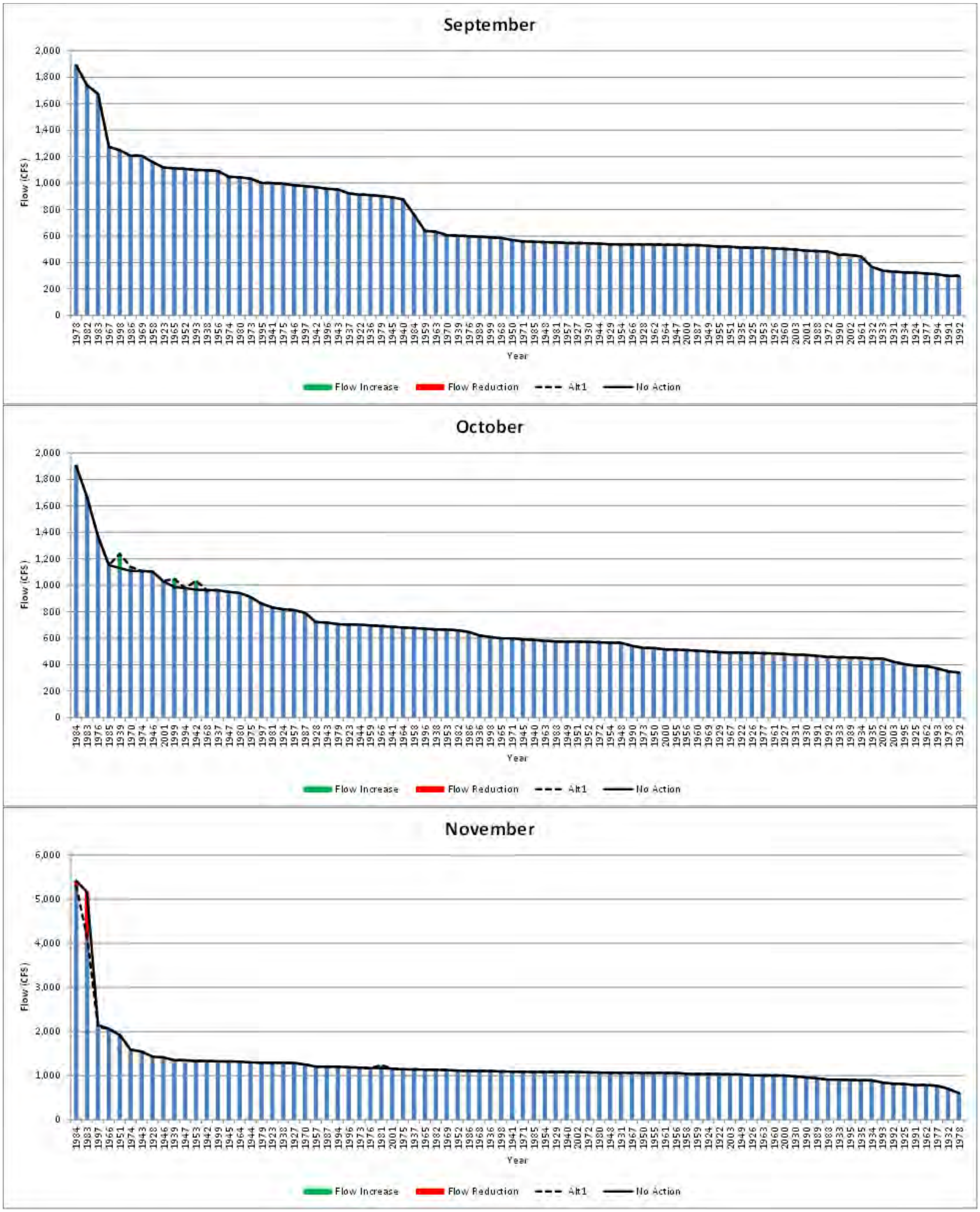


**Figure 5-20. Simulated San Joaquin River Flows Downstream from the Merced River Confluence During September, October, and November**

### *Impact FSH-17: Loss of Fish Habitat from Changes in Tributary Flows*

#### Extended Study Area – San Joaquin River Tributaries

*No Action Alternative* Under the No Action Alternative, flows in the tributaries frequently would not meet the flow standards presented in Table 5-6 that are assumed to provide maximum habitat. Table 5-6 is a simplification of the flow standards on the tributaries implemented in the CalSim II model. Specifics on the standards included in the CalSim II modeling are included in the Modeling Appendix. Comparison of the mean monthly CalSim II flows to these simplified standards may overestimate the magnitude and number of deviations from these flow conditions assumed to provide maximum habitat. Table 5-6 also includes partial month standards, which also may overstate the magnitude and number of deviations.

The Merced River downstream from McClure Reservoir would meet the standards shown in Table 5-6 for spawning, incubation/fry rearing, and juvenile rearing/migration just over 50 percent of the time (see Modeling Appendix for tables of results). However, as the river moves downstream toward the San Joaquin confluence, the flows rarely meet the standards shown in Table 5-6 for either juvenile rearing and migration or adult migration. Because the flows in the Merced River are very similar between the existing conditions and the No Action Alternative, the Merced River is expected to continue to experience similar effects under the No Action Alternative.

The Tuolumne River downstream from Don Pedro Reservoir would typically meet the flow standards identified in Table 5-6 for both Chinook salmon and steelhead. However, as the river approaches the San Joaquin River confluence, the flow standards for juvenile migration are more difficult to meet during the Dry and Critical water years (see Modeling Appendix for tables of results), and juvenile salmonids would migrate through less-than-optimal conditions. Because the flows in the Tuolumne River are very similar between the existing conditions and the No Action Alternative, the Tuolumne River is expected to continue to experience similar effects under the No Action Alternative.

The Stanislaus River periodically has difficulty meeting the standard established for juvenile migration for both Chinook salmon and steelhead (2,000 cfs). However, these flows are often not substantially less than 2,000, nor are there significantly too many months below the 4-month migration period in which they would be substantially under 2,000 cfs (see Modeling Appendix for tables of results). Because the flows in the Stanislaus River are very similar between the existing conditions and the No Action Alternative, the Stanislaus River is expected to continue to experience similar effects under the No Action Alternative conditions.

This impact would be **less than significant** under the No Action Alternative.

*Action Alternatives* Under the action alternatives, flows in the Merced River below McClure Dam or at the confluence, in the Tuolumne River below Don Pedro Dam or at the confluence, and the Stanislaus at Goodwin Dam and at the confluence would not change relative to the No Action Alternative (see Modeling Appendix for tables of results). Therefore, there would be no change to all life stages of Chinook salmon and steelhead under the action alternatives relative to the No Action Alternative under all hydrologic conditions. However, flows under the No Action Alternative do not always meet the flow standard for Chinook salmon and steelhead, therefore, the flow standard are not met under the action alternatives either.

There would be **no impact** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

#### *Impact FSH-18: Effects on Delta Fish Habitat from Changes in Water Temperatures and Dissolved Oxygen Concentrations*

### Extended Study Area – Delta

*No Action Alternative* As described in Impact FSH-15, water temperatures in the San Joaquin River as it enters the Delta are typically in equilibrium with air temperatures. By the time the river has traveled the 190 miles from Friant Dam, the releases from Friant Dam no longer have an effect on water temperatures in the San Joaquin River. Therefore, the No Action Alternative would not affect water temperatures in the Delta.

DO levels near the Stockton Deep Water Ship Channel are at times directly affected by San Joaquin River inflow, with low inflow resulting in reduced DO concentrations (Lee and Jones-Lee 2003). Under the No Action Alternative, average monthly San Joaquin River inflow during the September-through-November period of adult fall-run salmon upstream migration would be less than 2,000 cfs for about 15 percent of months.

When comparing the No Action Alternative to existing conditions, there would be minor changes in the magnitude of San Joaquin River inflow in all months, the only difference being substantial increases in April of all year types except Critical years. Additionally, there would be increases in the number of months with flows less than 2,000 cfs during the September through November period of adult fall-run Chinook salmon upstream migration, reducing suitable conditions for fall-run Chinook salmon (see Figure 5-20 and the Modeling Appendix for additional figures).

This impact would be **potentially significant** under the No Action Alternative.

*Action Alternatives* The action alternatives would not directly affect water temperatures of the San Joaquin River flowing into the Delta and, except in late winter through early summer months of Wet years, would have minimal effects on the volume of San Joaquin River inflow. There would be minimal changes to the frequency of San Joaquin River inflows less than 2,000 cfs during the fall-run Chinook salmon adult migration period of September through November. Therefore, effects on water temperature and DO would be minimal and adverse effects on fish habitat would be minor.

None of the action alternatives would significantly change the inflow from the San Joaquin River to the Delta when compared to either existing conditions or the No Action Alternative (see Figure 5-20 and the Modeling Appendix for additional figures). The largest change would occur during winter and spring of Wet years, with average reductions in inflows relative to existing conditions for all five action alternatives ranging between about 2 percent in December and 8 percent in May.

Inflows to the Delta are normally relatively high during winter and spring of Wet years, with water temperatures generally low, so the Wet year reductions in San Joaquin River inflow (see Figure 5-20 and the Modeling Appendix for additional figures) would not affect DO conditions for any Delta fishes. There were no changes in the frequency of inflows less than 2,000 cfs under any of the action alternatives relative to either existing conditions or the No Action Alternative. Future conditions unrelated to the action alternatives would be anticipated to create DO levels considered unsuitable for adult Chinook salmon, as described for the No Action Alternative. Although the anticipated changes to DO levels under the action alternatives would be small, they could further exacerbate the unsuitable conditions anticipated in the Delta.

Water temperatures in the south Delta would not be affected by the action alternatives. The SJR5Q water temperature model results show the action alternatives do not affect water temperatures on the San Joaquin River at the Merced River confluence under both existing and future conditions. Therefore, it is reasonable to conclude that water temperatures of San Joaquin River inflow into the Delta would not be affected by the action alternatives.

This impact would be **potentially significant** under the action alternatives. No feasible avoidance or minimization measures are available to reduce this impact below the level of significance. Mitigation for this impact is not proposed because no feasible mitigation is available to reduce the impact to a less-than-significant level.

#### *Impact FSH-19: Loss of Suitable Fish Habitat from Salinity Changes in the Delta*

**Extended Study Area – Delta**
*No Action Alternative* As discussed in Chapter 15, "Hydrology – Surface Water Quality," the No Action Alternative would result in moderate increases (less than 7 percent) in the long-term average salinity of the Delta in Dry and Critical years as compared to existing conditions. However, these changes would not violate any of the Delta salinity standards, including the D-1641 salinity objectives and X2 standard. As noted previously, the D-1641 salinity objectives and X2 standard are designed to protect sensitive Delta species such as delta smelt.

This impact would be **less than significant** under the No Action Alternative.

*Action Alternatives* The action alternatives would cause both increases and decreases in salinity as compared with existing conditions and the No Action Alternative, as shown in the Modeling Appendix. Simulated long-term average salinities in the San Joaquin River near Vernalis were lower than under the existing conditions in all months, particularly in January and April (with decreases of over 12 percent). Under the action alternatives, on a long-term average basis, all increases in simulated salinity were less than 2 percent across all year types, and less than or equal to 2 percent in Dry and Critical years as compared with existing conditions or the No Action Alternative. None of these changes to Delta salinity would result in any violations of the Delta standards.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### *Impact FSH-20: Loss of Suitable Fish Habitat from Change in Flow Patterns in the South Delta*

#### Extended Study Area – Delta

*No Action Alternative* The No Action Alternative would result in minimal changes in upstream (reverse) Old and Middle river flow (Table 5-10).

Under the No Action Alternative, no simulated flows between January and June are more negative than -5,000 cfs. Additionally, the presence of listed fish species dictates how the Delta will be operated. Per the take requirements and the USFWS 2008 and NMFS 2009 BO RPAs, resource agency representatives provide recommendations to the Water Operations Management Team (WOMT), which then considers recommendations from multiple work teams to inform changes in water operations. Therefore, operations could cease that would otherwise be detrimental to listed fish species.

Similarly, the I:E ratios prescribed in NMFS RPA Action IV.2.1 (NMFS 2009) would continue to be met during January through June, consistent with applicable laws, regulations, BOs, and court orders in place at the time the project is implemented and long-term operations would remain subject to existing permitting processes.

This impact would be **less than significant** under the No Action Alternative.

*Action Alternatives* The action alternatives would have little effect on San Joaquin River inflows, except for some reductions in late winter through early summer of Wet years. The greatest average reductions in simulated inflows, under the action alternatives as compared with the No Action Alternative, range between about 2 percent in December and 8 percent in May. These changes in inflow during Wet years are considered too small to significantly affect fish in the south Delta.

## Table 5-10. Comparison of Old and Middle River Flows Between Alternatives

| Month | Water Year Type | No Action Alternative Flow (cfs) | Difference in Flow under Alt 1 (cfs) | Difference in Flow under Alt2 (cfs) | Difference in Flow under Alt 3 (cfs) | Difference in Flow under Alt 4 (cfs) | Difference in Flow under Alt 5 (cfs) |
|---|---|---|---|---|---|---|---|
| January | All Years | -3,590 | -116 | -114 | -120 | -110 | -124 |
| | Wet | -2,136 | -393 | -388 | -407 | -375 | -421 |
| | Above-Normal | -3,656 | -59 | -59 | -59 | -59 | -59 |
| | Below-Normal | -4,244 | 63 | 63 | 63 | 63 | 63 |
| | Dry | -4,706 | 0 | 0 | 0 | 0 | 0 |
| | Critical | -4,268 | 4 | 4 | 4 | 4 | 4 |
| February | All Years | -3,345 | -127 | -126 | -126 | -111 | -125 |
| | Wet | -2,281 | -421 | -419 | -416 | -368 | -413 |
| | Above-Normal | -4,125 | -18 | -18 | -19 | -18 | -18 |
| | Below-Normal | -3,670 | -2 | -2 | -2 | -1 | -1 |
| | Dry | -4,138 | -1 | -1 | -1 | 0 | 0 |
| | Critical | -3,255 | 1 | 0 | 1 | 0 | 0 |
| March | All Years | -2,875 | -162 | -162 | -162 | -162 | -157 |
| | Wet | -1,317 | -558 | -558 | -557 | -557 | -540 |
| | Above-Normal | -4,459 | 5 | 5 | 5 | 5 | 7 |
| | Below-Normal | -4,298 | 0 | 0 | 0 | 0 | 0 |
| | Dry | -2,948 | 0 | 0 | 0 | 0 | 0 |
| | Critical | -2,411 | 0 | 0 | 0 | 0 | 0 |
| April | All Years | 1,057 | -77 | -77 | -77 | -63 | -81 |
| | Wet | 3,097 | -241 | -240 | -241 | -192 | -253 |
| | Above-Normal | 1,449 | 0 | 0 | 0 | 0 | 0 |
| | Below-Normal | 533 | 0 | 0 | 0 | 0 | 0 |
| | Dry | -210 | -43 | -43 | -43 | -43 | -43 |
| | Critical | -937 | -0 | -0 | -0 | 0 | 0 |
| May | All Years | 418 | 18 | 23 | 22 | 27 | 13 |
| | Wet | 2,110 | 62 | 63 | 61 | 77 | 27 |
| | Above-Normal | 542 | 0 | 0 | 0 | 0 | 0 |
| | Below-Normal | 42 | 0 | 0 | 0 | 0 | 0 |
| | Dry | -548 | 0 | 0 | 0 | 0 | 0 |
| | Critical | -1,151 | 1 | 24 | 24 | 24 | 24 |
| June | All Years | -3,728 | -22 | -22 | -22 | -27 | -33 |
| | Wet | -4,421 | -76 | -75 | -75 | -91 | -113 |
| | Above-Normal | -4,605 | 0 | 0 | 0 | 0 | 0 |
| | Below-Normal | -4,174 | 0 | 0 | 0 | 0 | 0 |
| | Dry | -2,892 | 0 | 0 | 0 | 0 | 0 |
| | Critical | -2,125 | 0 | 0 | 0 | 0 | 0 |
| July | All Years | -9,321 | -41 | -41 | -42 | -30 | -52 |
| | Wet | -8,476 | -148 | -148 | -150 | -111 | -185 |
| | Above-Normal | -10,187 | 11 | 11 | 11 | 11 | 11 |
| | Below-Normal | -10,915 | 7 | 7 | 7 | 7 | 6 |
| | Dry | -10,618 | -10 | -10 | -11 | -12 | -11 |
| | Critical | -7,373 | 4 | 4 | 4 | 4 | 4 |
| August | All Years | -8,817 | 6 | 7 | 7 | 7 | 7 |
| | Wet | -10,208 | -19 | -19 | -19 | -19 | -19 |
| | Above-Normal | -10,386 | 0 | 0 | 0 | 0 | 0 |
| | Below-Normal | -10,343 | -5 | -5 | -5 | -5 | -5 |
| | Dry | -7,689 | 2 | 3 | 1 | -1 | 0 |
| | Critical | -4,837 | 64 | 67 | 66 | 71 | 68 |

**Table 5-10. Comparison of Old and Middle River Flows Between Alternatives (contd.)**

| Month | Water Year Type | No Action Alternative Flow (cfs) | Difference in Flow under Alt 1 (cfs) | Difference in Flow under Alt 2 (cfs) | Difference in Flow under Alt 3 (cfs) | Difference in Flow under Alt 4 (cfs) | Difference in Flow under Alt 5 (cfs) |
|---|---|---|---|---|---|---|---|
| September | All Years | -8,325 | -19 | -19 | -18 | -17 | -19 |
| | Wet | -9,287 | 0 | 0 | 0 | 0 | 0 |
| | Above-Normal | -9,170 | -52 | -53 | -48 | -47 | -56 |
| | Below-Normal | -9,637 | 0 | 0 | 0 | 0 | 0 |
| | Dry | -8,266 | 14 | 14 | 15 | 17 | 16 |
| | Critical | -5,018 | -55 | -56 | -56 | -56 | -55 |
| October | All Years | -5,995 | 11 | 13 | 13 | 13 | 5 |
| | Wet | -6,229 | 28 | 28 | 28 | 28 | 3 |
| | Above-Normal | -6,947 | -7 | 0 | 0 | 0 | 0 |
| | Below-Normal | -5,470 | 26 | 26 | 26 | 26 | 26 |
| | Dry | -6,036 | -1 | 0 | 0 | 0 | 0 |
| | Critical | -5,084 | 3 | 3 | 3 | 3 | 3 |
| November | All Years | -6,051 | -138 | -139 | -132 | -137 | -142 |
| | Wet | -6,542 | -155 | -155 | -155 | -155 | -170 |
| | Above-Normal | -7,273 | -160 | -163 | -142 | -164 | -166 |
| | Below-Normal | -5,890 | -133 | -132 | -133 | -132 | -135 |
| | Dry | -5,711 | -246 | -247 | -234 | -234 | -233 |
| | Critical | -4,502 | -7 | -6 | -6 | -6 | -6 |
| December | All Years | -6,611 | -59 | -87 | -84 | -68 | -87 |
| | Wet | -6,343 | -150 | -150 | -138 | -85 | -150 |
| | Above-Normal | -5,821 | -59 | -67 | -68 | -66 | -65 |
| | Below-Normal | -7,247 | -17 | -17 | -17 | -17 | -17 |
| | Dry | -8,310 | -4 | -4 | -4 | -1 | -2 |
| | Critical | -5,905 | -2 | -138 | -139 | -138 | -139 |

Key:
Alt = Alternative Plan
cfs = cubic feet per second

The differences in Old and Middle river flows under the action alternatives relative to the No Action Alternative and existing conditions are minor. There are no occasions in which flows are pushed from under -5,000 cfs (less negative) to over -5,000 cfs (more negative) under any alternative during the December-through-June period (Table 5-10).

Expected changes in the I:E ratio are generally small and limited to Wet years, when they are expected to have less impact on habitat in the south Delta habitat. However, more substantial increases in the I:E ratio are expected for July in Critical years, as compared with existing conditions. The simulated increases in the I:E ratio result primarily from reductions in exports; little change is expected for San Joaquin River inflow in July (see Figure 5-21 and the Modeling Appendix for additional figures).

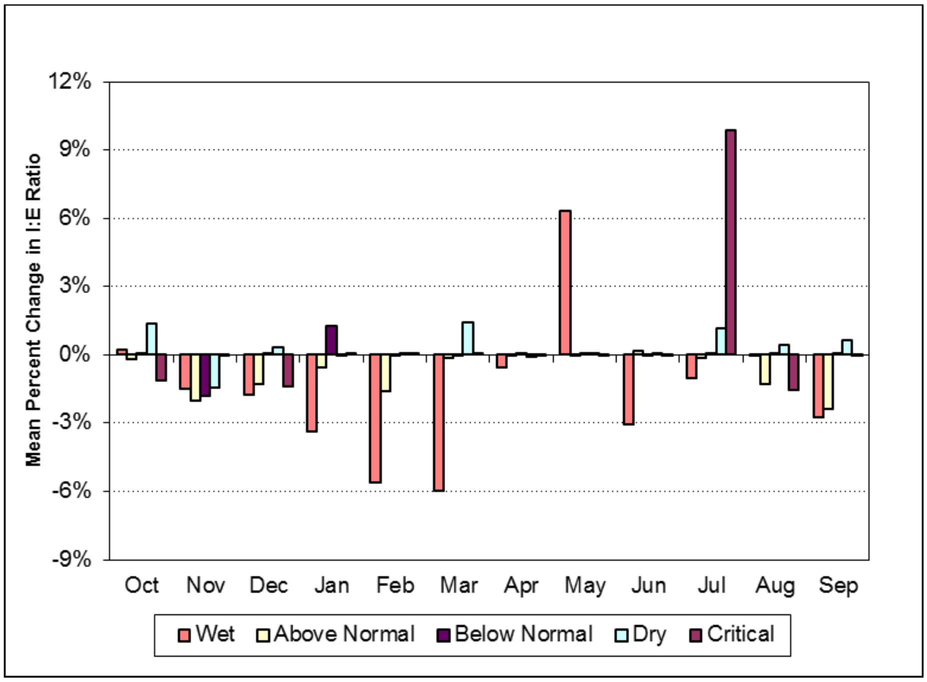


**Figure 5-21. Change in Inflow:Export Ratio Between Existing Conditions and Alternative Plan 1**

During the April and May period of San Joaquin River salmonid emigration, the frequency of I:E ratios below those prescribed in the NMFS RPA differed little between the action alternatives and existing conditions. As compared with the No Action Alternative, Alternatives Plans 1, 2, and 4 reduced the frequency of the low I:E ratios by about 6 percent in Wet years. There were no differences for other water year types. The reductions in the frequency of low I:E ratios is expected to benefit Delta fish species.

The action alternatives would result in both impacts and benefits to flow patterns that affect south Delta fish habitat. Additional protection would be provided to the fish because the action alternatives would be operated consistent with applicable laws, regulations, BOs, and court orders in place at the time the project is implemented.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### *Impact FSH-21: Reduction in Fish Abundance from Changes in Exports and Entrainment in the South Delta*

**Extended Study Area – Delta**

*No Action Alternative* The No Action Alternative would result in changes in exports at the Banks and Jones pumping facilities relative to the existing conditions. Between December and June, simulated monthly average exports increased over existing conditions by more than 5 percent in April of all year types except Critical years, and in June of Above-Normal years (Figure 5-22) under the No Action Alternative.

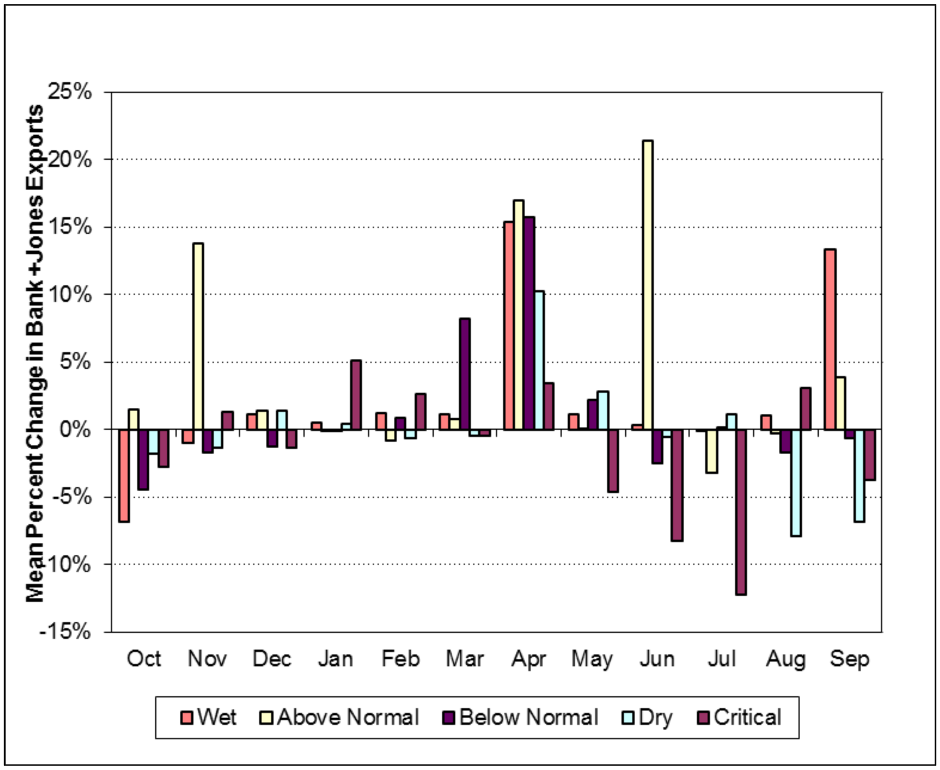


**Figure 5-22. Mean Percent Changes in Exports at the Banks and Jones Facilities Between Existing Conditions and the No Action Alternative**

Increases in south Delta exports could adversely affect sensitive fish species, including fall-run, spring-run, and winter-run Chinook salmon; steelhead; longfin smelt; and delta smelt. April and June are important months for migration or residency in the Delta of young life stages of most of these species. The young life stages are especially vulnerable to entrainment and other potentially adverse effects resulting from increased exports. Delta smelt spawn in late winter and spring, and the larvae are typically most abundant in April and May (Bennett 2005). Juvenile steelhead, fall-run Chinook salmon, and winter-run Chinook salmon migrate through or rear in the Delta in April. The increased exports, especially those in April, are expected to adversely affect these species. Many of the export increases during the December-through-June period of increased risk are expected to be more than 5 percent.

As stated previously, real-time fish monitoring that determines the presence of listed fish species at the export facilities dictates export pumping levels during critical months. Per the take requirements and the USFWS 2008 and NMFS 2009 BO RPAs, the WOMT considers recommendations from multiple work teams to inform changes in water operations. Therefore, operations may be ceased that could otherwise be detrimental to listed fish species. Therefore, potential increased diversions and fish entrainment estimated above by models may not necessarily happen in real-time because of regulatory limits that are triggered to reduce diversions and minimize entrainment.

This impact would be **potentially significant** under the No Action Alternative.

*Action Alternatives* The action alternatives would result in minor changes of Delta exports. Under the action alternatives, the mean level of Banks and Jones exports is expected to change less than 1 percent under all five of the action alternatives in most months and water year types. The largest increases in exports, ranging between 5 and 6 percent, would occur in September of Wet years. For November, increases in exports of greater than 5 percent would occur in about 10 percent to 14 percent of years at the 2005 level of development. During the December-through-June period of increased risk, increases of greater than 5 percent would be infrequent, occurring in a maximum of 6 percent of years for March under all action alternatives.

The largest reductions in exports, ranging between about 3 and 10 percent, would occur in April and May of Wet years and in July of Critical years under all the action alternatives.

The fish at greatest risk of entrainment at the Banks and Jones export facilities are small fish, particularly fish larvae. The increases in exports resulting from the action alternatives are expected to occur primarily during November and September, when few larval fish occur in the south Delta (Grimaldo et al.

2009b). Juvenile stages of Chinook salmon, steelhead trout, sturgeon, and others, as well as adults of smaller bodied species such as delta smelt, longfin smelt, and splittail, are also entrained at the Jones and Banks facilities, but few of these fish occur in the south Delta during September and November. Late fall-run Chinook salmon and green and white sturgeon are salvaged at the Banks and Jones facilities in September and November (Williams 2006, NMFS 2009, Harvey and Stroble 2013, DWR 2013a), but entrainment risk for the sturgeon species is relatively low (DWR 2013b) and the anticipated increase in exports is not considered to be large enough to affect populations of any of these species.

The reductions in exports for April and May of Wet years are likely to benefit steelhead, spring-run Chinook salmon, fall-run Chinook salmon, delta smelt, longfin smelt, and Sacramento splittail, all of whose early life stages are likely to occur in the south Delta during these months. The reduced exports in May would reduce entrainment in the south Delta, resulting in a beneficial effect to fish.

This impact would be **less than significant and beneficial** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### *Impact FSH-22: Loss of Suitable Fish Habitat Resulting from Changes in X2*

#### Extended Study Area – Delta

*No Action Alternative* Modeling results indicate that the No Action Alternative would generally have small effects on X2. The maximum monthly upstream shift in simulated X2 is about 3 km for October in Above-Normal years, and most of the maxima are less than 2 km. Table 5-11 shows the maximum shifts in simulated X2 for each month and water year type; the average mean monthly shifts (averaging upstream and downstream shifts) are, however, consistently less than 0.3 km and therefore substantially less than criteria for a 1 km upstream shift.

**Table 5-11. Maximum Shift in X2 Between Existing Conditions and the No Action Alternative**

| Month | Wet | Above-Normal | Below-Normal | Dry | Critical | Number of Years Greater than 1 km Upstream |
|---|---|---|---|---|---|---|
| January | 0.7 | 0.3 | 0.2 | 0.3 | 2.5 | 1 |
| February | 0.6 | 0.1 | 0.1 | 0.9 | 2.6 | 1 |
| March | 0.1 | 0.9 | 1.1 | 2.7 | 0.2 | 2 |
| April | 0.2 | 0.3 | 0.1 | 0.7 | 1.1 | 1 |
| May | 0.7 | 0.5 | 0.3 | 1.3 | 1.6 | 4 |
| June | 1.2 | 1.0 | 0.7 | 1.0 | 0.9 | 2 |
| July | 0.8 | 0.4 | 0.5 | 0.4 | 0.1 | 0 |
| August | 1.2 | 0.2 | 0.5 | 0.3 | 0.3 | 1 |
| September | 1.9 | 0.2 | 0.1 | 1.5 | 0.8 | 3 |
| October | 1.4 | 3.0 | 0.3 | 0.2 | 1.1 | 3 |
| November | 1.5 | 0.7 | 0.2 | 0.5 | 0.6 | 1 |
| December | 0.9 | 1.5 | 0.5 | 0.8 | 0.1 | 1 |

Key:
km = kilometer

D-1641 establishes the X2 standard, which is reinforced by the fisheries requirements established in the USFWS 2008 and NMFS 2009 BO RPAs. CVP and SWP facilities in the Delta and upstream watersheds are operated to meet the requirements of D-1641 and BO RPAs, and this would not change under the No Action Alternative. It is therefore anticipated that the No Action Alternative would continue to operate under these standards. However, neither the future events related to fish locations nor behaviors of the decision-making process of the resource agencies can be determined at this time.

This impact would be **potentially significant** under the No Action Alternative.

*Action Alternatives* Modeling results indicate that the action alternatives would have little effect on X2 (Table 5-12 and additional information in the Modeling appendix). The average differences in simulated X2 between the action alternatives and the No Action Alternative and existing conditions range between 0.2 and -0.2 km. The maximum mean monthly upstream difference in simulated X2 for all the action alternatives, as compared with existing conditions and the No Action Alternative, is around 1 km for May in Wet years. The maximum mean monthly upstream shift in simulated X2, as compared with the No Action Alternative, was just over 2.5 km in November of a single Wet year for Alternative Plan 1; and about 2.5 km in November of Wet years, and in December of Critical years, for Alternative Plans 2, 3, and 4. Most of the simulated maxima for both existing and future conditions are less than 1 km.

**Table 5-12. Number of Years X2 is Located More than 1 Kilometer Upstream from the Location Under Existing Conditions and No Action Alternative**

| **Existing Condition** | **Alt 1** | **Alt 2** | **Alt 3** | **Alt 4** | **Alt 5** |
|---|---|---|---|---|---|
| January | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 0 | 0 | 0 |
| April | 0 | 0 | 0 | 0 | 0 |
| May | 1 | 1 | 1 | 1 | 1 |
| June | 1 | 1 | 1 | 1 | 2 |
| July | 1 | 1 | 1 | 1 | 2 |
| August | 0 | 0 | 0 | 0 | 1 |
| September | 0 | 0 | 0 | 0 | 0 |
| October | 0 | 0 | 0 | 0 | 0 |
| November | 0 | 0 | 0 | 0 | 0 |
| December | 0 | 0 | 0 | 0 | 0 |
| **No Action Alternative** | **Alt 1** | **Alt 2** | **Alt 3** | **Alt 4** | **Alt 5** |
| January | 0 | 0 | 0 | 0 | 1 |
| February | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 0 | 0 | 0 |
| April | 0 | 0 | 0 | 0 | 0 |
| May | 0 | 0 | 0 | 0 | 0 |
| June | 0 | 0 | 0 | 0 | 0 |
| July | 2 | 2 | 2 | 2 | 3 |
| August | 0 | 0 | 0 | 0 | 1 |
| September | 0 | 0 | 0 | 0 | 0 |
| October | 0 | 0 | 0 | 0 | 0 |
| November | 1 | 1 | 1 | 1 | 1 |
| December | 1 | 2 | 2 | 2 | 2 |

Key:
Alt = Alternative Plan

The effects of the action alternatives on the X2 location during the September-through-November period and the January-through-June period would be minor, and are not expected to significantly affect fish habitat. Additionally, the Delta facilities are operated to provide protection to listed fish species, and this would not change under the action alternatives. The action alternatives would be operated consistent with applicable laws, regulations, BOs, and court orders in place at the time the project is implemented.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

### Mitigation Measures

This section discusses mitigation measures for each potentially significant and significant impact described in the environmental consequences section.

No mitigation is required for Impacts FSH-2 through FSH-8 in the primary study area, as these impacts would have no impact or be less than significant, less than significant and beneficial, or beneficial under the action alternatives. No mitigation is required for Impacts FSH-10 through FSH-22 in the primary study area, as there would be no impact under the action alternatives.

In the extended study area, there would be no impact under the action alternatives under Impacts FSH-1 through FSH-9. No mitigation is required for Impacts FSH-10 (under Alternative Plans 1 through 4), or for FSH-12 through FSH-17 and FSH-19 through FSH-22 (under all action alternatives) in the extended study area as these impacts would have no impact, or be less than significant or less than significant and beneficial for all action alternatives.

Impacts FSH-1 and FSH-9 within the primary study area would be significant under the action alternatives. No feasible mitigation measures are available to reduce these impacts to a less-than-significant level. Therefore, Impacts FSH-1 and FSH-9 in the primary study area would be **significant and unavoidable** under all action alternatives.

Impact FSH-10 within the extended study area would be potentially significant under Alternative Plan 5. No feasible mitigation measures are available to reduce this impact to a less-than-significant level. Therefore, Impact FSH-10 in the extended study area would be **potentially significant and unavoidable** under Alternative Plan 5.

Impact FSH-11 within the extended study area would be significant under all action alternatives. No feasible mitigation measures are available to reduce this impact to a less-than-significant level. Therefore, Impact FSH-11 in the extended study area would be **significant and unavoidable** under all action alternatives.

Impact FSH-18 within the extended study area would be potentially significant under all action alternatives. No feasible mitigation measures are available to reduce this impact to a less-than-significant level. Therefore, Impact FSH-18 in the extended study area would be **potentially significant and unavoidable** under all action alternatives.

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