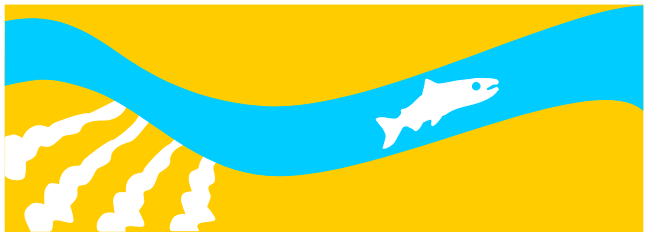
Public Draft

2013 Monitoring and Analysis Plan

SAN JOAQUIN RIVER
RESTORATION PROGRAM



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Prepared for and in cooperation with the SJRRP by MWH

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Abbreviations and Acronyms

2D	two-dimensional
Act	San Joaquin River Restoration Settlement Act
ATR	Annual Technical Report
CDEC	California Data Exchange Center
cfs	cubic foot per second
DFG	California Department of Fish and Game
DO	dissolved oxygen
DWR	California Department of Water Resources
EA/IS	Environmental Assessment/Initial Study
EDT	Ecosystems Diagnosis and Treatment
EIS/R	Environmental Impact Statement/Report
Implementing Agencies	agencies responsible for implementing the Settlement
LiDAR	light detection and ranging
MAP	Monitoring and Analysis Plan
MMP	Monitoring and Management Plan
NMFS	National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
PEIR	Program Environmental Impact Report
PEIS/R	Program Environmental Impact Statement/Report
PIT	passive integrated transponder
RA	Restoration Administrator
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RWA	Recovered Water Account
Settlement	Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.*
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Program
State	State of California
State Board	State Water Resources Control Board
SWAMP	Surface Water Ambient Monitoring Program
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1.0 Introduction

The Monitoring and Analysis Plan (MAP) is a living document that is updated yearly as part of the San Joaquin River Restoration Program (SJRRP) planning and reporting process to provide a long-term strategy and present revised information needs based on the status of SJRRP implementation. Because there is uncertainty associated with implementation, data collection and analyses, priority is directed toward collecting data that is most meaningful to inform these uncertainties. The MAP presents a directed approach to define the conditions for successful implementation of the SJRRP and prioritizing projects and multi-year studies that directly contribute to understanding those conditions.

The MAP presents both immediate and long-term objectives to address uncertainties associated with implementing the SJRRP. The immediate objectives of the MAP are to identify monitoring and study activities planned for 2013 to support implementation of the SJRRP, and to solicit feedback on 2013 activities through the public review process. The MAP also provides a long-term strategy by identifying actions identified in the *Working Draft Framework for Implementation* (SJRRP, 2012b) for the SJRRP, identifying timelines for completing those actions, highlighting uncertainties and areas of concern, and identifying challenges associated with setting the future direction. A description of the data collected in support of studies to address objectives and to monitor long-term status and trends associated with physical and biological conditions of the San Joaquin River (SJR) are presented in the MAP.

1.1 Settlement Background

Agencies responsible for implementing the SJRRP (Implementing Agencies) include the U.S. Department of the Interior, Bureau of Reclamation (Reclamation); U.S. Fish and Wildlife Service (USFWS); California Natural Resources Agency; California Department of Water Resources (DWR); California Department of Fish and Game (DFG); U.S. Department of Commerce; and National Marine Fisheries Service (NMFS). Implementing Agencies of the SJRRP are developing an approach to address water management; Restoration Flows; channel and structural improvements; and reintroduction of salmonids, identified in the Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.* (Settlement) to meet or improve the success of SJRRP implementation. Collecting data and performing analysis to address questions about how the SJR will function under implementation of the Settlement will inform approaches for addressing the issues mentioned above. Questions have been identified or will be identified. Data collection and technical analyses will center on physical and biological processes that affect information needs identified in the Settlement and will contribute to reducing uncertainties related to addressing the questions.

These approaches are being developed to meet the two primary goals of the Settlement. The primary goals are as follows:

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

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

To meet the Restoration Goal, the Implementing Agencies are faced with the challenge of identifying physical and biological conditions that would support restoring and maintaining fish in "good condition," and how those physical and biological conditions should be met through implementing actions. The Settlement and Implementing Agencies have defined a list of potential projects and actions developed through site-specific studies and the Program Environmental Impact Statement/Report (PEIS/R) (SJRRP, 2012a). These actions are identified and described in the *Working Draft Framework for Implementation* (SJRRP, 2012b). Actions for meeting the Restoration Goal would result in the conveyance of nondamaging flows and provide, at a minimum, a migration corridor for Chinook adult and juvenile salmon to complete their lifecycle. Core actions for meeting the Water Management Goal would result in completion of the actions identified in the Settlement and SJRRP Settlement Act (Act) to reduce or avoid water supply impacts as a result of Interim and Restoration flows. Additional actions identified by Implementing Agencies are categorized by themes that are associated with the questions to be addressed in understanding how the SJR will function under implementation of the SJRRP.

1.2 MAP Organization and Development Process

To meet the Restoration and Water Management goals, the Implementing Agencies identified actions that have been categorized into themes to describe characteristics of a viable program. These themes are as follows:

- **Flow Management** – Encompasses all actions under Paragraph 13 of the Settlement, including operational actions at Friant Dam, compliance with hydrographs defined in the Settlement, recapture accounting, scheduling, water acquisitions, banking, and permit requirements.

- **Conveyance** – Involves establishing nondamaging channel capacities to allow releases that provide for fish movement and to maintain acceptable water temperatures.

- **Entrainment Protection** – Includes actions to screen diversion facilities and identify whether other diversions will entrain large numbers of emigrating juveniles to prevent the loss of juvenile salmon.

- **Predation** – Includes studies to assess and limit predation of juvenile salmon that affects migration survival and impedes the SJRRP from meeting fish population targets.

- **Rearing Habitat** – Involves establishing or improving rearing habitat to promote a healthy salmon population in the SJR.

- **Spawning and Incubation** – Involves identifying and providing appropriate conditions to improve survival and hatch eggs successfully.

- **Adult Migration Paths** – Includes actions to remove false migration paths that lead to unsuitable spawning habitat, being trapped, or prohibiting fish from traveling to suitable habitat in time to reproduce.

- **Fish Passage** – Involves creating a reliable passage corridor to help fish move down and up the SJR to complete their life cycles.

- **Fish Reintroduction** – Includes conducting a series of efforts to further understand the reintroduction process through developing a captive Chinook salmon broodstock, conducting expanded studies to address key uncertainties, and implementing pilot Chinook salmon release efforts to test and refine strategies.

- **Water Management** – Encompasses actions that include identifying, developing, and implementing projects and programs to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim and Restoration flows provided for in the Settlement.

This MAP groups actions, questions, and studies by the above-mentioned themes. Prioritizing implementation of actions is driven by meeting the scientific needs to address uncertainties and the schedules for potential projects and actions described in the Settlement, Public Law 111-11, environmental compliance, and Restoration Administrator (RA) recommendations.

Questions associated with each theme will be presented in the MAP. The list of questions will be updated and revised as new information becomes available through data collection and analyses. During the next year, the SJRRP anticipates convening interdisciplinary study groups tasked with the goal of refining questions and reevaluating uncertainties associated with each theme. The interdisciplinary study groups will provide an opportunity to (1) develop integrated approaches to addressing remaining uncertainties, and (2) reduce the potential for assessments that have little or no value when completed as stand-alone studies. The interdisciplinary study groups will convene multiple times throughout the year to establish an adaptive approach to prioritizing and addressing questions.

The studies define hypotheses and provide rationale for identifying the types of information needed to support SJRRP decisions and actions, including actions such as modeling, monitoring, and analysis activities. Studies may be completed in 1 year or

may span multiple years and would typically consist of monitoring or data gathering during a short-term period to address an uncertainty.

The MAP also presents studies that may be implemented in response to information needs identified in resource-specific Monitoring and Management Plans (MMP). The current role of the MMPs is to identify information needs and describe specific knowledge gaps to be addressed through monitoring and studies. The MMPs are intended to track long-term implementation approaches.

The MAP follows the SJRRP annual planning and reporting process (see Figure 1-1), which includes the MAP, Mid-Year workshop and data report, and Annual Technical Report (ATR). The studies presented in this MAP are planned for 2013 and will be reported in the 2013 ATR. The 2013 ATR will also consist of updates to the MMPs to reflect the current state of resource-specific knowledge. Site-specific project and agency actions will be described further based on their current status in the 2013 ATR.

The MAP is developed with input from the Implementing Agencies, RA, stakeholders, and other technical specialists to define appropriate data needs and study methods, including both scope and accuracy of the study plans, to support decisions, and appropriate monitoring and/or analysis used to obtain the data. The SJRRP makes the MAP available in draft form for public review before finalizing plans for the following year. The public review period provides an opportunity for the public to read and submit comments on the document. Following the public review period, the public comments will be evaluated and considered for revising the MAP.

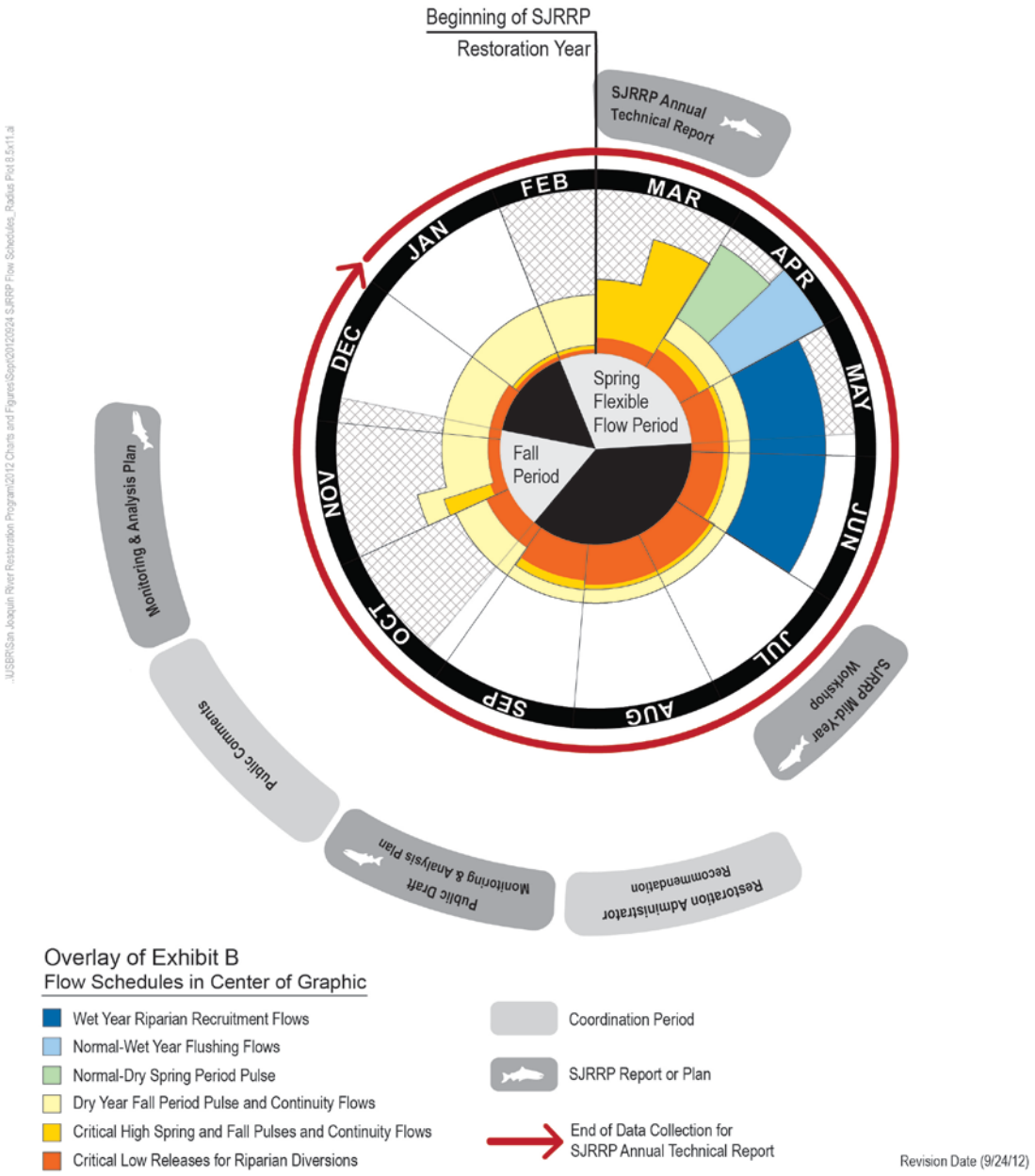


Figure 1-1.
Monitoring and Reporting Schedule

1.3 Document Organization

Document organization is discussed below.

Section 2, Monitoring Status and Trends – Describes the long-term monitoring performed to meet Settlement requirements and to record status and trends for different physical and biological conditions.

Section 3, Actions, Questions, and Studies – Describes actions that address key questions; questions needing decisions to implement the Settlement, legislation, and program goals; and studies that focus on addressing uncertainties.

Section 4, Environmental Compliance – Describes monitoring and analysis components that are incorporated into actions to meet permit conditions and commitments in environmental documents.

Section 5, Monitoring Network – Describes the components monitored and presentation of current and proposed monitoring locations.

Section 6, Analytical Tools – Describes available numerical models and other technical tools used to analyze monitoring data and proposed revisions to analytical tools.

Section 7, Monitoring Activities Summary – Summarizes the schedule and budget for monitoring activities in 2013.

Section 8, Conclusions – Summarizes the anticipated outcomes of 2013 monitoring and analysis activities.

Section 9, References – List of sources used to compile this MAP.

Appendix A Studies – Presents of studies selected for implementation in 2013. The studies presented in Appendix A are supported by information collected from the monitoring network, and analysis conducted using available analytical tools presented in Sections 5 and 6. The studies presented in Appendix A were prioritized based on efforts to address key actions consistent with the SJRRP implementation schedule, and are described in the *Working Draft Framework for Implementation* (SJRRP, 2012b).

Appendix B Restoration Administrator Recommendations for 2013 Priority Monitoring and Assessment Actions (placeholder)

Appendix C Budget Summary –Provides a summary the budget for each study during 2013.

2.0 Monitoring Status and Trends

The SJRRP conducts long-term monitoring to meet Settlement requirements and to record status and trends for different physical and biological parameters. Long-term monitoring efforts can be used to inform the Implementing Agencies of how management actions relate to and affect conditions in the Restoration Area. Long-term monitoring may also be used to demonstrate effectiveness of actions implemented under the SJRRP. The SJRRP reports this data on an annual basis in the ATR and the monitoring data is used to answer questions related to studies described in Section 3, "Actions, Questions, and Studies."

2.1 Flow and Stage Monitoring

The Implementing Agencies conduct stream gaging to understand river conditions and collect information to address actions. In addition to flow gage monitoring, sensors at these sites also include a probe for detecting water temperature, DO, electrical conductivity, and chlorophyll.

Table 2-1 lists the stations that collect flow and stage data that undergo quality assurance/quality control (QA/QC). Flow data from other stations along the San Joaquin River that have not undergone QA/QC are available at the California Data Exchange Center (CDEC).

Table 2-1.
California Data Exchange Center Flow and Stage Measurement Stations

Stations
SJF – Below Friant Dam*
DNB – Donny Bridge
GRF – Gravelly Ford*
SJB – Below Chowchilla Bifurcation Structure*
SJN – San Mateo Ave.
MEN – Near Mendota Dam
SDP – Sack Dam near Dos Palos*
SWA – Washington Road*
ELN – El Nido
SJS – Stevinson
FFB – Fremont Ford Bridge
SMN – Merced Confluence*

Key:
* Settlement requires flow monitoring at these stations.

2.2 Temperature Monitoring

DFG and Reclamation collect surface water temperature data from sites along the SJR for the purpose of monitoring the status and tracking trends of the surface water temperature regime. The locations of temperature monitoring stations throughout the SJRRP reaches are presented in the *Temperature Atlas* at http://restoresjr.net/flows/WaterQuality (SJRRP, 2012d).

2.3 Groundwater Monitoring

Reclamation collects groundwater elevation data from the SJRRP groundwater monitoring well network to inform seepage management. The *Seepage Management Plan* (SJRRP, 2011) describes monitoring and operating guidelines for reducing Interim or Restoration flows to address any material adverse impacts caused by Interim and Restoration flows in the SJR identified by the SJRRP groundwater monitoring program.

The SJRRP groundwater monitoring well network includes 148 wells installed by the program, excluding temporary wells. A single monitoring well atlas that reports groundwater levels for 254 wells, including the SJRRP groundwater monitoring wells, temporary wells, and other wells in the vicinity of the SJR and is published at http://www.restoresjr.net/flows/Groundwater (SJRRP, 2012e).

2.4 Terrain

Terrestrial and bathymetrical light detection and ranging (LiDAR), and color infrared and/or hyperspectral aerial imagery will be collected on an annual basis.

2.5 Vegetation Monitoring

Riparian vegetation along the SJR between Friant Dam and the Mendota Pool has been significantly modified by agricultural development, hydrologic changes from operations of Friant Dam, and construction and operation of flood control levees and the bypass system.

Twenty permanent vegetation transects were established within Reaches 1A, 1B, 2A, 2B, 3, 4A, and 4B2 (i.e., San Luis National Wildlife Refuge), and the Eastside and Mariposa bypasses (Study 23, Appendix A). Vegetation transects are monitored annually to monitor status and trends of plant cover, composition, overstory height, and stem density along each transect.

2.6 Sediment

The U.S. Geological Survey (USGS) will continue collecting sediment data in 2013 as part of an annual monitoring program (Study 21, Appendix A). Sediment data collected includes suspended sediment, bedload, and bed material to monitor long-term changes in geomorphology.

USGS is also conducting a study to collect continuous surrogate measurements of bedload sediment transport using hydrophone installations on the SJR (Study 18, Appendix A). The objective of this study is to evaluate the use of hydrophone stations for estimating coarse bedload sediment transport dynamics at high temporal resolutions (e.g., hourly or finer) on the main stem SJR downstream from Friant Dam for water years 2013 and 2014. Three separate types of installations will be evaluated: two stereo hydrophone installations and one "Quadraphone" (double stereo) installation co-located at existing bedload sampling locations for measuring coarse bedload transport rates, and two stereo hydrophone installations located at riffle sites for estimating thresholds of coarse bedload mobilization and cessation. Each type of hydrophone installation will be evaluated for its accuracy in estimating coarse bedload transport rates and bed mobilization using data collected by other studies funded by the SJRRP. In particular, the hydrophone data will be evaluated for the ability to "tune" hydrophone response to the relative low rates and low bedload grain sizes present on the SJR. In addition, the 'Quadraphone' installation will be assessed for the potential to spatially locate bedload movement within the river, using calibrated time-of-travel techniques.

In addition, USGS is continuing its San Joaquin River Tributary Sediment Transport and Geomorphology Study (Study 22, Appendix A). The purpose of this study is to quantify the sediment input from two major tributaries, Cottonwood Creek and Little Dry Creek, to the San Joaquin River downstream from Friant Dam. The amount and type of sediment contributed from the two major tributaries is not well understood but likely will play a substantial role in the sediment budget of the San Joaquin River, given the lack of upstream sediment supply due to Friant Dam. The amount and timing of fine and coarse sediment contributed by these tributaries can affect aquatic and riparian species, which are a focus of the SJRRP.

2.7 Biological Monitoring

Multiple studies associated with long-term biological monitoring of status and trends are presented in this MAP, including the following:

- Fish Assemblage Inventory and Monitoring (Study 9, Appendix A)
- San Joaquin River passive integrated transponder (PIT) Tag Monitoring and Site-Specific Technology Development (Study 15, Appendix A)
- Macroinvertebrate Surface Water Ambient Monitoring Program (SWAMP) Bioassessment (see Section 13, Appendix A, 2012 MAP, for complete study plan)

2.7.1.1 Fish Assemblage Inventory and Monitoring

To assess achievement of the Restoration Goal an inventory and monitoring program is being conducted to identify fish abundance and diversity within the Restoration Area (Study 9, Appendix A). Describing a baseline fish assemblage within the Restoration Area during the beginning stages is useful for long-term monitoring. Information on chronological analysis of the temporal and spatial distribution, relative abundance, and diversity of fish species will help with the SJRRP Restoration Goal's success. This information can also be used to adaptively manage future efforts for a more effective implementation of the Restoration Goal.

2.7.1.2 San Joaquin River PIT Tag Monitoring and Site-Specific Technology Development

The SJR is highly regulated and water flow decisions may impact juvenile Chinook salmon downstream migration patterns. Data recorded from the SJR PIT Tag Monitoring and Site-Specific Technology Development Study can be used to determine areas that contribute to salmon mortality, migration rate, and emigration routes through the Restoration Area under a variety of flow conditions (Study 15, Appendix A). This information will be used to better inform management while making decisions regarding reintroduction timing and flows, and pathways through the system that provide the greatest chance for survival. These data will also be used to estimate reach-specific and Restoration Area-wide juvenile Chinook salmon survival rates providing more accurate information for the Emigrating Salmonid Habitat Estimation model to predict the number of juvenile production to meet the SJRRP population goals. These data can be used to better understand the survival and migration paths of juvenile Chinook salmon while adaptively managing future decisions toward reaching the Restoration Goal.

PIT tag monitoring is planned to continue in 2013 after the study is initiated in 2012.

2.7.1.3 Macroinvertebrate SWAMP Bioassessment

Restoration Flows are intended to be sufficient in condition to provide habitat that meets life history requirements of Chinook salmon (*Oncorhynchus tshawytscha*) and other native fishes in the SJR. These requirements include habitat characteristics such as good water quality and availability of food resources. When attempting to restore a river and its extirpated fishery, a key element of the habitat is the benthic macroinvertebrate assemblage because it can be used to indicate water quality and is a primary food source for fish. Thus, biological assessment of the benthic community will provide information to evaluate the impact of Restoration Flows on salmonid riverine habitat.

This study corresponds to the second year of a planned 3-year collaborative study by DWR and DFG (see Section 13, Appendix A, 2012 MAP, for complete study plan).

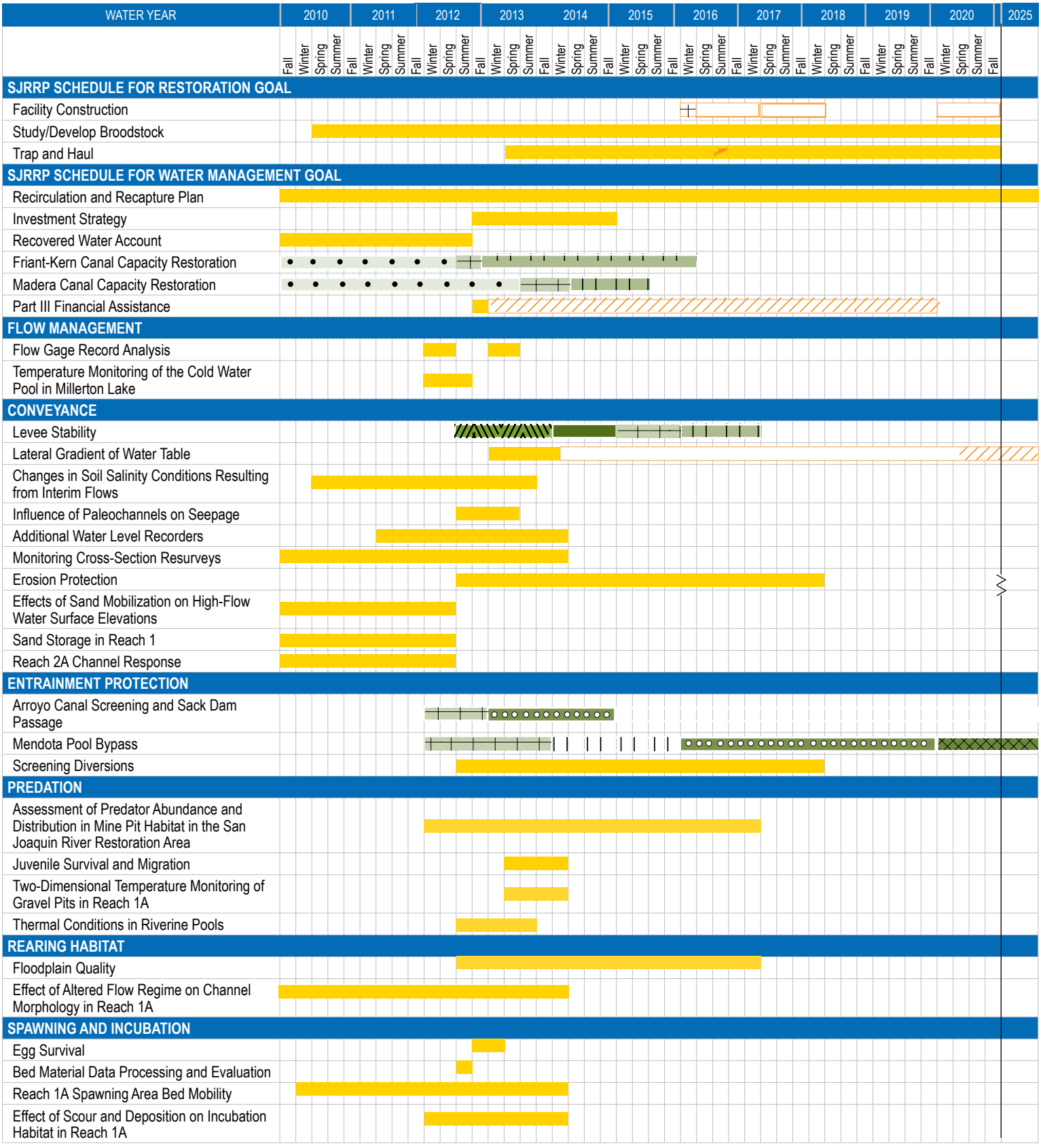
3.0 Actions, Questions, and Studies

The MAP presents a long-term approach for planning and implementation of the SJRRP. As part of this approach, actions and uncertainties have been identified. This section is organized by themes that describe the characteristics for successful implementation of the SJRRP to help prioritize potential actions (see Section 1.0 for list of themes). These themes represent objectives for which additional information will be collected in consideration of releasing and conveying Interim and Restoration flows, reintroducing fish and providing for fishery needs, protecting Third Parties, and reducing or avoiding water supply impacts. Questions will be identified under each theme to identify the areas of uncertainty associated with implementation of the SJRRP. Actions have been identified below under each theme to support further addressing the information needs. The SJRRP released a draft schedule for implementing actions to support meeting the Restoration Goal and Water Management Goal in the *Working Draft Framework for Implementation* (SJRRP, 2012b). This schedule, and the schedule for individual studies submitted and planned for implementation during 2013, related to the themes described below are presented in Figure 3-1.

Data collection and monitoring activities supporting studies addressing actions will be prioritized based the schedules presented in Figure 3-1. In addition to using the schedules presented in Figure 3-1, the interdisciplinary study groups will collectively use its expertise to suggest the order in which data collection and monitoring activities are implemented or the order for prioritization to address evolving uncertainties. The interdisciplinary study groups will be focused on the following areas of uncertainty:

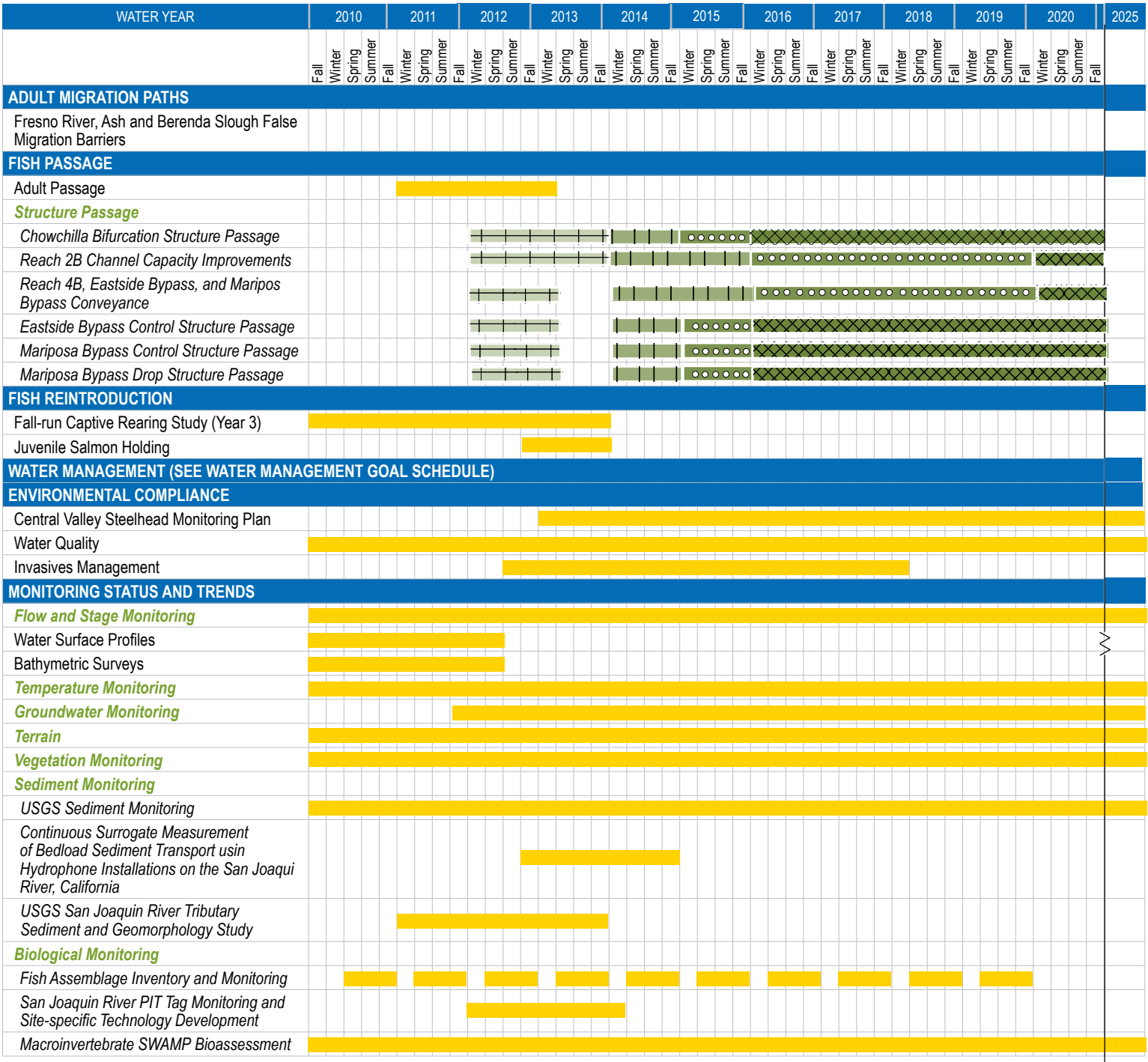
- Chinook Salmon Spawning habitat
- Chinook Salmon Rearing habitat
- Chinook Salmon Adult migration
- Channel capacity
- Chinook Salmon Juvenile predation
- Real-time flow scheduling

The interdisciplinary study groups will also focus on the key questions to be addressed and use an adaptive management approach to guide SJRRP activities towards meeting the Restoration Goal and Water Management Goal.



KEY

- Conservation Facility Complete
- Complete Fish Passages at Flow Control Structures
- Conservation Facility Fully Operational
- Mendota Pool Bypass Complete
- Full Fish Releases
- Levee Geotechnical Exploration
- Revise Channel Capacity Constraints
- Monitoring and Analysis/Activity
- Pontential Monitoring and Analysis/Activity
- Feasibility Study
- NEPA/CEQA Compliance
- Final Design
- Construction
- Operational



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- Final Design
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This section describes the current level of understanding or ongoing efforts associated with each theme, the key questions to be addressed associated with each theme, the proposed actions identified in the *Working Draft Framework for Implementation* (SJRRP, 2012b), studies planned for 2013 associated with addressing the actions, and a schedule for completion of actions (presented in Figure 3-1). Complete studies are provided in Appendix A.

3.1 Flow Management

Flow management encompasses all actions under Paragraph 13 of the Settlement. Actions under Paragraph 13 include operational actions at Friant Dam, compliance with hydrographs defined in the Settlement, recapture accounting, scheduling, water acquisitions, banking, and permit requirements. Reclamation currently implements these actions through a program of Interim Flows, development of Restoration Flow Guidelines, and the MAP and MYTR/ATR.

3.1.1 Actions

Actions associated with flow management, identified in the *Working Draft Framework for Implementation* (SJRRP, 2012b), include the following:

- Stream gage monitoring releases from Friant Dam and locations specified in Exhibit B of the Settlement.
- Monitoring of unexpected seepage losses and unreleased Restoration Flows.

A long-term question to be addressed for successful implementation is the concept of flow scheduling to facilitate fish survival and migration. This is one of the key questions for SJRRP, because flow management provides a potentially powerful tool for influencing fish survival and migration. The Interim and Restoration flows' flexible flow period allows managing of releases to meet SJRRP objectives. Implementing Agencies have the ability to manage the timing, magnitude, and duration of water releases. However, the trade-offs of flow flexibility for temperature management; providing floodplain habitat; or providing pulse flows to initiate fish migration needs to meet SJRRP goals are not well understood. Additional actions that have been identified by Implementing Agencies to understand these trade-offs include the following:

- **Acquire Water for Unexpected Seepage Losses** – Acquisition of water or options on water to meet flow targets consistent with the Restoration Flow Guidelines and Paragraph 13(c) of the Settlement.
- **Bank or Store Unreleased Restoration Flows** – Use of water not released for any reason consistent with the Restoration Flow Guidelines and Paragraph 13(j) of the Settlement.

3.1.2 Questions

<To be included in final 2013 MAP.>

3.1.3 Studies

Two studies planned for implementation in 2013 focus on addressing uncertainties associated with flow management:

- Flow Gage Record Analysis (Study 1, Appendix A)
- Temperature Monitoring of Cold Water Pool in Millerton Lake (Study 5, Appendix A)

3.1.3.1 Flow Gage Record Analysis

The flow gage record analysis study is planned for 2013 and is related to the flow management theme. This study addresses a key program question of understanding unexpected seepage losses downstream from Friant Dam. This study will inform compliance flow releases at Friant Dam to achieve Gravelly Ford flow targets, and also inform the potential for purchased water. The schedule for completing this study will align with the SJRRP planning and reporting process and the study will be completed for the 2013 ATR.

This is the second year of the historical and water year flow gage record analysis study. As mentioned, the study will take place in 2013 and will repeat annually. Data collected to support this study includes flow gage monitoring, described in Section 4, Monitoring Status and Trends.

3.1.3.2 Temperature Monitoring of Cold Water Pool in Millerton Lake

Temperature monitoring of the cold water pool in Millerton Lake will provide data to support consideration of management actions to release flows from higher in the water column as a potential solution to improve temperature conditions for fisheries. Because water temperatures affect all life stages of Chinook salmon, it is critical to address the key question of whether the temperature of inflows to the SJR from Millerton Lake will provide a suitable fisheries habitat. The availability and the effect that the Millerton Lake cold water pool has on instream river temperatures are not well understood. Water temperature in the lake is being monitored to evaluate how releases from Millerton Lake's cold water pool relate to instream SJR temperatures.

This is the second year of the Millerton Lake cold water pool management study. The study will take place again in 2013 and may repeat annually until Implementing Agencies conclude that sufficient information has been collected for proposing and implementing flow scheduling to support temperature management.

3.2 Conveyance

Conveyance involves establishing nondamaging channel capacities to allow releases that provide for fish movement and to maintain acceptable water temperatures. The PEIS/R calls for Restoration Flows to be limited to then-existing channel capacity based on U.S. Army Corps of Engineers criteria for levee through- and under-seepage. Potential actions to increase channel capacity and thereby establish additional conveyance include

constructing levee setbacks for physical capacity, improving levee stability to maintain the flood control project, and constructing new seepage projects to reduce or avoid material adverse impacts from groundwater seepage.

Reclamation and other Implementing Agencies are currently completing site-specific environmental compliance documentation for actions under the Reach 2B Channel Capacity Improvements and Mendota Pool Bypass Improvements and Reach 4B, Eastside Bypass, and Mariposa Bypass Conveyance Improvement projects, consistent with Paragraph 11 of the Settlement. Environmental documentation for these actions is anticipated on the following schedule:

- Draft Environmental Impact Statement/Report (EIS/R) for Reach 2B Channel Capacity Improvements and Mendota Pool Bypass Improvements is anticipated to be released in spring 2013
- Final EIS/R for Reach 2B Channel Capacity Improvements and Mendota Pool Bypass Improvements is anticipated to be released in summer 2014
- Draft EIS/R for Reach 4B, Eastside Bypass, and Mariposa Bypass Conveyance Improvements is anticipated to be released in January 2013

Collecting data on levee materials is used to determine levee stability risks. In the absence of sufficient data to evaluate levee stability, Reclamation is dedicated to maintaining flows below the outside toe. Levee constraints currently limit flows at the following locations:

- Upstream form the Mendota Pool to 810 cubic feet per second (cfs) in Reach 2B
- Below Sack Dam to 600 cfs in the Eastside Bypass

Other current efforts to support evaluation of levee stability include geotechnical investigations underway by DWR to collect relevant data to identify and prioritize bottleneck areas for levee remediation.

Reclamation developed a *Seepage Management Plan* (SJRRP, 2011) in coordination with the landowners, last updated in March 2011, which lays out a groundwater monitoring network and identifies thresholds in wells within the monitoring network. Reclamation limits the release of Interim Flows to flow rates that do not cause groundwater levels to rise above thresholds. Reclamation can sometimes recapture a portion of the releases from Friant Dam to reduce or avoid downstream impacts from groundwater seepage. Seepage constraints currently limit flows upstream from the Mendota Pool to 2,100 cfs in Reach 2A. Seepage constraints vary seasonally and by hydrology below Sack Dam, and currently limit flows to between zero and 140 cfs in the Eastside Bypass between the Sand Slough Control Structure and Mariposa Bypass Bifurcation Structure.

The PEIS/R also calls for addressing seepage effects through easements and/or compensation for seepage effects to landowners. Implementing physical or real-estate-

related seepage projects will allow higher flow rates without groundwater levels rising above thresholds. Reclamation, in coordination with landowners, has nearly completed developing a *Seepage Project Handbook*, which specifies the process for working with landowners, and timelines for implementing seepage projects. Reclamation has initiated several seepage projects to increase nondamaging conveyance capacity.

3.2.1 Actions

Several actions have been identified by the Implementing Agencies as part of the *Working Draft Framework for Implementation* (SJRRP, 2012b) related to the conveyance theme that include the following:

- Levee improvements for lengths impacted at 2,000 cfs conveyance in Reaches 2A, 3, 4A, and 5.

- **Up to 2,000 cfs of conveyance by 2016** – This action suggests that seepage improvements be made for parcels impacted at 2,000 cfs conveyance in Reaches 2A, 3, 4A, and 5.

- **Reach 2B Channel Capacity Improvements** – This would include construction of levees for 4,500 cfs capacity without engineering floodplain habitat through grading or planting of vegetation. Temperature criteria identified a conveyance of 2,000 cfs as a core need. Although construction of the Mendota Pool Bypass may accomplish nondamaging conveyance near 2,000 cfs, the Implementing Agencies included this as an action to meet requirements in Paragraph 11(a) of the Settlement. Conveyance levels from seepage and levee stability actions show incremental improvements to existing levees as an alternative to constructing the 4,500 cfs Settlement project. Construction would include relocations, levee construction, partial removal of existing levees, and riprap bank protection on Bend 10.

- **Reach 4B, Eastside Bypass, and Mariposa Bypass Conveyance** – This would include constructing flow routing facilities at the Sand Slough Control Structure, levee construction or repair, low-flow channel excavation, and transportation crossing improvements in either the old river channel or the flood bypass system. A series of channel capacity constraints in these areas prevent the conveyance of 2,000 cfs.

Another action for seepage was identified by the Implementing Agencies in the *Working Draft Framework for Implementation* (SJRRP, 2012b) that suggests seepage improvements be made between 2019 and 2023 for parcels impacted at greater than 2,000 cfs.

3.2.2 Questions

<To be included in final 2013 MAP.>

3.2.3 Studies

Studies planned for implementation in 2013 addressing conveyance issues include the following:

- Levee Geotechnical Exploration (Study 13, Appendix A)
- Lateral Gradient of Water Table (Study 2, Appendix A)
- Changes in Soil Salinity Conditions Resulting from Interim Flows (Study 3, Appendix A)
- Influence of Paleochannels on Seepage (Study 4, Appendix A)
- Additional Water Level Recorders (Study 24, Appendix A)
- Monitoring Cross-Section Resurveys (Study 25, Appendix A)

3.2.3.1 Levee Geotechnical Exploration

The Levee Geotechnical Exploration Study will evaluate the potential risk impacts of Interim and Restoration flows under the SJRRP. As an early step in the process, obtaining geotechnical information on existing levees in the SJR and flood bypasses will help evaluate the geotechnical integrity of levees. This study will develop preliminary information to address the action that identifies potential levee improvements for lengths impacted at 2,000 cfs conveyance in Reaches 2A, 3, 4A, and 5, and the Eastside Bypass.

The Levee Geotechnical Exploration Study is anticipated to be completed in 2013. Following levee geotechnical exploration, progress on levee stability evaluation is proposed to proceed on the following schedule.

- **2014** – Revision of channel capacity constraints following completion of levee evaluation
- **2015** – Completion of environmental compliance and design
- **2016** – Initiation of construction activities

3.2.3.2 Lateral Gradient of Water Table

The Lateral Gradient of Water Table Study will provide information including the following: (1) lateral extent of influence from surface water flow in Reach 4A on the near river, shallow groundwater system response, (2) relationships of surface water flows to other groundwater influences, such as rainfall, irrigation of fields, and canal conveyance facilities, and (3) changes in the soil salinity profile and movement of salts from different sources. This study will inform the key question of identifying where seepage concerns exist, and also improve SJRRP understanding to support updates to the *Seepage Management Plan* (SJRRP, 2011).

This is the second year of the Lateral Gradient of Water Table Study. This study will take place in 2013 and may repeat annually until the Implementing Agencies conclude that

sufficient information has been collected to propose and implement seepage management actions.

3.2.3.3 Changes in Soil Salinity Conditions Resulting from Interim Flows

The Changes in Soil Salinity Conditions Resulting from Interim Flows Study will establish baseline salinity levels for seepage-prone areas, and quantify salinity changes over time so that the presence of shallow groundwater during Interim Flows may be understood in relation to existing conditions. This study will also inform the key question of identifying where seepage concerns exist, and improve SJRRP understanding to support updates to the *Seepage Management Plan* (SJRRP, 2011).

This is the second year of the Changes in Soil Salinity Conditions Resulting from Interim Flows Study. This study will take place in 2013 and may repeat annually until the Implementing Agencies conclude that sufficient information has been collected to propose and implement seepage management actions.

3.2.3.4 Influence of Paleochannels on Seepage

The Influence of Paleochannels on Seepage Study will address whether (1) paleochannels exist along the SJR, (2) if the paleochannels exist, the extent of paleochannel influence on seepage extent, and (3) if the paleochannels exist, changes to project design necessitated by existence of paleochannels at a site.

The field work component of the Influence of Paleochannels on Seepage Study began in June 2012 and is expected to conclude in September 2012, subject to landowner access and irrigation schedules. Technical analysis of the data collected for this study will occur during and after this period. Groundwater modeling to support this analysis will be conducted in winter 2012 and spring 2013. A draft report is anticipated for the 2012 ATR in March 2013.

3.2.3.5 Additional Water Level Recorders

The Additional Water Level Recorders Study involves collecting data to inform hydraulic models being used to assess channel capacity, fishery habitat, channel stability, and many other aspects of SJRRP planning and design. This study was initiated in 2010 and data collection is ongoing. The current plan is to analyze data and determine if more or alternative locations should be installed. The analysis will extend through 2012 and into 2013, with the possibility of adding or moving recorders in 2013. The effectiveness of the recorders and whether recorders should be added or moved will also be periodically evaluated.

3.2.3.6 Monitoring Cross Section Resurveys

The Monitoring Cross Section Resurveys Study involves collecting data to inform the Implementing Agencies about whether Interim and Restoration flow releases are causing systematic changes in channel geometry that could lead to a reduction in channel capacity and stability. This study will continue to provide data that can be used to assess mid- and long-term changes in channel geometry and substrate characteristics in the sand-bed portions of a reach in response to the Interim and Restoration flow releases.

This study was initiated in 2010 and will continue in summer 2013 if flows occur during flood season. Analysis of past surveys, including the rate of change and identification of flow triggers for future surveys, should be complete in 2013.

3.3 Entrainment Protection

Entrainment protection includes actions to screen diversion facilities to prevent the loss of juvenile salmon. Major known locations for juvenile salmon entrainment have been identified, but questions remain about whether other diversions will entrain large numbers of emigrating juveniles. The Implementing Agencies are currently developing plans for implementing these actions to screen Arroyo Canal and bypass the Mendota Pool. Diversions that were not identified as a known major entrainment problem have been noted and include riparian diversions and the diversion at Lone Willow Slough. Additional potential actions described in the *Working Draft Framework for Implementation* (SJRRP, 2012b) would address entrainment at these locations pending further evaluation of the level of loss and need. These diversions are not expected to entrain large number of juvenile salmon, but fish monitoring and studies for juvenile losses will track reach-specific losses.

3.3.1 Actions

Actions associated with entrainment protection include screening the Arroyo Canal and constructing a bypass at the Mendota Pool. Evaluations of expected diversion rates and field studies on fish survival identified the Mendota Pool as a potential major source of juvenile salmon loss through entrainment into water diversions in most years. Bypassing fish around the Mendota Pool or moving the Mendota Pool into Fresno Slough would resolve this concern.

3.3.2 Questions

<To be included in final 2013 MAP.>

3.3.3 Studies

No studies are currently underway to directly screen smaller diversions, but the fish survival studies (Juvenile Survival and Migration (Study 10, Appendix A) and SJR passive integrated transponder (PIT) Tag Monitoring and Site-Specific Technology Development (Study 15, Appendix A)) will help determine the location of losses and guide targeted studies. Flow levels comparable to anticipated Restoration Flows and a complete migration corridor for juvenile salmon will help further understand potential losses from smaller diversions. Juvenile survival monitoring will identify reach-specific losses of juveniles, and any areas of large losses can be further investigated with targeted studies. The PIT tag feasibility study is also a step in developing a system to monitor for losses by reach and at specific structures. Future fish releases and monitoring efforts will inform the program on potential losses from these diversions.

3.4 Predation

Predation of juvenile salmon can have a large effect on migration survival and impede the SJRRP from meeting fish population targets. The Settlement calls for addressing gravel mine pit habitat in the SJR, but other areas have also been identified as predator habitat that overlaps with the juvenile salmon migration corridor. Given the potential high level of loss from predation, the expense of remedial actions as integrated approach to predation management is warranted.

Given the cost and difficulty of predator control actions, the SJRRP will investigate actual losses from predation. If these losses are deemed significant, the SJRRP should review methods to reduce the predation pressure on migrating salmon and evaluate the potential for these actions to reduce losses form predation and increase the probability of meeting fishery objectives.

The gravel mine pits and lower SJR reaches (4 and 5) have been identified as areas suitable for predator populations that should be evaluated. Any structure in the system can also provide predator habitat; therefore, existing structures should be evaluated for predation threats, and new structures designed to not provide predator habitat.

3.4.1 Actions

Actions associated with this theme include filling and isolating gravel mine pits, and other predator avoidance and predator management actions. The gravel mine pits in the Restoration Area have been identified as a potential contributor to juvenile salmon loss. The gravel pits provide habitat for predatory fish, and the slow current through these pools can expose juvenile salmon to high predation mortality. The SJRRP is currently studying predator populations in these gravel mine pits and survival of juvenile salmon through the gravel mine pits. These studies will advise future actions.

Gravel mine pit filling and isolation actions have not been implemented, but the Implementing Agencies are developing plans for these actions.

3.4.2 Questions

<To be included in final 2013 MAP.>

3.4.3 Studies

Four studies planned for implementation in 2013 focus on addressing uncertainties associated with predation and juvenile salmon survival in gravel mine pits in the SJR. Results from these studies will inform Implementing Agencies whether gravel mine pit filling and isolation actions would contribute to a successful program. The studies include the following:

- Assessment of Predator Abundance and Distribution in Mine Pit Habitat in San Joaquin River Restoration Area (Study 11, Appendix A)

- Juvenile Survival and Migration (Year 3 – Telemetry) (Study 10, Appendix A)

- Two-Dimensional Temperature Modeling of Gravel Pits in Reach 1A (Study 19, Appendix A)

- Effect of Altered Flow Regime on Channel Morphology in Reach 1A (Study 26, Appendix A)

3.4.3.1 Assessment of Predator Abundance and Distribution in Mine Pit Habitat in San Joaquin River Restoration Area

A multiple-year study is currently underway to evaluate predator population composition, relative abundance, and habitat use within the system. This study will also evaluate predation of Chinook salmon that have been released into the system. These evaluations will help resolve to what extent predation is likely to be an issue, and can help focus efforts to reduce or control predation. In 2013, the juvenile survival study is focused on evaluating survival within the mine pit complex and integrated with the predator abundance studies.

The Assessment of Predator Abundance and Distribution in Mine Pit Habitat in San Joaquin River Restoration Area Study will improve understanding of predator populations in gravel mine pits, and the information collected will allow the Implementing Agencies to identify the highest priority gravel mining pits to fill. Prioritizing the mine pits for restoration is a Phase II action in the Settlement. Additionally, management decisions regarding appropriate release locations for juvenile salmonids can benefit from information gathered from this study.

The Assessment of Predator Abundance and Distribution in Mine Pit Habitat in San Joaquin River Restoration Area Study is anticipated to be a 5-year effort, with completion in 2017.

3.4.3.2 Juvenile Survival and Migration (Year 3 – Telemetry)

Restoration of the gravel mine pits is identified as a high priority action in the Settlement, and studies would help quantify predation risk and, if necessary, the habitats that pose the greatest risk of predation. Results from this study will inform the Implementing Agencies on predaceous species of fish that are associated with different river features, including gravel mine pits, and identify habitats associated with the greatest risk of predation.

This study is planned to be implemented in spring/early summer 2013. The work completed in 2013 will conclude the third year of the overall study.

3.4.3.3 Two-Dimensional Temperature Modeling of Gravel Pits in Reach 1A

The Two-Dimensional Temperature Modeling of Gravel Pits in Reach 1A Study will improve understanding of the spatial and temporal variations in temperature in the SJR and adjacent gravel pits. The two-dimensional temperature model proposed for this study will produce depths and velocities for the study area that can be compared with documented preferred conditions of predators within the SJR to identify areas and flows that are favorable to different predator species. An improved understanding of the interactions between the river and gravel pit water temperatures may also help to identify the most effective mechanisms to reduce predation potential. An assessment of predator

abundance and distribution was conducted within gravel pits present in the study area in 2012 (SJRRP, 2012c). In addition, ongoing temperature monitoring of the gravel pits and river within the study area took place in 2012 and will likely continue in the future (SJRRP, 2012c). Data collected from these studies can be combined with results from the 2D temperature model to examine interactions among hydraulic conditions, temperature, and predation. The primary goal of the 2D temperature model is to offer insight for controlling water temperatures during critical life stages. In addition, the modeling effort may also assist in determining which gravel mine pits may be most favorable to certain predator species, and in evaluating restoration techniques to promote hydraulic and temperature conditions that would suppress specific predator species during critical life stages for juvenile salmonids.

Modeling efforts and associated analysis are planned to be implemented in 2013.

3.4.3.4 Effect of Altered Flow Regime on Channel Morphology in Reach 1A

The Effect of Altered Flow Regime on Channel Morphology in Reach 1A Study will inform the Implementing Agencies on habitat quality, specifically by collecting data and developing modeling predictions of the availability of specific habitat types based on flow conditions. Deep pools, which provide temperature and predation refuge, holding habitat, and overhanging banks that provide protection from predation, will be evaluated as part of this study.

This study will also provide information relevant to the rearing habitat and spawning and incubation themes. The channel evolution model associated with this study is currently under development. Topographic resurveys of riffles and pools are planned for summer 2013 in Reach 1A if flows are high enough to cause observable bed geometry changes or tracer movement.

3.5 Rearing Habitat

Flow scheduling is a key question that relates to temperature management, Interim and Restoration flows pulse flows for migration, and providing overbank/floodplain habitat. Invertebrates associated with juvenile rearing habitat in the floodplain may have some bearing on the capability of anadromous salmonids to generate self-sustaining populations in this system. Recruitments of aquatic and terrestrial invertebrates will provide information, location, and quality of floodplain habitat for rearing habitat, along with the potential for survival and growth of inhabiting salmonids.

3.5.1 Actions

Actions associated with establishing or improving rearing habitat include grading floodplains and planting riparian vegetation. Actions to establish floodplain vegetation have not been implemented, but the Implementing Agencies are developing plans for these actions. Floodplain grading and vegetation actions would “jump-start” the productive potential of floodplain habitat for juvenile salmon. Conveyance actions described above assumed minimal or no actions to plant and grade floodplain areas.

3.5.2 Questions

<To be included in final 2013 MAP.>

3.5.3 Studies

Two studies planned for implementation in 2013 focus on addressing uncertainties associated with rearing habitat. Results from these studies will inform the Implementing Agencies on whether sufficient rearing habitat is available for a successful program. The studies include the following:

- Floodplain Quality (Study 16, Appendix A)
- Effect of Altered Flow Regime on Channel Morphology in Reach 1A (Study 26, Appendix A)
- Thermal Conditions in Riverine Pools (Study 29, Appendix A)

3.5.3.1 Floodplain Quality

The Restoration Goal of the SJRRP includes the return of viable, long-term, and sustainable populations of naturally reproducing spring- and fall-run Chinook salmon. To realize restoration of the Lower San Joaquin River salmon populations, successful completion of the freshwater portion of the life-cycle must occur. Of special importance is the survival and growth of juvenile salmon in floodplain environments. These temporarily inundated environments often provide conditions that lead to increased salmon growth and presumably better survival. The floodplain quality study will inform the Implementing Agencies on available existing fish habitat.

Field work associated with this study is planned for a 3-week period in March and April 2013. Additional technical analyses will take place before field work is initiated and after completion of field studies.

3.5.3.2 Effect of Altered Flow Regime on Channel Morphology in Reach 1A

The Effect of Altered Flow Regime on Channel Morphology in Reach 1A Study will inform the Implementing Agencies on habitat quality, specifically by collecting data and developing modeling predictions of the availability of specific habitat types based on flow conditions. Flow complexity is beneficial to juvenile rearing and will be evaluated as part of this study.

This study will also provide information relevant to the predation and spawning and incubation themes. The channel evolution model associated with this study is currently under development. Topographic resurveys of riffles and pools are planned for summer 2013 in Reach 1A if flows are high enough to cause observable bed geometry changes or tracer movement.

3.5.4 Thermal Conditions in Riverine Pools

Thermal refugia provide the cold water habitat needed by salmonids when ambient water temperatures exceed their temperature tolerances. It is created when groundwater, hyporheic exchange, or a combination of both upwells cold water into the surface water.

Upwelling flow forms cold water patches along the streambed and thermal stratification in riverine pools.

This study will be conducted to quantify the amount and quality of thermal refugia in fifteen different San Joaquin River pools from the Eastside Bypass/Reach 4 to Reach 5. These locations are to be instrumented from July to August 2012.

3.6 Spawning and Incubation

Incubating salmon eggs require appropriate conditions (temperature, spawning gravel size distribution, water quality including DO and pH, etc.) to survive and hatch successfully. During spawning activity and redd construction, Chinook eggs are buried in the substrate, at depths from around 30 centimeters (e.g., DeVries, 1997) to 45 centimeters (Geist, 2000). This relatively deep substrate region is often in the zone of surface water and groundwater interaction, typically referred to as the hyporheic zone. Hyporheic conditions within the redd may differ markedly from those found at the surface (e.g., Soulsby, et al., 2001). Hyporheic conditions may vary widely for different redds because of variation in channel morphology, groundwater connectivity, and substrate permeability (Arntzen, et al., 2006).

The SJRRP initiated several studies in 2010 to begin addressing uncertainties associated with spawning and incubation habitat. These multi-year studies are further described below.

3.6.1 Actions

Actions associated with improving spawning and incubation include habitat improvements such as gravel augmentation and artificial riffle construction. Spawning habitat augmentation in Reach 1 includes surveys of spawning gravel within the Restoration Area that identified quality spawning gravel in the upper reaches, and also identified that some degree of gravel augmentation could support reintroduction objectives. These actions have not been implemented, but the Implementing Agencies are developing plans for these actions.

3.6.2 Questions

<To be included in final 2013 MAP.>

3.6.3 Studies

Five studies planned for implementation in 2013 focus on addressing uncertainties associated with spawning and incubation. Results from these studies will inform the Implementing Agencies on whether sufficient spawning and incubation provide adequate habitat for a successful program. The studies include the following:

- Egg Survival (Study 8, Appendix A)
- Bed Material Data Processing and Evaluation (Study 17, Appendix A)

- Reach 1A Spawning Area Bed Mobility (Study 28, Appendix A)

- Effect of Scour and Deposition on Incubation Habitat in Reach 1A (Study 27, Appendix A)

- Effect of Altered Flow Regime on Channel Morphology in Reach 1A Study 26, Appendix A)

3.6.3.1 Egg Survival

The Restoration Goal of the SJRRP includes the return of viable, long-term, and sustainable populations of naturally reproducing spring- and fall-run Chinook salmon. To realize restoration of lower San Joaquin River salmon populations, successful completion of their freshwater portion of the life-cycle must occur. A proposed component of this goal is the importation of salmon embryos from an appropriate source and incubation of those embryos within the lower river to successful emergence. For this to occur, the gravel environment must not only meet the requirements of spawning females, it must allow for successful incubation and emergence. While it has been hypothesized that an appropriate spawning and incubation matrix is available, the last salmon to successfully spawn in the lower river was over 5 decades ago (McBain and Trush, 2002). Therefore, the suitability of the available habitat must be fully evaluated.

This study addresses several limiting factors (i.e., sedimentation, streamflow, temperature, gravel quality, and gravel quantity) to the "Healthy Fry Production" life stage (via egg survival) of Chinook salmon (FMWG, 2009), and provides information on existing conditions to inform the reintroduction of salmon by 2012 through identifying factors that may contribute to significant mortality of introduced salmonids.

3.6.3.2 Bed Material Data Processing and Evaluation

Bed material information is often used in studies to address potential impacts of flow releases under the SJRRP on sediment transport, channel morphology, vegetation, and habitat. With the continuation of Interim Flows and recent flood releases, potential changes in bed material size distributions and quantities of sand present in the bed material are unknown. During spring 2009 and again in summer 2012, Reclamation conducted field visits to collect bed material throughout Reach 1 to compare to historical bed material data, and to investigate visible changes associated with flow changes between 2009 and 2012. Evaluating changes in bed material data for short time scales (3 – 5 years) is a step in monitoring how differences in releases from Friant Dam potentially influence bed material gradations. In addition to monitoring for change, acquired sediment data may be used in numerical modeling, gravel mobilization studies, and other investigations of spawning gravel quality. This study proposes to complete processing of photogrammetric sediment samples and bed material samples conducted in June 2012, incorporate results into the sediment atlas, and evaluate potential changes in bed material from historical conditions and between 2009 and 2012.

3.6.3.3 Reach 1A Spawning Area Bed Mobility

The Reach 1A Spawning Area Bed Mobility Study would inform a key question regarding limiting factors associated with healthy fry production that include egg survival

and redd superimposition (SJRRP, 2009). Egg survival depends on intragravel flow delivery of dissolved oxygen (DO), which is influenced by fine sediment content within gravel interstices. Redd superimposition depends on availability of suitable spawning gravels relative to the number of spawning pairs. The suitability of spawning gravels is not only based on grain size composition but also the looseness of bed material such that it allows ease of redd construction. Therefore, understanding the condition of the stream bed (i.e., texture, amount of sand and silt, and degree of bed reinforcement) in areas that are otherwise expected to be suitable for spawning (i.e., have sufficient flow velocity and depth during spawning and incubation periods) is pertinent to the success of the restoration effort.

This study was initiated in January 2010. Data collection was complete in 2012 and data reporting will be completed in 2013.

3.6.3.4 Effect of Scour and Deposition on Incubation Habitat in Reach 1A

The effect of scour and deposition on incubation habitat in Reach 1A study will address uncertainties associated with the potential for excessive scour to expose buried eggs to abrasive flows and predation, thereby reducing the productivity of redds. This study is intended to examine the role that discharge plays in influencing successful incubation and emergence.

Field work associated with this study was initiated in 2010 and will extend into 2013. Data collection and reporting is expected to continue in collaboration with SJRRP egg survival studies.

3.6.3.5 Effect of Altered Flow Regime on Channel Morphology in Reach 1A

The Effect of Altered Flow Regime on Channel Morphology in Reach 1A Study will inform the Implementing Agencies on habitat quality, specifically by collecting data and developing modeling predictions for the availability of specific habitat types based on flow conditions. Bed texture data collected as part of this study will inform the Implementing Agencies on existing habitat and the potential for successful incubation and emergence.

This study will also provide information relevant to the predation and spawning and incubation themes. The channel evolution model associated with this study is currently under development. Topographic resurveys of riffles and pools are planned for summer 2013 Reach 1A if flows are high enough to cause observable bed geometry changes or tracer movement.

3.7 Adult Migration Paths

False migration paths are pathways that attract adult migrating salmon but do not lead to suitable spawning habitat. Adults traveling into these false pathways often become trapped or die in the false pathway. Even if a pathway does not lead to mortality, the delay to migration can prohibit fish from traveling to suitable habitat in time to reproduce. Actions associated with this theme would include constructing barriers to

prevent adult anadromous fish from straying into false migration pathways. The Implementing Agencies identified actions to construct the Salt Slough and Mud Slough barriers to prevent false migration pathways for adult anadromous fish, and are currently developing plans for implementing these actions. However, no studies are currently underway to support resolving uncertainties associated with adult migration paths. An additional potential action identified in the *Working Draft Framework for Implementation* (SJRRP, 2012b) as an improvement is to include an evaluation of Fresno River, Ash, and Berenda Slough False Migration Barriers (Chowchilla Bypass).

The Kings River Barrier represents one adult pathway that may attract adult salmon from the San Joaquin River in flood years. The SJRRP should determine the frequency that the King's River Barrier may attract adult salmon from the Restoration Area and the risk its operation poses to the SJRRP for meeting fishery population objectives.

Potential adult migration pathways may also exist at the Newman Wasteway and locations within the Chowchilla Bypass (e.g., Ash and Berenda sloughs). Adult migration monitoring should be at a resolution that will allow the SJRRP to identify the source of losses within the migration corridor.

The timeline for completing these actions is 2013.

3.8 Fish Passage

One of the actions identified by the Implementing Agencies is to meet structural and channel improvements as described in Paragraph 11(a) of the Settlement. Therefore, a number of specific actions were identified to for next year.

For the purpose of planning, the Implementing Agencies assumed that adult salmon will enter the flood bypasses during wet years.

Creating a reliable passage corridor was identified as a means to help fish move down and up the SJR to complete their life cycles. Adult fish must be able to return to spawn for salmon reintroduction to be successful. Adult passage impediments can be a complete barrier that does not allow salmon to continue migrating to spawning grounds. Major losses through juvenile entrainment can also preclude restoring salmon populations to the San Joaquin River. Actions to reduce juvenile entrainment were included as actions where the Implementing Agencies expect a high degree of juvenile loss and a high expected frequency of occurrence.

Actions associated with this theme include establishing acceptable depths, velocities, and jump heights at structures and road crossings, modifying structures, and maintaining access across the river, for fish passage. The Implementing Agencies identified numerous fish passage actions that would have the highest priority for implementation. These actions include Chowchilla Bifurcation Structure Passage, San Joaquin River Control Structure Passage, Mendota Pool Bypass, Arroyo Canal Screening and Sack Dam Passage, Eastside Bypass Control Structure Passage, Mariposa Bypass Control Structure

Passage, and Mariposa Bypass Drop Structure Passage. The Implementing Agencies identified additional actions that would be prioritized after the actions above that include increased conveyance in Reaches 2A, 3, 4A, and 5; San Mateo Road Crossing; Chowchilla Bypass Passage at Crossings (Avenue 18 ½ and Avenue 21); and Eastside Bypass Passage at Crossings and structures (Dan McNamara Road, Merced National Wildlife Refuge Weirs).

Reclamation and other Implementing Agencies are currently completing site-specific environmental compliance documentation for the above actions consistent with Paragraph 11 of the Settlement. The environmental documentation for these actions is anticipated on the following schedule:

- Draft Environmental Assessment/Initial Study (EA/IS) for Arroyo Canal Screening and Sack Dam Passage was released on June 1, 2012

- Final EA/IS for Arroyo Canal Screening and Sack Dam Passage is anticipated to be released in October 2012

3.8.1 Actions

Specific actions identified in the *Working Draft Framework for Implementation* (SJRRP, 2012b) associated with the structural improvements identified above include the following:

- **Chowchilla Bifurcation Structure Passage** – This would include constructing a fish ladder or ramp. Water velocities at the existing structure are expected to exceed fish passage criteria during flood flows and create an impediment to adult passage.

- **San Joaquin River Control Structure Passage** – This would include constructing a fish ladder or ramp on the existing structure or replacing the structure as part of water supply facilities for the Mendota Pool. Hydraulic analysis indicates that water velocities during flood flows would exceed criteria for adult Chinook salmon passage at the existing structure.

- **Arroyo Canal Screening and Sack Dam Passage** – This would include constructing a fish screen on the Arroyo Canal and passage facilities at Sack Dam. Arroyo Canal was identified as very likely to entrain a large proportion of juvenile salmon. Screening the canal would prevent this loss. Sack Dam has been identified as a passage barrier for adult salmon when the boards are in place. The drop height of over 2.5 feet in the spring would impede upstream passage.

- **Eastside Bypass Control Structure Passage** – This would include constructing a fish ladder or ramp. Excessive velocities at the existing structure during flood flows exceed the fish passage criteria and impede adult upstream migration.

- **Mariposa Bypass Control Structure Passage** – This would include constructing fish passage in coordination with a drop structure and low-flow channel

modifications. Excessive velocities at the existing structure exceed fish passage criteria maximums and would impede upstream adult migration.

- **Mariposa Bypass Drop Structure Passage** – This would include constructing passage in coordination with a control structure and low-flow channel modifications. This drop structure is an adult fish passage impediment at all flow levels. Modification or removal will allow fish to pass.

- **Mendota Pool Bypass** – The Mendota Pool is a potential major source of juvenile salmon loss through entrainment into water diversions in most years. Bypassing fish around the Mendota Pool, modifying the structure, or moving the Mendota Pool into Fresno Slough would resolve this concern.

Additional actions have not been implemented, but the Implementing Agencies are developing plans for these actions. These actions are identified in the *Working Draft Framework for Implementation* (SJRRP, 2012b) by the Implementing Agencies include the following:

- **San Mateo Road Crossing** – The San Mateo Avenue road crossing was identified as a potential adult migration impediment, but it is uncertain how significant this barrier is for adult passage. At high flows, adult passage is not expected to be impaired, but it uncertainty exists regarding passage impacts and how monitoring should be implemented to determine the degree to which the existing crossing would delay or impede fish passage.

- **Chowchilla Bypass Passage at Crossings**

  - **Avenue 18 ½** – Fish are expected to migrate up the Chowchilla Bypass during flood flows, and may encounter this crossing. Hydraulic analysis indicates a high elevation drop. Modifying this crossing would increase confidence about the ability of fish to migrate through the bypass under flood conditions.

  - **Avenue 21** – Fish are expected to migrate up the Chowchilla Bypass during flood flows, and may encounter this crossing. Hydraulic analysis indicates a high elevation drop. Modifying this crossing would increase confidence about the ability of fish to migrate through the bypass under flood conditions.

- **Eastside Bypass Passage at Crossings and Structures**

  - **Dan McNamara Road** – This road crossing could potentially impact adult migration, but it is not believed to completely impede upstream passage.

  - **Merced National Wildlife Refuge Weirs** – The Merced Refuge weir can present a vertical drop barrier for upstream migrating salmon under low- to moderate-flow conditions. This barrier is expected to be more of a passage impediment for fall-run Chinook salmon because they will migrate at lower

flows than spring-run Chinook salmon in most years. Operation of the weir, such as removing the flashboards, may resolve this impediment.

The schedule for implementing the actions is presented in Figure 2-1. The Implementing Agencies identified other actions as potential improvements:

- King's River Fish Barrier (Reach 2B)
- Washington Avenue Bridge Replacement (Reach 4B)
- Turner Island Road Bridge Replacement (Reach 4B)
- El Nido Road Crossing Passage (Eastside Bypass)
- Chamberlain Road Crossing (Eastside Bypass)
- Mariposa Bypass Road Crossing (Bypass)
- Newman Wasteway Barrier (Reach 5)
- Other Barriers (Reach 5)

3.8.2 Questions

<To be included in final 2013 MAP.>

3.8.3 Studies

Studies planned for implementation in 2013 addressing fish passage issues include the following:

- Adult Passage (Study 20, Appendix A)
- Adult Passage – Nonstructural Passage Impediments (see Study 12, Appendix A, 2012 MAP, for complete study)
- Trap and Haul of Adult Fall Run Chinook (Study 6, Appendix A)

3.8.3.1 Adult Passage

This study is working to develop conceptual alternatives to improve conditions on the river to allow for unimpeded fish passage for the entire Restoration Area and will recommend fish passage improvements by developing alternative solutions at structures that have been identified as potential fish barriers. This work will be completed during 2013. The focus fish for the evaluation will be adult Chinook salmon, but can include other fish species if there is evidence that they will be present at the structure and will need passage.

3.8.3.2 Adult Passage - Nonstructural Passage Impediments (see Study 12, Appendix A, 2012 MAP for complete study)

In addition to structural impediments, adult migration may be impeded by shallow water conditions, unidentified shallow water crossings, and water quality conditions (e.g., temperature). A study is currently underway to identify these nonstructural passage barriers. Previous years' efforts have focused on evaluating conditions through hydrologic models. This effort will incorporate field monitoring of sites that were identified as possible adult passage impediments. If the report identifies potential passage impediments that could limit meeting SJRRP objectives, the SJRRP may elevate potential projects or manage flow levels for passage conditions.

3.9 Fish Reintroduction

The Implementing Agencies will conduct a series of efforts to further understand the reintroduction process through developing a captive Chinook salmon broodstock, conducting expanded studies to address key uncertainties, and implementing pilot Chinook salmon release efforts to test and refine strategies. Starting in 2010, fall-run broodstock were collected and raised in the Interim Facility to refine captive rearing techniques. Experimental studies were initiated in spring 2012 with juvenile study fish from the Feather River Hatchery on the SJR.

The SJRRP is preparing for returning adults by setting up a trap and haul operation in Reach 5 for fall 2012. Trap and haul programs have been used in other systems to allow fish passage before resolving all fish passage impediments (Zimmerman, 1996). Returning adults would be trapped and transported to upstream areas. Low numbers of adult returns are expected from the initial releases, which will allow fish to be actively captured and transported. The Implementing Agencies can begin testing a trap, haul, and release program before the return of SJRRP released fish by relying on fall-run Chinook salmon from San Joaquin River tributaries that stray into the Restoration Area.

3.9.1 Actions

Actions to improve understanding of the fish reintroduction process include preparing for a spring-run broodstock program, trap and haul of fall-run adults above the Hills Ferry Barrier, translocation of eggs or juveniles from the Feather River Hatchery to the SJR, and a continuation of a fall-run Chinook salmon broodstock experiment.

Trap and haul actions would involve moving adult fish and eventually juvenile fish around passage barriers. A number of passage barriers exist within the Restoration Area. Fish released into the system prior to these passage issues being completely resolved will involve assistance to reach suitable rearing, holding, and spawning habitat. Trap and haul operations have been used in other systems to provide salmon passage around impoundments and other barriers to allow fish releases before resolving all passage issues.

3.9.2 Questions

<To be included in final 2013 MAP.>

3.9.3 Studies

Three studies planned for implementation in 2013 focus on addressing uncertainties associated with fish reintroduction. Results from these studies will inform the Implementing Agencies on whether there is sufficient habitat quantity and quality for reintroduction under a successful program. The studies include the following:

- Captive Rearing Study (Year 3) (Study 12, Appendix A)
- Juvenile Salmon Holding (Study 7, Appendix A)
- Trap and Haul of Adult Fall-Run Chinook (Study 6, Appendix A)

3.9.3.1 Captive Rearing Study (Year 3)

The goal of the Captive Rearing Study is to continue to investigate methods for the captive rearing of Chinook salmon from spawning through adulthood in an effort to be fully prepared to work with threatened spring-run Chinook and to increase the chances for successfully developing a self-sustaining, self-reproducing population of spring-run Chinook salmon in the SJR. The SJRRP *Fisheries Implementation Plan* (SJRRP, 2010a) prioritized studies to address information needs for fish restoration and identified the Fall-run Captive Rearing Study as a high priority before spring-run Chinook salmon are reintroduced, which is required by the Settlement by December 31, 2012. The study is also identified as instrumental in the SJRRP *Hatchery and Genetic Management Plan* (SJRRP, 2010b), which was submitted to the National Oceanic and Atmospheric Administration (NOAA) NMFS as an Appendix to the 10(a)1(A) Enhancement of Species permit application (USFWS, 2011).

This study is in the third year of a 4-year program; the objectives of the program change annually.

3.9.3.2 Juvenile Salmon Holding

The juvenile salmon holding study is a critical component of salmonid reintroduction efforts. Whether reintroduction in 2012/2013 involves spring-run or fall-run Chinook salmon, either are likely to be held in the SJR until they are large enough to be tagged so that they can be identified as SJRRP stocks for numerous regulatory reasons. Further, juveniles held in this study are likely to be used to support other studies evaluating site- and reach-specific survival and movement rates.

Data collected over the life of the study will be used to determine if out-of-basin juvenile salmon can imprint on, and will return as adults to, the SJR after being held for at least 10 days. This will inform future reintroduction strategy decisions. Rotary screw trap operations will also lay the foundation for long-term monitoring to inform future decisions about reintroduction, population management, water operations, and restoration activities.

3.9.3.3 Trap and Haul of Adult Fall Run Chinook

This study will involve trapping salmon in Reach 5 and relocating the salmon to Reach 1 of the Restoration Area. Field activities associated with this study will include

transporting adult Chinook salmon around existing barriers in the SJR to suitable holding and spawning habitat and developing protocols to successfully trap and haul adult salmon.

The objectives associated with this study include assessing the viability of trapping and hauling adult salmon, assessing spawning site selection of adults transported to Reach 1, and establishing a long-term plan for using trap and haul activities.

3.10 Water Management

Water Management Goal actions include identifying, developing, and implementing projects and programs to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim and Restoration flows provided for in the Settlement. The reduction in water deliveries caused by the Interim and Restoration flows is monitored and recorded in the Recovered Water Account (RWA). The SJRRP prioritizes and measures the success of actions by their ability to reduce RWA balances of Friant Division long-term contractors.

The Implementing Agencies identified actions in the *Working Draft Framework for Implementation* (SJRRP, 2012b) associated with water management to include Friant-Kern and Madera Canals Capacity Restoration; Part III, Recapture, Recirculation, and Other Projects; Outreach and Technical Support; and Investment Strategy Development. Reclamation, in coordination with appropriate Federal, State of California (State), regional, and local authorities, is authorized and directed to conduct feasibility studies on restoring the capacity of the Friant-Kern and Madera canals to such capacity as previously designed and constructed by Reclamation. After completion of, and consistent with, the applicable feasibility study, Reclamation is authorized to construct improvements and facilities in accordance with applicable Federal and State laws. Initially, Reclamation jointly evaluated restoration of the capacities of the Friant-Kern and Madera canals. However, because of unique differences in the design and construction of the canals, Reclamation has since separated the evaluation into two separate feasibility studies.

4.0 Environmental Compliance

SJRRP actions are subject to environmental compliance. This section provides an overview of the environmental documents and permits that affect implementation of the SJRRP. These requirements are taken into consideration when developing and performing monitoring and analysis activities to support the SJRRP. The data collected through this mandatory monitoring and analysis may be used to address other SJRRP uncertainties. The SJRRP reports this data on an annual basis in the ATR.

4.1 Final Program Environmental Impact Statement/Report

The Final SJRRP PEIS/R (SJRRP, 2012a) contains a Conservation Strategy with elements to be incorporated into projects to avoid or minimize adverse effects to listed species. To meet the Conservation Strategy goals of controlling and managing invasive species and conserving special-status species, monitoring and analysis will be performed to establish baseline species presence in the Restoration Area, and to design more specific protective measures.

4.2 Central Valley Steelhead Monitoring Plan

As part of the Water Year 2010 through Water Year 2012 Interim Flows projects, Reclamation committed to a Central Valley Steelhead Monitoring Plan. Spring Interim Flows occurring from February 1 through June 1 could attract adult steelhead into the Restoration Area. Attracted steelhead would not have access to appropriate spawning habitat because of a number of impassable barriers. Reclamation, in coordination with the Fisheries Management Work Group, has proposed a Steelhead Monitoring Plan to facilitate detection of steelhead on the SJR upstream from the Merced River confluence and to transport to suitable habitats downstream from the mouth of the Merced River.

This study is a multi-year study and will implement monitoring activities during 2013 for Central Valley Steelhead in the Restoration Area (Study 14, Appendix A).

4.3 State Water Resources Control Board Water Rights Orders

On October 1, 2009, the State Water Resources Control Board (State Board) issued Order 2009-058-DWR for the Water Year 2010 Interim Flows Project. Order 2009-058-DWR required explicit monitoring during implementation of Water Year 2010 Interim Flows. These requirements included monitoring flow, water quality, seepage, and invasive species, consistent with the MMPs and the *Water Quality Monitoring and Quality Assurance Plan* identified in the Water Year 2010 Interim Flows Project EA/IS

(Reclamation, 2009). Order 2009-058-DWR further required monitoring of water quality and sediments at several locations along the river, beginning in fall 2009. Order 2009-058-DWR also required Reclamation to develop a monitoring plan, acceptable to the Deputy Director for Water Rights, for releases that began after February 1, 2010.

Reclamation developed the *2009 – 2013 Interim Flows Release Program Water Quality Monitoring Plan* in January 2010, in part to meet the water quality and bed sediment monitoring requirements of Order 2009-058-DWR. According to the plan, the core of SJRRP monitoring includes a series of sensors along the SJR that will make continuous measurements of physical conditions, including flow, depth, temperature, specific conductance (salinity), pH, DO, turbidity, and chlorophyll. Raw data are posted by the California Data Exchange Center (CDEC) (www.cdec.water.ca.gov) and linked to the SJRRP Web site.

On September 30, 2010, the State Board issued an order for the Water Year 2011 Interim Flows Project. Order 2010-029-DWR states that Reclamation is required to continue implementing the 2009–2013 *Interim Flows Release Program Water Quality Monitoring Plan* and a water quality response plan. Order 2010-029-DWR requires Reclamation to submit requests to modify the *Interim Flows Release Program Water Quality Monitoring Plan* in writing to the Deputy Director for Water Rights; modifications may only be made upon written approval of the Deputy Director for Water Rights. Order 2010-029-DWR required Reclamation to develop and submit to the Deputy Director for Water Rights, by February 1, 2011, a Water Quality Response Plan completed to address the following: (1) contribution of Interim Flows to high salinity conditions in the Delta-Mendota Canal, Mendota Pool, and Fresno Slough, (2) an identification of the different entities and individuals who may contribute to or play a role in the response to high salinity conditions, (3) the current legal and contractual roles and responsibilities of those entities, and (4) possible mechanisms, including those under the control of Reclamation and those that are the responsibility of other entities and individuals. Order 2010-029-DWR also stated that Reclamation is required to implement monitoring of temperature changes in Millerton Reservoir and to implement a schedule for ramping flow releases, consistent with the Settlement.

For Water Year 2012, the State Board approved the temporary transfer of water and change petitions filed on July 28, 2011, pursuant to Water Code sections 1725 and 1707 for Permits 11885, 11886 and 11887. A long-term petition is anticipated to be in place in 2013 that may require some modifications.

5.0 Monitoring Network

The SJRRP maintains a network of installed monitoring equipment and permanent survey locations to meet Settlement requirements and environmental commitments, and to collect relevant data during Interim Flows. This section presents changes to the monitoring network scheduled for 2013 to promote integration of all sensors and to disclose available data. Existing infrastructure is documented in resource-specific monitoring plans and atlases.

The monitoring network is continually refined to meet the evolving information needs of the SJRRP. Table 5-1 presents monitoring network installations planned for 2013, and Table 5-2 presents monitoring network surveys planned for 2013.

Data collected from the monitoring network are presented in the MYTR and ATR annually. Real-time data available from flow gage stations are available through CDEC and can be accessed through links on the SJRRP Web site (http://restoresjr.net). Groundwater levels from select wells and water quality measurements from telemetered stations are also available in real-time and are accessible on the SJRRP Web site. The data collected from the SJRRP monitoring network will be analyzed in studies to support SJRRP implementation and management actions.

Table 5-1.
Monitoring Equipment Installation

Monitoring Stations/Sites	2013 Plans	Relevant Study Name
Temperature	New monitoring locations may be included pending flow conditions (available on the SJRRP Web site at http://restoresjr.net).	Temperature Monitoring for Adult Migration
PIT tag arrays	Two additional structure arrays may be designed and constructed.	San Joaquin River PIT Tag Monitoring and Site-Specific Technology Development (Reclamation, USFWS)
Hydrophone and quadraphone stations	Five stereo hydrophone stations and one quadraphone station will be installed on the San Joaquin River, Little Dry Creek, and two riffles.	Continuous Surrogate Measurement of Bedload Sediment Transport Using Hydrophone Installations on the San Joaquin River, California (USGS)
Water-level recorders	Recorders will be added or relocated as identified based on data needs	Additional Water Level Recorders (DWR)
Groundwater monitoring wells	Thirty-four proposed wells will be installed.	Monitoring Well Network Optimization (Reclamation)
Levee drilling	Drilling will begin in late 2012 and continue in 2013.	Levee Geotechnical Exploration (DWR)

Key:
DWR = California Department of Water Resources
MAP = Monitoring and Analysis Plan
PIT = passive integrated transponder
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
SJRRP = San Joaquin River Restoration Program
USFWS = U.S. Fish and Wildlife Service
USGS = U.S. Geological Survey

Table 5-2.
Monitoring Network Surveys

Survey Type	Purpose	2013 Plans	Relevant Study Name
Water surface profiles	Hydraulic model calibration	No water surface profile surveys planned for 2013.	Surface Water Profile Surveys and Discharge Measurements (DWR)
Bathymetric	Hydraulic model calibration	No bathymetric surveys planned for 2013.	
Cross sections	Hydraulic model calibration	Resurveys to be conducted only if flows reach a range expected to significantly change bed topography.	Monitoring Cross-Section Resurveys (DWR)
Aerial	Inundation mapping, habitat assessments, vegetation mapping	No aerials planned for 2013.	Not applicable
Vegetation	Model calibration, detection of invasive species, riparian recruitment information.	Annual vegetation surveys planned for 2013.	Not applicable
Bed material sampling	Hydraulic model calibration	No bed material sampling planned for 2013.	Bed Material Data Collection (Reclamation), DWR studies.
Invertebrate studies	Habitat assessment	Sampling to be completed by early fall 2012. Refined bioassessment techniques will be applied in the bypass system.	Benthic Macroinvertebrate SWAMP Bioassessment (DWR, DFG)

Key:
DFG = California Department of Fish and Game
DWR = California Department of Water Resources
MAP = Monitoring and Analysis Plan
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
SWAMP = Surface Water Ambient Monitoring Program

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6.0 Analytical Tools

This section discloses the analytical tools currently available or under development for the SJRRP (Table 6-1). These tools can be used to help meet study goals, and to simulate additional action that need to take place to promote successful implementation of the Settlement.

Analytical tools provide a numerical representation of conceptual models. Monitoring data collection for the SJRRP can improve calibration and validation of these tools and fill in physical data gaps.

Table 6-1.
Analytical Tools for SJRRP

Model	Type	Purpose	Status	Model Application
DTM	Terrain	Digital terrain model of San Joaquin River	Complete with exception of incorporating 2011 gravel pit surveys for Reach 1A	Support other model development/updates
HEC-RAS	Hydraulic (1D)	Water surface (Inundation mapping)	Completing mapping review and incorporating updated bathymetry for steady-state model	Support Reach 4B pit study: includes refined model with vertical N values and original model with horizontal N values
SRH-2D	Hydraulic	Depth/velocity/habitat mapping	Existing conditions model available; some reaches modified to evaluate alternatives (Reclamation, 2008)	Support floodplain rearing study
SRH-2D	Sediment	Transport/habitat mapping	Finishing modeling and analyzing results	Analyze sediment deposition dynamics at bypass in Reach 2A.
SRH-2D	Temperature	Habitat mapping	Temperature model will be updated in 2013 (see Study 19)	Test temperature in model gravel pits in Reach 2B
SRH-1D	1D mobile boundary sediment	Transport	Geometry to be updated	Support Reach 2B study proposed alignments
HEC-5Q	1D hydraulic routing, temperature	San Joaquin River temperature	Complete (Reclamation, 2007)	Modeling for proposed hydrographs to aid flow scheduling
CE-QUAL-W2	Temperature (vertical 2D)	Millerton Lake cold water pool	Complete (Portland State University, 2012)	Simulate cold water pool in Millerton Lake
SRH-1DV	Cross section vegetation	Vegetation response to flow and sediment conditions	Geometry to be updated	Support design work on Reach 2B and Reach 4B site-specific projects

Table 6-1.
Analytical Tools for SJRRP (contd.)

Model	Type	Purpose	Status	Model Application
CVHM	Groundwater	Groundwater flow	Complete (USGS, 2012)	Run preliminary simulations related to Reach 2B proposed alignments
EDT	Fisheries	Population response to habitat conditions	Under refinement	Run preliminary simulations related to Reach 2B proposed alignments
ESHE	Fisheries	Floodplain habitat	Under development	Identify floodplain habitat needs for salmon

Key:
1D = one-dimensional
2D = two-dimensional
CVHM = Central Valley Hydrologic Model
DTM = Digital Terrain Model
EDT = Ecosystem Diagnosis and Treatment
ESHE = Emigrating Salmonid Habitat Estimation
HEC = Hydrologic Engineering Center
RAS = River Analysis System
SJRRP = San Joaquin River Restoration Program
SRH = Sedimentation and River Hydraulics

7.0 Monitoring Activities Summary

This section lists what type of monitoring activities are going to occur in 2013, and can be used to help coordinate efforts among agencies to efficiently collect relevant data to implement the SJRRP. Table 7-1 summarizes the schedule for monitoring activities in 2013. Study numbers below reference Appendix A study sections. The budget for the 2013 studies is presented in Appendix C. Attachment 1 presents a table identifying studies presented in the 2012 MAP and the status of those studies.

Table 7-1.
Monitoring Activities Summary

2013 MAP Appendix A Study	Study	Monitoring	Schedule/Frequency
1	Flow Gage Record Analysis	Surface water	Continuous
2	Lateral Gradient of Water Table	Surface water, groundwater, soil monitoring, and tile drain system flow	Continuous
3	Changes in Soil Salinity Conditions Resulting from Interim Flows	Soil salinity	On as-needed basis
4	Influence of Paleochannels on Seepage	Seepage	June through September 2012
5	Temperature Monitoring of Cold Water Pool in Millerton Lake	Reservoir temperature	Continuous
6	Trap and Haul of Adult Fall Run Chinook	Fisheries	October 2012 to 2020
7	Juvenile Salmon Holding	Fisheries	Spring 2013
8	Egg Survival (Fall 2012)	Water quality, sedimentation, and hydraulics	Mid-September 2012 through January 2013
9	Fish Assemblage Inventory and Monitoring	Fisheries	Annual
10	Juvenile Salmonid Migration and Survival (Year 3 – Telemetry)	Fisheries	Start spring/early summer of 2013
11	Assessment of Predator Abundance and Distribution in Mine Pit Habitat in the San Joaquin River Restoration Area	Fish tagging and stomach analysis, surface temperature, DO, and turbidity	One week each month January 2013 through June 2013
12	Captive Rearing Study (Year 3)	DO, temperature, and feed quantity Fish weights, lengths, and condition factors will be measured	Daily Every 2 to 3 months
13	Levee Geotechnical Exploration	Drilling	Summer 2012 through summer 2013

Table 7-1.
Monitoring Activities Summary (contd.)

2013 MAP Appendix A Study	Study	Monitoring	Schedule/Frequency
14	Central Valley Steelhead (*Oncorhynchus mykiss*) Monitoring Plan for the San Joaquin River Restoration Program	Electrofishing Fyke nets with wing walls and traps Trammel nets	Monthly during December through March 2013 Mid-December through March 15, 2013 December through March 2013
15	San Joaquin River PIT Tag Monitoring and Site-Specific Technology Development	PIT tag arrays	Maintained for 6 – 8 weeks in spring 2013
16	Floodplain Quality	Habitat field work	March and April 2013
17	Bed Material Data Processing and Evaluation	Sediment	Data collection complete
18	Continuous Surrogate Measurement of Bedload Sediment Transport Using Hydrophone Installations on San Joaquin River, California	Bed topography	Continuous
19	Two-Dimensional Temperature Monitoring of Gravel Pits in Reach 1A	Modeling	Not applicable
20	Adult Passage	Fisheries	January through March 2013
21	USGS Sediment Monitoring	Sediment	Every other week during February through June
22	USGS San Joaquin River Tributary Sediment and Geomorphology Study	Sediment and Geomorphic	Winter 2012 and spring 2013
23	Vegetation Monitoring	Vegetation	5 days between June and August
24	Additional Water Level Recorders	Surface water	Continuous
25	Monitoring Cross-Section Resurveys	Bed Topography	Only if flows are sufficient to move bed material
26	Effect of Altered Flow Regime on Channel Morphology in Reach 1A	Topography	Data collection to continue in collaboration with egg survival study.
27	Effect of Scour and Deposition on Incubation Habitat in Reach 1A	Fisheries	November and December 2012
28	Reach 1A Spawning Area Bed Mobility	Bed Topography	Data collection complete
29	Thermal Conditions in Riverine Pools	Temperature, Pressure, Conductivity	July to August 2012 at 15 minute intervals

Key:
DO = dissolved oxygen
MAP = Monitoring and Analysis Plan
PIT = passive integrated transponder

8.0 Conclusions

At the end of 2013, the SJRRP expects to have progressed on addressing the uncertainties for actions within each theme through completion of study questions and redevelopment of new pathways to address uncertainties. The following section is organized by theme and summarizes anticipated outcomes of 2013 monitoring and analysis activities.

- **Flow Management** – Refined approach to flow scheduling incorporating input from cold water pool management; Fisheries Management Work Group regarding fisheries temperature needs during different periods of the year and juvenile responses to pulses; continued flow gage record analysis to identify any trends in losses from Friant Dam to Gravelly Ford; and updated reports of recapture accounting.

- **Conveyance** – Completion of levee geotechnical evaluations and initiation of revisions to channel capacity constraints at the beginning of 2014; Draft EIS/R for both the Reach 2B Channel Capacity Improvements, and Reach 4B, Eastside Bypass, and Mariposa Bypass Conveyance site-specific projects; updated thresholds for *Seepage Management Plan* (SJRRP, 2011); additional groundwater, soil salinity, and soil texture data to inform design of seepage projects to improve SJRRP flow conveyance.

- **Entrainment Protection** – Identification of locations with entrainment issues in addition to those already identified in site-specific projects to understand fish survival.

- **Adult Migration Paths** – Understanding of adult migration patterns under existing conditions using data collected from trapping upstream from the Hills Ferry, China Island, and Mud Slough and Salt Slough barriers.

- **Fish Passage** – Understanding of sturgeon occurrence, passage routes, upstream migration extent, annual timing, and habitat preferences in the Restoration Area to inform site-specific fish passage structural designs; identify any nonstructural passage impediments not addressed in the structural improvement projects.

- **Predation** – Understanding of predation risk through measuring predator abundance near the gravel mine pits and juvenile survival in the Restoration Area.

- **Rearing Habitat** – Development of methods to estimate floodplain habitat quality for juvenile salmon and better understanding of trade-offs among different floodplain management options.

- **Spawning and Incubation** – Understanding of relationship between Friant Dam releases and gravel water quality conditions (for the range of flows released in fall 2012) for spawning and incubation in Reach 1A.

- **Fish Reintroduction** – Preparation for a spring-run Chinook salmon broodstock program, a trap and haul of fall-run adults above Hills Ferry Barrier, translocation of eggs or juveniles from the Feather River Hatchery to SJR, and continuation of a fall-run Chinook salmon broodstock experiment.

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