2009 – 2013 Interim Flow Release Program, Water Quality Monitoring Plan

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List of Abbreviations and Acronyms

ºC	degrees Celsius
ºF	degrees Fahrenheit
COC	chain of custody
CVP	Central Valley Project
RWQCB	Central Valley Regional Water Quality Board
Delta	Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DMO	data management organization
DO	dissolved oxygen
DWR	California Department of Water Resources
SC	Specific conductance
mg/L	milligrams per liter
NRDC	Natural Resources Defense Council
PEIS/R	Program Environmental Impact Statement/Report
ppb	parts per billion
ppm	parts per million
QA	Quality Assurance
QC	Quality Control
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
SJRRP	San Joaquin River Restoration Program
SOP	standard operating procedure
SWAMP	Surface Water Ambient Monitoring Program
TM	Technical Memorandum
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service

1.0 Summary

The purpose of this document is to describe a program to monitor water quality changes that may occur with the 2010 – 2013 Interim Flow Release Program of the San Joaquin River Restoration Program (SJRRP). This document was prepared by the Interagency Water Quality Monitoring Workgroup[1]. The San Joaquin River Restoration 2009-2013 Interim Flow Release Program Water Quality Monitoring Plan (Monitoring Plan), as proposed, will be conducted by staff of SJRRP Implementing Agencies and will complement independent monitoring by other Federal, State, and private agencies.

This Monitoring Plan is intended to measure the quality of water as it travels from Friant Dam down the San Joaquin River. The flow modifications at Friant Dam are specified in the Stipulation of Settlement[2]. The implementation of the Settlement is authorized under Section 3406(c)(1) of the Central Valley Project Improvement Act (CVPIA) Title 34 (Public Law 102-575) and the San Joaquin River Restoration Settlement Act, included in Public Law 111-11. Publicly available, high quality data are critical for demonstrating compliance with the provisions of the Settlement and determining the impacts that Interim Flows may have on water quality conditions in the river between Friant Dam and the confluence with the Merced River.

The California State Water Resources Control Board issued a Water Rights Order[3] (Order) that authorizes changes to water rights permits needed to implement the Interim Flow Release Program. The Order requires monitoring of water quality and sediments at several locations along the river. In June 2009, a draft Fish Management Plan was prepared by the Technical Workgroup[4] that included many recommendations for monitoring water quality for (1) cold, freshwater habitat, (2) migration of aquatic organisms, and (3) spawning, reproduction, and early development. This Monitoring Plan has been designed to meet the requirements of the Water Rights Order and compliment the adaptive management design of the Fish Management Plan.

Several sampling techniques will be used to collect samples of water, including real-time, grab, and composite using autosamplers. The core of the program will be a series of sensors along the river that will make continuous measurements of physical conditions, including flow, depth, temperature, specific conductance (salinity), pH, dissolved oxygen (DO), turbidity, and chlorophyll. The data will be averaged every 15 minutes and then sent via satellite to the Internet as preliminary data. Raw data will be posted by the California Data Exchange Center

[1] U.S. Department of the Interior, Bureau of Reclamation (Reclamation), Fish and Wildlife Service (FWS), the California Departments of Water Resources (DWR) and Fish and Game (DFG), and the California Environmental Protection Agency.

[2] Natural Resources Defense Council, et al. v. Kirk Rodgers, as Director of the Mid-Pacific Region of the U. S. Bureau of Reclamation, et al. September 13, 2006. Stipulation of Settlement. U. S. District Court, Eastern District of California (Sacramento Division).

[3] California Environmental Protection Agency, State Water Resources Control Board, September 30, 2009. Order WR 2009-0058-DWR Temporary transfer of Water and Change Pursuant to Water Code Sections 1725 and 1707.

[4] SJRRP, June 2009. Draft Fisheries Management Plan: A Framework for Adaptive Management in the San Joaquin River Restoration Program

(www.cdec.water.ca.gov) and linked to the SJRRP website. Water and bed sediment monitoring will be conducted as required under the Water Rights Order. The location and parameters to be tested are listed in Tables 2 and 3 of this Monitoring Plan.

In addition, water samples will be collected at other places of importance for fish passage and survival. The location and frequency of sampling and analytical parameters will be developed with the Fisheries Management Work Group and will be modified as needed. The Fisheries Management Work Group is a key component of the SJRRP, consisting of a multi-agency group of fisheries experts. The recommended locations and parameters are listed in Appendix B of this plan.

Verified data will be compiled and published on-line by an independent data management organization. Annual synthesis reports will be written by staff of the agencies and contractors collecting the data for this Monitoring Plan.

2.0 Title

San Joaquin River Restoration Program

2010 – 2013 Interim Flow Release Water Quality Monitoring Plan

3.0 Background

Friant Dam is located on the San Joaquin River near Fresno, California. The United States Bureau of Reclamation (Reclamation) has diverted water from the river below the dam since 1952 to irrigate more than a million acres of farmland that produce a variety of crops worth over $2.5 billion annually. Numerous communities depend on Friant water, such as the City of Fresno, and it is the sole source of water for the small communities of Friant, Orange Cove, Lindsay, Strathmore and Terra Bella. These diversions have removed most of the water from the river, and many times the river has been dry at Gravelly Ford, about 40 miles below the dam.

Degraded water quality in various segments of the San Joaquin River has been a serious problem for several decades due to low river flows and discharges from agricultural areas, wildlife refuges, and municipal waste water treatment plants. Degraded water quality has been identified as a potential limiting factor for Chinook salmon and other native fishes. Constituents such as pesticides and other urban and agricultural wastes may affect water quality parameters such as DO and turbidity, creating habitat unsuitable for Chinook salmon.

In 1998, the Central Valley Regional Water Quality Control Board (RWQCB) adopted a Water Quality Control Plan[5] for the Sacramento and San Joaquin River basins (Basin Plan) as the regulatory reference for meeting Federal and State requirements. Specific water quality standards associated with the lower San Joaquin River apply to boron, molybdenum, selenium, dissolved oxygen, pH, pesticides, and salinity, as measured at Vernalis and other locations along the San Joaquin River as it enters the Delta. One of the high priority issues of the Basin Plan review is the regulatory guidance for total maximum daily load (TMDL) standards at locations along the San Joaquin River. Mud and Salt Sloughs, which flow into the San Joaquin River upstream from the Merced River, and the San Joaquin River from Mendota Pool downstream to Vernalis are listed as impaired water bodies.[6]

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and the Central Valley Project (CVP) Friant Division contractors. After more than 18 years of litigation of this lawsuit, known as NRDC et al. v. Kirk Rodgers et al., a settlement (Settlement) was reached[7]. On September 13, 2006, the Settling Parties, including NRDC, Friant Water Users Authority (FWUA), and the U.S. Departments of the Interior and Commerce, agreed on the terms and conditions of the Settlement, which was subsequently approved by the U.S. Eastern District Court of California on October 23, 2006. The planning and environmental review necessary to implement the Settlement is authorized under Section 3406(c)(1) of the Central Valley Project Improvement Act (CVPIA) Title 34, (Public Law 102-575) and the San Joaquin River Restoration Settlement Act, included in Public Law 111-11. The Secretary of the Interior is authorized and directed to implement the terms and conditions of the Settlement through the Act.

The SJRRP is a comprehensive long-term effort to restore flows in the San Joaquin River from Friant Dam to the confluence of the Merced River and restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply from the restoration flows. Staff from Reclamation, the California Department of Water resources (DWR), the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the California Department of Fish and Game (DFG), will implement the Settlement.

The Settlement has two primary goals:

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

[5] California Regional Water Quality Control Board, Central Valley Region, Revised February 2007. The Water Quality Control Plan (Basin Plan) for the Central Valley Region, Fourth Edition. The Sacramento River Basin and the San Joaquin River Basin.

[6] SJRRP, October 2007. Draft Purpose and Need Statement.

[7] Natural Resources Defense Council, et al. v. Kirk Rodgers, as Director of the Mid-Pacific Region of the U. S. Bureau of Reclamation, et al. September 13, 2006. Stipulation of Settlement. U. S. District Court, Eastern District of California (Sacramento Division).

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

Increasing flows in the San Joaquin River from Friant Dam to the Merced River and downstream reaches has the potential to improve water quality conditions under various hydrologic conditions in some reaches of the river. Opportunities to improve water quality in the San Joaquin River will be identified and evaluated to the extent that they are consistent with actions that address the Restoration and Water Management goals.

Degraded water quality has been identified as a potential limiting factor for Chinook salmon and other native fishes. Constituents such as pesticides and other urban and agricultural wastes may affect water quality parameters such as DO and turbidity, creating habitat unsuitable for Chinook salmon. Sources of adverse water-quality conditions and whether or not discharge conditions will improve water quality are unknown. Evaluating and taking management actions for these conditions may be necessary to successfully meet the Restoration Goal. All life stages of Chinook salmon could be affected.

It is expected that the monitoring framework described below for monitoring for physical habitat parameters will enable the collection of information required for real-time decision making, as well as to collect information to evaluate the success of the SJRRP and its objectives.

Paragraph 18 of the Settlement describes the roles and responsibilities of the Restoration Administrator (RA) and the Technical Advisory Committee (TAC). The Implementing Agencies responsible for monitoring are a part of the TAC as either non-voting members (DFG and DWR) or Liaisons (Reclamation, NMFS, and USFWS). To facilitate real-time flow decisions the Implementing Agencies will be available to the TAC to compile and assess current information regarding water operations, Chinook salmon and other fish condition, such as stages of reproductive development, geographic distribution, relative abundance, and physical habitat conditions.

The SJRRP will coordinate with land owners, irrigation districts, and other relevant entities to identify water quality improvement opportunities associated with implementing the SJRRP.

3.1 Beneficial Uses

The data collection and analysis performed for the release of the Interim Flows Program has the potential to provide a broad range of beneficial uses including, but not limited to, fisheries. Fisheries resources in the area associated with existing native species and proposed reintroduction of Chinook salmon stand to benefit from the knowledge of general trends in water quality, flow and temperature. Specific information has the ability to tell fisheries experts what environmental conditions are present and allow them to make more informed decisions to manage fish species.

3.2 Study Area

The Study Area for this Monitoring Plan (Figure 1) encompasses over 152 miles of the San Joaquin River from Millerton Lake to the Merced River confluence. This Monitoring Plan will also incorporate data from other agencies involved with planning and implementation efforts along the San Joaquin River to evaluate regional effects of the restoration effort.

The river is divided in the five reaches between Friant Dam and the confluence with the Merced River (Figures 4 to 8) with different hydrologic features:

Reach 1	River Miles 268 – 225	Friant Dam to Gravelly Ford
Reach 2	River Miles 225 – 205	Gravelly Ford to Mendota Dam
Reach 3	River Miles 205 – 182	Mendota Dam to Sack Dam
Reach 4	River Miles 182 – 136	Sack Dam to Bear Creek
Reach 5	River Miles 136 – 118	Bear Creek to Merced River

Figure 2 is a diagram that shows the locations of the water monitoring stations with respect to major tributaries to and diversions from the San Joaquin River. The locations of water quality monitoring stations specified in the Water Rights Order are summarized in Table 2. Bed sediment monitoring sites, also specified in the Water Rights Order, are listed in Table 3.

Figure 3 is a diagram showing the location of real-time monitoring sites along the river listed in Table 1.

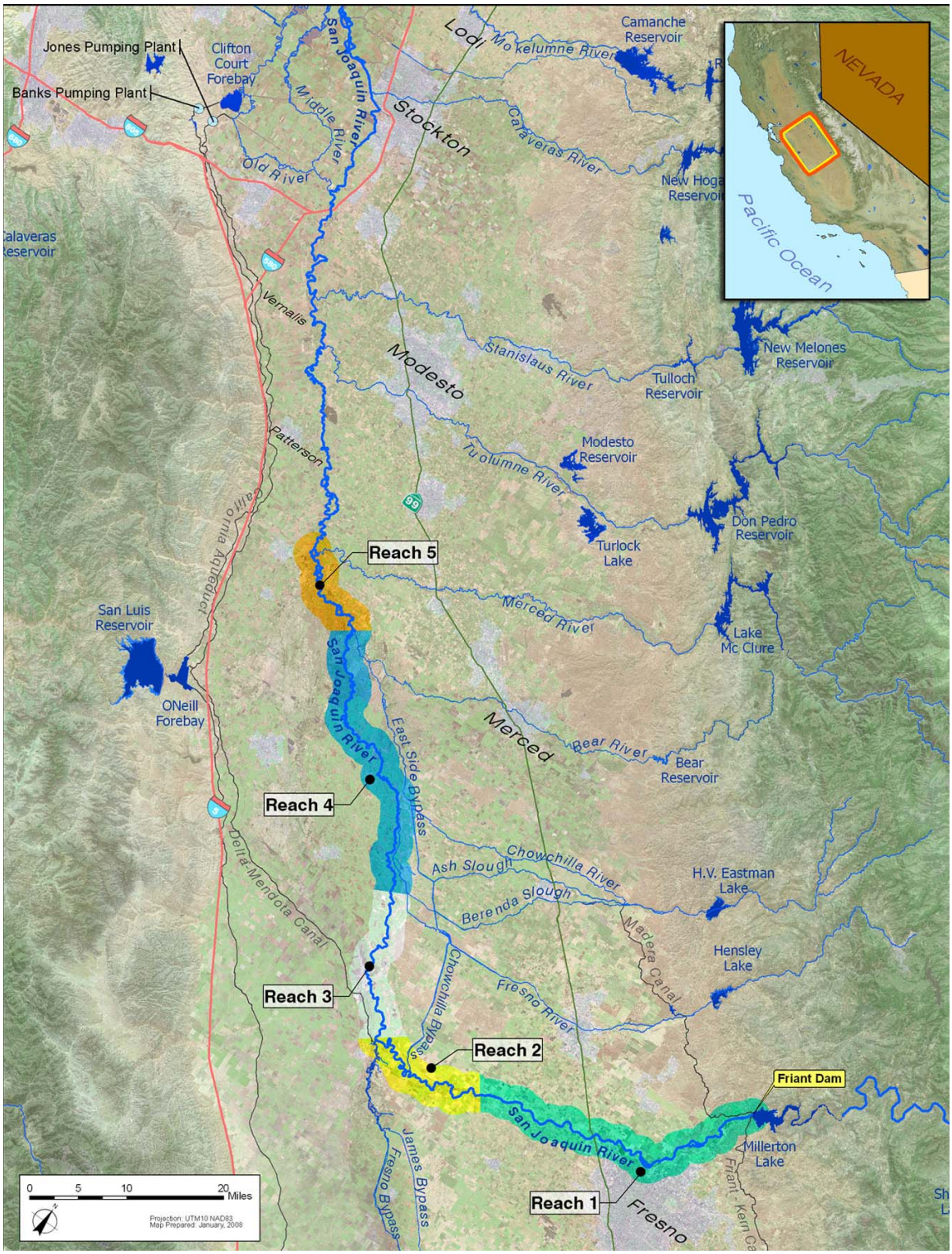

Figure 1.
Location Map – San Joaquin River Restoration Program Showing Five Reaches of the Study Area Between Friant Dam and the Confluence with the Merced River

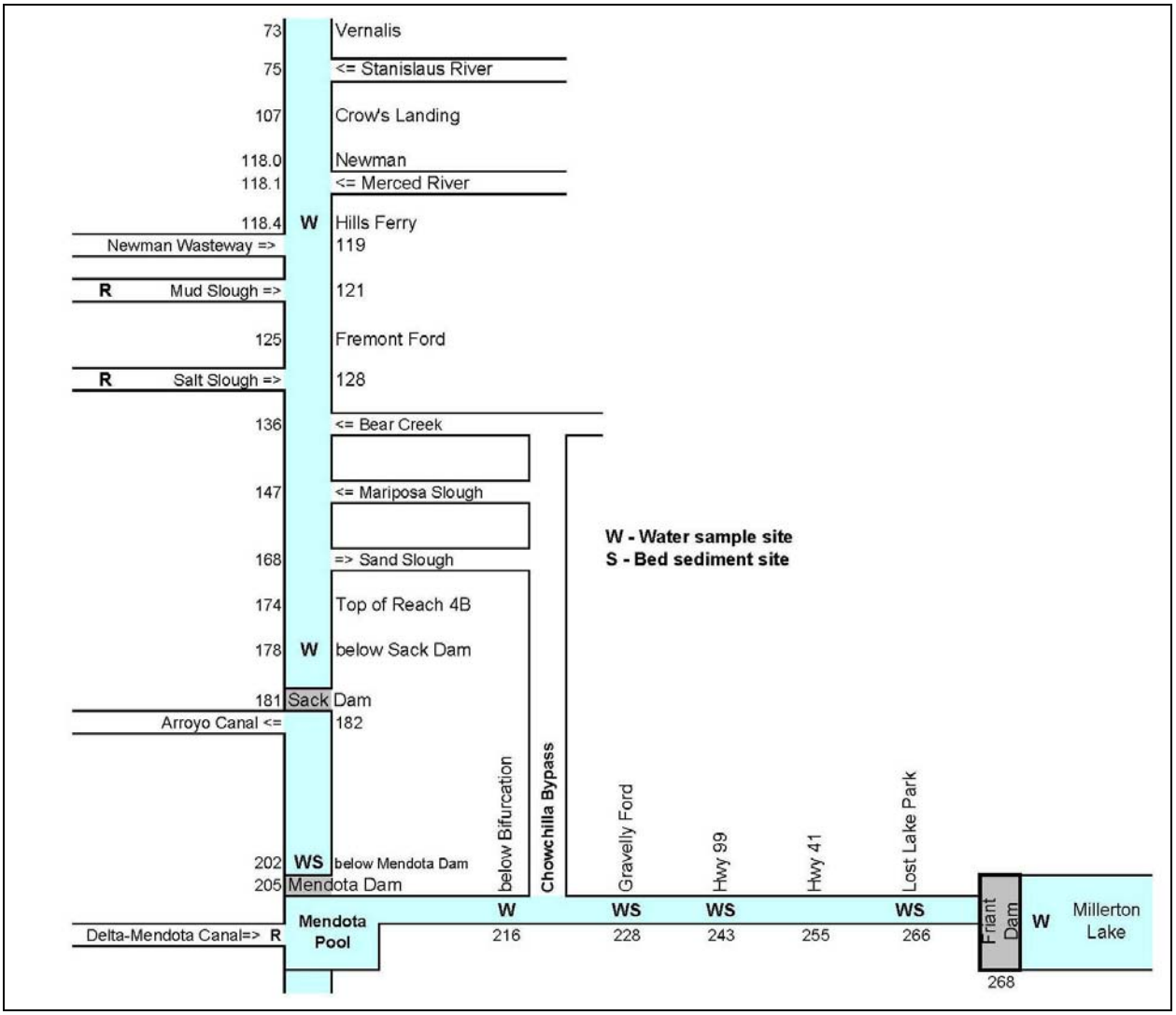

Figure 2.
Diagram of the San Joaquin River from Friant Dam to Below the Merced River Showing Water and Sediment Monitoring Sites Specified in the Water Rights Order

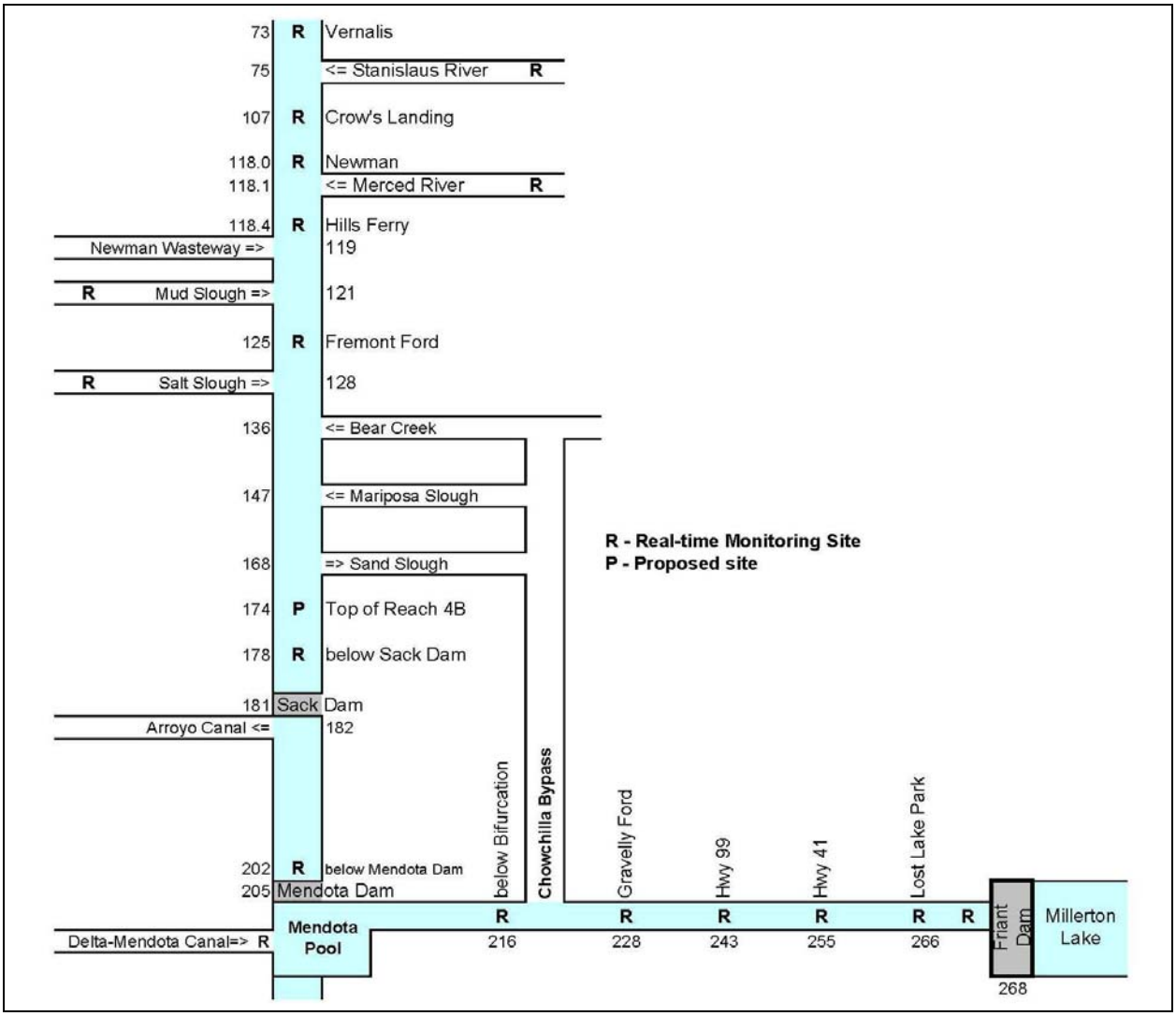

Figure 3.
Diagram of the San Joaquin River from Friant Dam to Below the Merced River Showing Real-time Monitoring Sites

Table 1.
Real-Time Water Quality Monitoring Sites

Location	Responsible Agency	CDEC	Parameters	Frequency	Remarks
Millerton Lake	Reclamation (Friant)	MIL	Temperature, DO	Monthly	Grab sample
San Joaquin River at Friant Dam	Reclamation (Friant)	P	Flow, physical	Continuous	Multiple parameter sonde
San Joaquin River below Friant Dam (Lost Lake Park)	USGS	SJF	Flow	Continuous	
San Joaquin River at Highway 41	Reclamation (Friant)	H41	Stage	Continuous	
San Joaquin River at Highway 99					
San Joaquin River at Gravelly Ford	Reclamation (Friant)	GRF	Flow, physical	Continuous	Multiple parameter sonde
San Joaquin River below bifurcation	Reclamation (Friant)	SJB	Flow, physical	Continuous	Multiple parameter sonde
Delta-Mendota Canal Check 21	Reclamation (CVO)	DM3	EC	Continuous	
San Joaquin River near Mendota (below Mendota Dam)	USGS	MEN	Flow	Continuous	
San Joaquin River below Sack Dam	DWR	P	Flow, physical	Continuous*	Multiple parameter sonde*
San Joaquin River at top of Reach 4B	TBD	P	Flow, physical	Continuous*	Multiple parameter sonde*
San Joaquin River at Fremont Ford Bridge	USGS	FFB	Flow, physical	Continuous	Multiple parameter sonde
San Joaquin River at Hills Ferry	USGS	P	Flow, physical	Continuous*	Multiple parameter sonde
San Joaquin River near Newman (below Merced River)	USGS	NEW	Flow	Continuous	
San Joaquin River near Crows Landing	USGS	SCL	Flow, physical	Continuous	Grassland Bypass Project Station N

Notes:

P – Proposed sites, scheduled to operate in 2010

TBD – Agency to be determined

Physical parameters include specific conductance, temperature, pH, dissolved oxygen, turbidity, and/or chlorophyll

Parameters may be adjusted based on results of 2009 Interim Flow monitoring.

Table 2.
Water Quality Monitoring Sites Specified in the Water Rights Order

Monitoring Site	Reach	TSS	Nutrients	TOC/DOC	Bacteria	Trace Elements	Pesticides	Bed Sediments
Millerton Lake	1A	W						
SJR just below Friant Dam	1A	W	W	W	W	W	W	1P
SJR near HWY 99	1A	W	W	W	W	W	W	1P
SJR at Gravelly Ford	2A	W	W	W	W	W	W	1P
SJR below Bifurcation	2B	W						
SJR near Mendota	3	W	W	W	W	W	W	1P
SJR below Sack Dam	4A	W						
SJR at Fremont Ford	5	W						
SJR at Hills Ferry	5	W						

Sampling frequency:
Water: Twice weekly, October 1 - 14, 2009; weekly, October 15 - November 20,2009
Sediment: Once following interim flows (December 2009)

Table 3.
Bed Sediment Monitoring Sites Specified in the Water Rights Order

Monitoring Site	Reach	CDEC	Flow	Temperature	pH	Dissolved Oxygen	Chlorophyll	Turbidity	EC
Millerton Lake	1A	MIL	C						
SJR just below Friant Dam	1A	P	C	C	C	C	C	C	C
SJR at HWY 41	1A	H41	C						
SJR near HWY 99	1A	DNB	C	P	P	P	P	P	P
SJR at Gravelly Ford	2A	GRF	C	C	C	C	C	C	C
SJR below Bifurcation	2B	SJB	C	C	C	C	C	C	C
SJR near Mendota	3	MEN	C						
SJR below Sack Dam	4A	P	P	P	P	P	P	P	P
SJR at Fremont Ford	5	FFB	C	C					C
SJR at Hills Ferry	5	P	C	C	P	P	P	P	C
SJR at Crows Landing	5	SCL	C	C					C

C=continuous monitoring using YSI 6600 multiparameter sondes
P=pending installation of sondes

4.0 Study Methods and Materials

4.1 Monitoring Design

The objectives of this Monitoring Plan follow the regulatory requirements set forth in the Water Rights Order WR 2009-0058-DWR (Order), which discusses the need for water quality monitoring and Monitoring Plan development (See Appendix B). The primary objective of this Monitoring Plan is to obtain high quality data to support the SJRRP and to meet the terms of the Order.

Reclamation will be responsible for the purchase and use of all materials associated with this Monitoring Plan. Most sampling equipment will be owned and operated by Reclamation staff. Reclamation's Quality Assurance Officer will be responsible for training of all field staff and verification of methods and results.

The Monitoring Plan provided in this document is compliant with the Surface Water Ambient Monitoring Quality Assurance Monitoring Program (SWAMP) guidelines.

4.2 Adaptation to Real-Time Conditions

Given the uncertainty associated with restoration of Chinook salmon and native fish populations to the San Joaquin River, and complexity of the SJRRP, a real-time management program is needed to ensure the SJRRP can be flexible, adjusting as new information becomes available. The response of reestablished Chinook salmon and other fishes to physical factors such as temperature, streamflow, climate change, and the impacts of various limiting factors is unknown.[8]

Real-time management will allow decision makers to take advantage of a variety of strategies and techniques that are adjusted, refined, and/or modified based on an improved understanding of system dynamics. SJRRP restoration actions are restricted to the Restoration Area, thus limiting the application of real-time management on an ecosystem-wide basis. Thorough monitoring and evaluation of real-time management actions are critical to successful learning and resolution of scientific uncertainties. Results of monitoring and evaluation will be used to redefine problems, reexamine goals, and/or refine conceptual and quantitative models, to ensure efficient learning and adaptation of management techniques.

By using real-time management, the SSJRP will respond and change the implementation and management strategy as new knowledge is gained. This real-time management approach will (1) maximize the likelihood of success of actions, (2) increase learning opportunities, (3) identify data needs and reduce uncertainties, (4) use the best available information to provide technical

[8] SJRRP, June 2009. Draft Fisheries Management Plan, Page 1-3

support and increase the confidence in future decisions and recommendations, and (5) prioritize management actions.

4.3 Indicators and Measurement Parameters

The following sections describe the parameters for real-time and laboratory measurement of water quality, as well as methods for quality control, data management, and data reporting.

4.3.1 Real-Time Water Quality Monitoring Parameters

Parameters that will be monitored on a real-time basis at the stations discussed above for this Monitoring Plan are described below. Methods of measurement, along with range, resolution, and accuracy of specified sensors are provided in Table 2.

Temperature

Temperature is a physical property of a system measured in degrees Fahrenheit (ºF) or Celsius (ºC). Temperature is a critical parameter for various life stages of salmonids.

Salinity

Salinity is a measure of dissolved elements in water. It is the sum weight of many different elements within a given volume of water, reported in milligrams per liter (mg/L) or parts per million (ppm). Salinity is an ecological factor of considerable importance, influencing the types of organisms, such as plants and fish, that live and grow in a body of water. Salinity can be estimated by measuring the specific conductance (SC) of water.

Dissolved Oxygen

In aquatic environments, DO is a measure of the amount of oxygen (O_2) dissolved in water. Super saturation can sometimes be harmful for organisms and can cause decompression sickness. Lack of dissolved oxygen is also harmful. DO is measured in standard solution units such as millimoles O_2 per liter (mmol/L) or milligrams O_2.

pH

The property of pH is a measure of the acidity or alkalinity of a solution given by the concentration of hydrogen ions. Values of pH in water are commonly in the range 0 to 14 units. Aqueous solutions at 25°C with a pH of less than 7 are considered acidic, while those with a pH of greater than 7 are considered basic (alkaline). When a pH level is 7.0, it is defined as “neutral” at 25°C. The pH reading of a solution is usually obtained by comparing unknown solutions to those of known pH.

Turbidity

Turbidity is the cloudiness or haziness of a fluid, caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

Chlorophyll

Chlorophyll, in various forms, is bound within the living cells of algae and other phytoplankton found in surface water. Chlorophyll is a key biochemical component in the molecular apparatus that is responsible for photosynthesis, the critical process in which the energy from sunlight is

used to produce life-sustaining oxygen. In the photosynthetic reaction, carbon dioxide is reduced by water, and chlorophyll assists this transfer.

Algae refer to simple aquatic organisms, such as seaweed, pond scum, and plankton, that are plantlike and contain chlorophyll. For *in-situ* monitoring, the measured parameter is the chlorophyll contained within the phytoplankton.

Monitoring chlorophyll levels is a direct way of tracking algal growth as an indicator organism for the health of a particular body of water.

When algae populations bloom, then crash and die in response to changing environmental conditions, they deplete DO levels – a primary cause of most fish kills. High levels of nitrogen and phosphorus can be indicators of pollution from manmade sources, such as septic system leakage, poorly functioning wastewater treatment plants, or fertilizer runoff. Thus, chlorophyll measurement can be used as an indirect indicator of nutrient levels.

The most widely used measure of phytoplankton biomass is chlorophyll a. It has several advantages as a measure of phytoplankton biomass, including (1) the measurement is relatively simple and direct, (2) it integrates cell types and ages, (3) it accounts to some extent for cell viability, and (4) it can be quantitatively coupled to important optical characteristics of water.

Table 4.
Real-Time Monitoring Physical Parameters

Temperature	
Method	Digital thermometer (YSI 6600 sonde)
Range	-5 to +45 ºC
Resolution	0.01 ºC
Accuracy	± 0.15 ºC
Salinity – Specific Conductance	
Method	Conductivity meter (YSI 6600 sonde)
Range	0 to 100 mS/cm
Resolution	0.001 to 0.1 mS/cm (range-dependent)
Accuracy	± 0.5%, ±0.1 mS/cm
Dissolved Oxygen	
Method	Digital probe (YSI 6600 sonde)
Range	0 to 50 mg/L
Resolution	0.01 mg/L
Accuracy	0 to 20 mg/L: ± 2% of reading or 0.2% mg/L 20 to 50 mg/L%: ± 6% of reading
pH	
Method	Digital probe (YSI 6600 sonde)
Range	0 to 14 units
Resolution	0.01 unit
Accuracy	± 0.2% unit
Turbidity	
Method	Turbidity meter (YSI 6600 sonde)
Range	0 to 1,000 NTU
Resolution	0.1 NTU
Accuracy	± 5% of reading or 2 NTU
Depth	200 feet
Chlorophyll	
Method	Digital sensor (YSI 6600 sonde)
Range	0 to 400 µg/L
Resolution	0.1 µg/L Chlorophyll; 0.1% FS
Depth	200 feet

Key:
ºC = degrees Celsius
FS = fluorescence
µg/L = micrograms per liter
mg/L = milligrams per liter
mS/cm = milliSiemens per centimeter
NTU = Nephelometric turbidity unit

4.3.2 Sampling For Laboratory Analyses of Water Quality

The following sections describe constituents for laboratory analyses of water quality, as well as methods for water quality sampling and chain of custody documentation. Reclamation will execute contracts with select laboratories that have met its standards of quality assurance and data validity.

Constituents

The complete list of constituents to be measured at various sites along the SJRRP study area will be determined as needed by relevant scientific personnel for fish and water management purposes. Parameters may include selenium, mercury, boron, nutrients, and other compounds that cannot be measured with field sensors.

Sampling Methods

Grab samples may be collected using a stainless steel sampling device. This device is a cage on a pole that holds the sampling bottle. Grab samples may also be collected from the stream bank directly into sample bottles or into a churn-splitter. This technique is for samples collected weekly or less frequently. Reclamation will specify the sampling details in a Quality Assurance Project Plan to be prepared for the SJRRP. Details will include sample volume, correct container, preservative, and handling. Some samples will require immediate delivery to the analytical lab. Reclamation will train field staff to collect samples.

Depth/width integrated samples will be collected where parameters may not be evenly mixed across the river channel. This method involves collecting samples at regular intervals across the channel. Reclamation will train field staff to conduct this sampling method.

Time composite samples, if needed, will be collected using an autosampler. Daily composite samples typically consist of two to eight subsamples taken per day and mixed into one sample. Weekly composite samples will consist of seven consecutive daily subsamples mixed into one sample. Reclamation and the Central Valley Regional Water Quality Control Board (Central Valley RWQCB) currently use autosamplers to collect daily composite samples from the Delta-Mendota Canal, San Luis Drain, and San Joaquin River at Crows Landing. Reclamation staff will be available to deploy and operate autosamplers as needed to support the SJRRP.

Chain of Custody Documentation

Chain of custody (COC) documentation will be initiated during sample collection for all matrices and maintained throughout analytical and storage processes. All individuals transferring and receiving samples will sign, date, and record the time on the COC that the samples are transferred. Each agency will follow its established COC procedures and use various agency and laboratory COC records. Reclamation will train field staff to complete COC forms.

Laboratory COC procedures are described in each laboratory's Quality Assurance Program Manual, which is kept on file with the Quality Control Officer (QCO). Laboratories must receive the COC documentation submitted with each batch of samples and sign, date, and record the time the samples are transferred. Laboratories will also note any sample discrepancies (e.g., labeling, breakage). This documentation must be maintained for a minimum of 5 years. After generating the laboratory data report for the client, samples will be stored for a minimum of 30 days in a secured area prior to disposal.

4.4 Data Analysis and Assessment

The SJRRP Streamflow and Water Quality Monitoring Subgroup will have regular conference calls to discuss updates and data related to the release of flows from Friant Dam and the related information collected from the San Joaquin River as water moves through the existing channel. Compilations of data will be reviewed by the Subgroup to identify trends and justify changes to the Monitoring Plan and implement real-time management strategies.

An annual meeting will occur with Interagency staff to review collected water quality monitoring data, to analyze the general trends, and to write an annual report that summarizes the findings.

4.5 Data Collection and Frequency of Sampling

Interim Flow water will be tracked and sampled at several sites along the river as specified in the Water Rights Order and for the benefit of fishery management. The foundation of this Monitoring Plan will be a series of sensors located along the study area that will provide real-time measurements of physical conditions (Table 1). The sondes will measure stage (depth), flow, specific conductance, temperature, dissolved oxygen, and pH. The locations of the sensors are listed in Table 1 and are shown on Figure 3.

Routine samples of water will be collected at the sites listed in Table 2 for analyses of various parameters required by the Water Rights Order. Other sites will be added to support fish management research. The frequency of sampling and analytical parameters will be is based on initial findings from the 2009 Interim Flow Water Quality Monitoring, the requirements of the Order, and recommendations from the SJRRP Streamflow and Water Quality Monitoring Subgroup.

Additional water quality monitoring locations may be warranted as new site conditions dictate. Therefore, this list may be revised based upon future data needs.

4.6 Spatial and Temporal Scale

4.6.1 Reach 1

Tables 5, 6, and 7 describe locations for water quality monitoring within Reach 1, which are shown in Figure 4.

Table 5.
San Joaquin River at Friant Dam

Description	The station is located at the base of Friant Dam.
Purpose	To measure the initial volume, temperature, and quality of water released from the dam into the river for riparian diversions and the SJRRP.
Responsible Agency	Reclamation, Friant Dam office, is responsible for operation of the dam and will maintain this water quality station.
Existing Equipment	Stage recorder, multi-parameter sonde, linked to CDEC via satellite.

Note: The sonde will be installed end of the wall between the river valves and the spillway.

Table 6.
San Joaquin River below Friant Dam (Lost Lake Park)

Description	The station will be located near the existing USGS flow monitoring site in Lost Lake Park.
Purpose	To measure the quality of water released from the dam into the river for riparian diversions and the SJRRP.
Responsible Agency	Reclamation, Friant Dam office, will maintain this monitoring station. USGS will continue to measure flow. Reclamation, Environmental Monitoring Branch (MP-157), will collect water samples; if needed, an autosampler could be operated here.
Existing Equipment	Stage recorder, linked to CDEC via satellite.
Revision	Add autosampler, multiple parameter sonde.

Table 7.
San Joaquin River at Highway 99 (Camp Pashayan)

Description	This site is located about 25 miles downstream from Friant Dam, near several golf courses.
Purpose	To measure the quality of water in the river near possible sources of nutrient and pesticide contamination
Responsible Agency	Reclamation, MP-157
Existing Equipment	None
Modifications	Get permission to access the river through Camp Pashayan

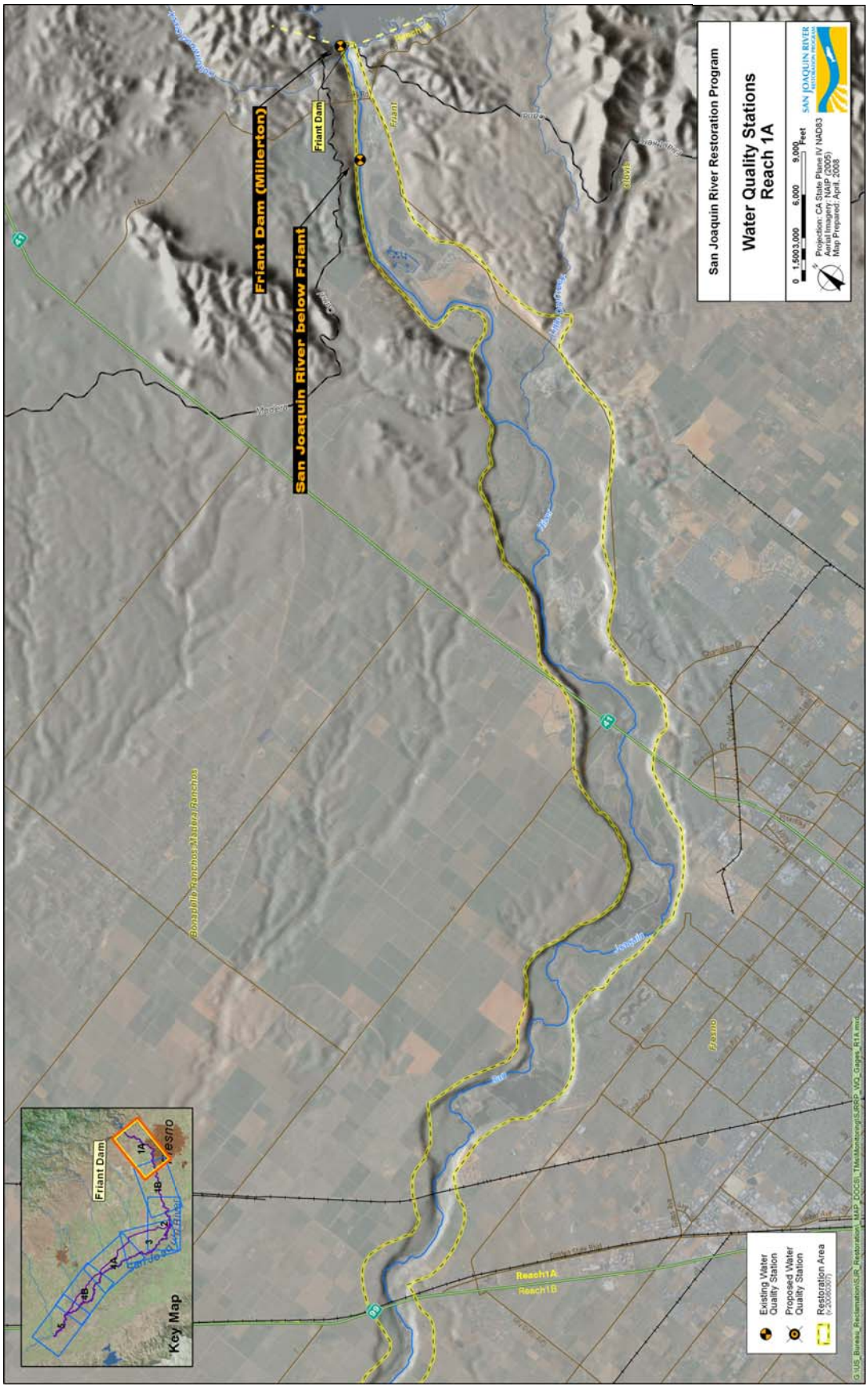

Figure 4.
Reach 1 Water Quality Monitoring Stations

4.6.2 Reach 2

Water quality monitoring locations within Reach 2 are described in Tables 8 and 9, and shown in Figure 5.

Table 8.
San Joaquin River at Gravelly Ford

Description	This site is located about 40 miles downstream from Friant Dam, where the last riparian diversion occurs; from here, the Restoration Flows will sustain the river.
Purpose	To measure the volume and temperature of water in the river.
Responsible Agency	Reclamation, Friant Dam office.
Existing Equipment	Stage recorder, multiple parameter sonde, linked to CDEC via satellite.

Table 9.
San Joaquin River below Chowchilla Bifurcation

Description	This site is located about 54 miles downstream from Friant Dam, below the Chowchilla Bypass. This is a flood control channel and inlet to the Mendota Pool.
Purpose	To measure the volume and temperature of water in the river.
Responsible Agency	Reclamation, Friant Dam office.
Existing Equipment	Stage recorder, multiple parameter sonde linked to CDEC via satellite.

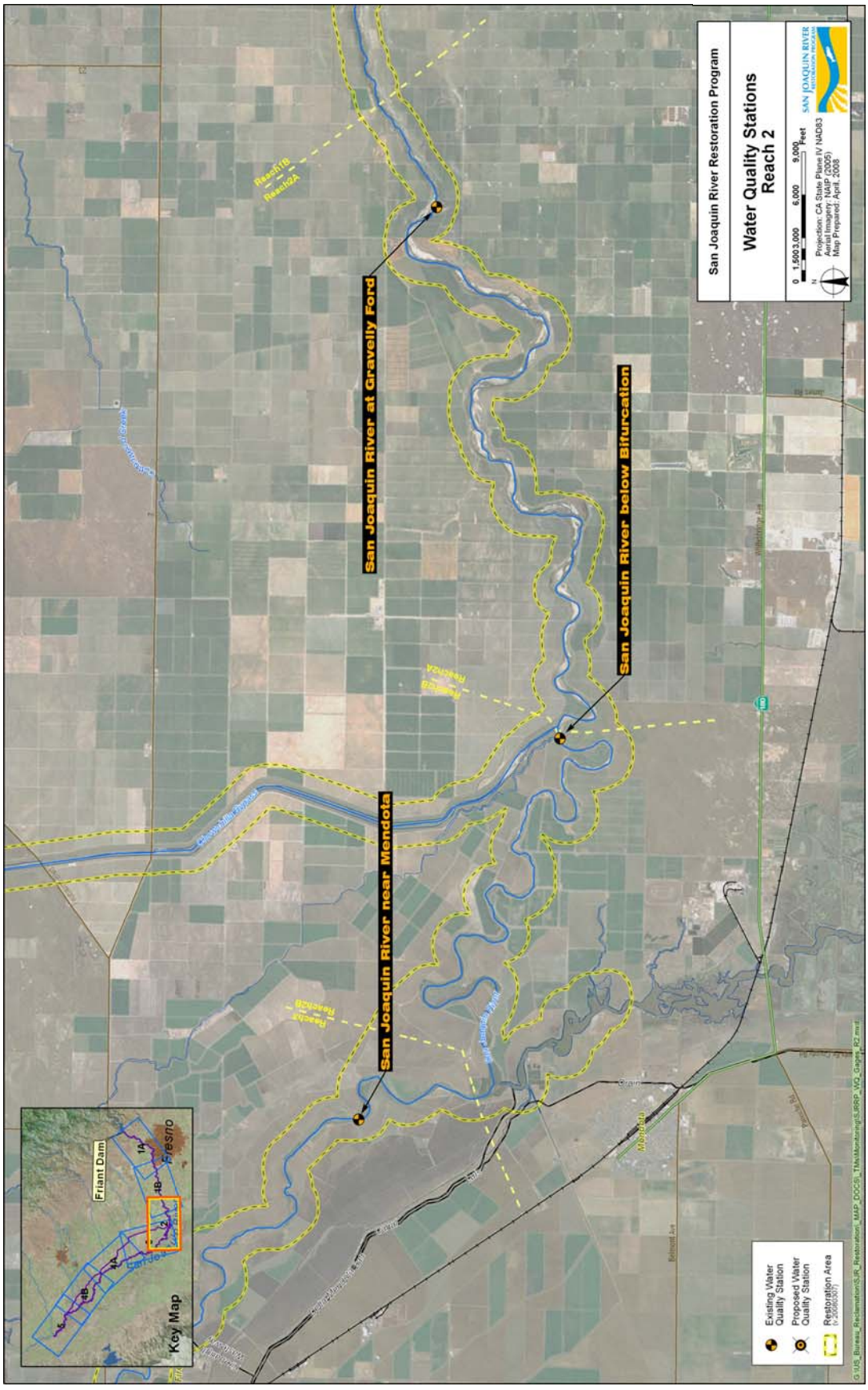

Figure 5.
Reach 2 Water Quality Monitoring Stations

4.6.3 Reach 3

Table 10 describes the location of a water quality monitoring station for the SJRRP in Reach 3, shown in Figure 6. In addition to the station described below, Reclamation will operate two water quality stations that measure the quality of water in the Mendota Pool: Delta-Mendota Canal Check 21, and Central California Irrigation District Main Canal headworks at Bass Avenue. Data from these sites will be integrated into this Monitoring Plan.

Table 10.
San Joaquin River near Mendota (below Mendota Dam)

Description	The Mendota Dam impounds water from the Kings River, San Joaquin River, and Delta-Mendota Canal. The blend of waters varies in volume and quality. Possible site for an autosampler.
Purpose	To measure the volume, temperature, and quality of water in the river.
Responsible Agency	Reclamation (MP-157)
Existing Equipment	Stage recorder, linked to CDEC.
Revision	Add multiple parameter sonde and autosampler; connect power supply.

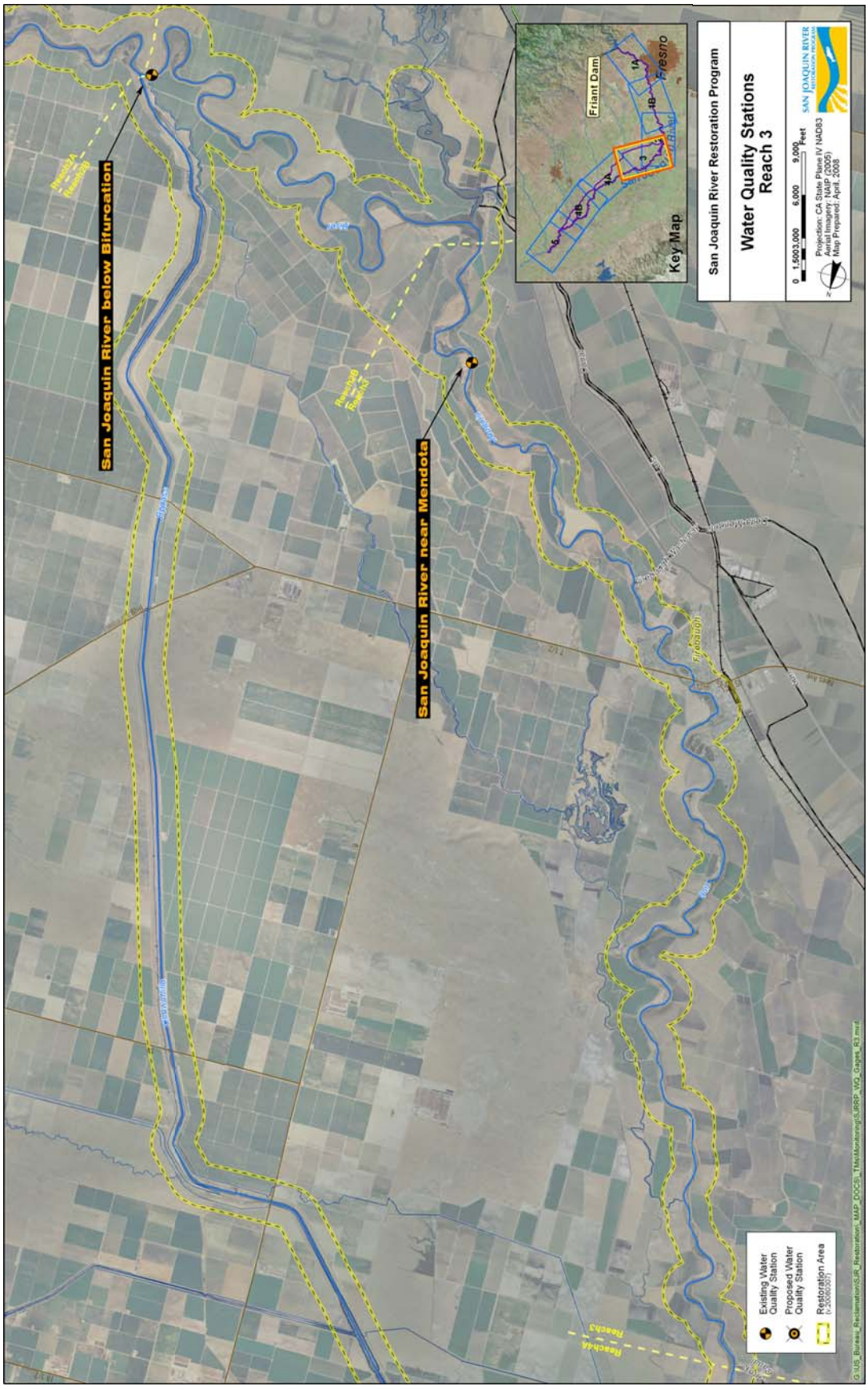

Figure 6.
Reach 3 Water Quality Monitoring Stations

4.6.4 Reach 4

The water quality monitoring stations for the SJRRP in Reach 4 are described in Tables 11 and 12, and shown in Figure 7. In addition to the sites described below, flow and water quality data collected by the USGS and Central Valley RWQCB for Salt Slough at Lander Avenue may be used by the SJRRP. The USGS measures flow, electrical conductivity (EC), and temperature at this site, and the Central Valley RWQCB collects water samples each week to analyze selenium and boron. DWR collects flow data in the River at Lander Avenue (Highway 165).

Table 11.
San Joaquin River near Dos Palos (below Sack Dam)

Description	This is a major point of diversion of water to agriculture and wildlife refuges. SJRRP flows will sustain the river below this point.
Purpose	To measure the volume, temperature, and water quality in the river.
Responsible Agency	DWR
Existing Equipment	Flow measurement and multiple parameter sonde.

Table 12.
San Joaquin River at the Top of Reach 4B

Description	The river at this site receives water from the east via the Mariposa and Eastside bypasses, and from the west via Salt Slough.
Purpose	The quality of the blended waters may be harmful to migrating fish.
Responsible Agency	TBD
Existing Equipment	None
Revision	Install flow measurement devices and multiple parameter sonde.

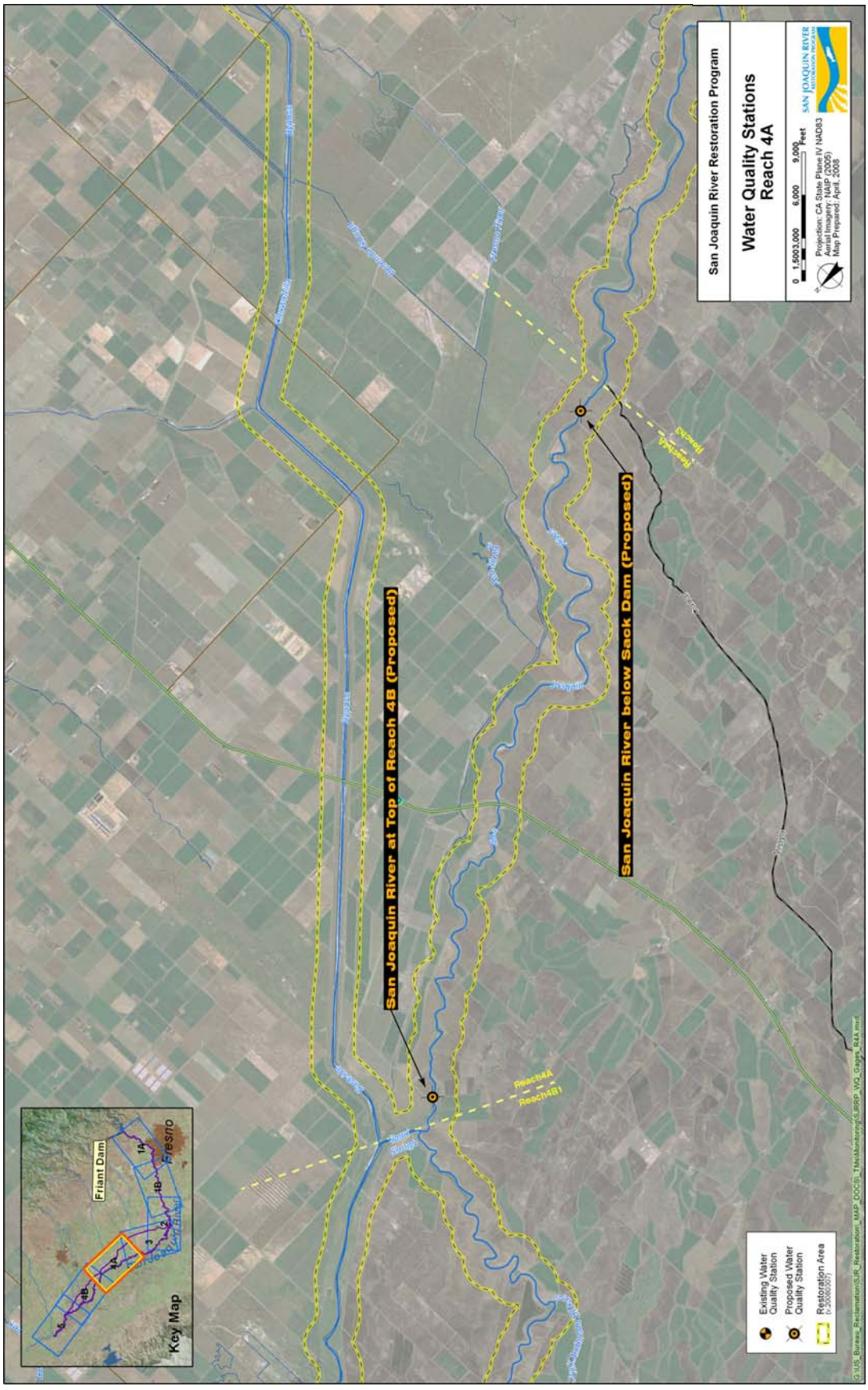

Figure 7.
Reach 4 Water Quality Monitoring Stations

4.6.5 Reach 5

Tables 13 and 14 describe locations of water quality monitoring stations for the SJRRP in Reach 5. The locations of these stations are shown in Figure 8. Water quality data collected by other agencies at tributaries to the San Joaquin River near Reach 5 may be used by the SJRRP. These sites include Mud Slough near Gustine, and Newman Wasteway. At Mud Slough near Gustine, USGS measures EC and temperature, while Central Valley RWQCB collects water samples each week to analyze selenium and boron. When water is released from the Delta-Mendota Canal to the San Joaquin River through the Newman Wasteway, Reclamation monitors water quality and toxicity in the Newman Wasteway and San Joaquin River.

Table 13.
San Joaquin River at Fremont Ford Bridge

Description	The river at this site receives water from local farms and refuges and Salt Slough (Grassland Bypass Project Station G).
Purpose	To measure flow and quality of water in Reach 5.
Responsible Agency	Flow, EC, temperature: USGS Other parameters: Central Valley RWQCB (SWAMP)
Existing Equipment	GOES station, linked to CDEC.
Revision	Upgrade existing multiple parameter sonde to measure turbidity and dissolved oxygen.

Note:
Flow and water quality separately funded by Reclamation and Central Valley RWQCB, respectively. Based on available funds, the Grassland Bypass Project will continue to monitor flow, salinity, temperature, selenium, and nutrients. These data will be incorporated in this Monitoring Plan.

Table 14.
San Joaquin River at Hills Ferry

Description	The site is located at Hills Ferry, about one half-mile upstream from the confluence of the Merced River.
Purpose	This is where the net volume of water attributed to SJJRP Flows will be measured. Many biological and water quality parameters have been measured here for with the Grassland Bypass Project.
Responsible Agency	Flow, EC, temperature: USGS
Existing Equipment	GOES station, linked to CDEC; autosampler site

Note: Weekly grab samples for selenium and boron are collected for Grassland Bypass Project.

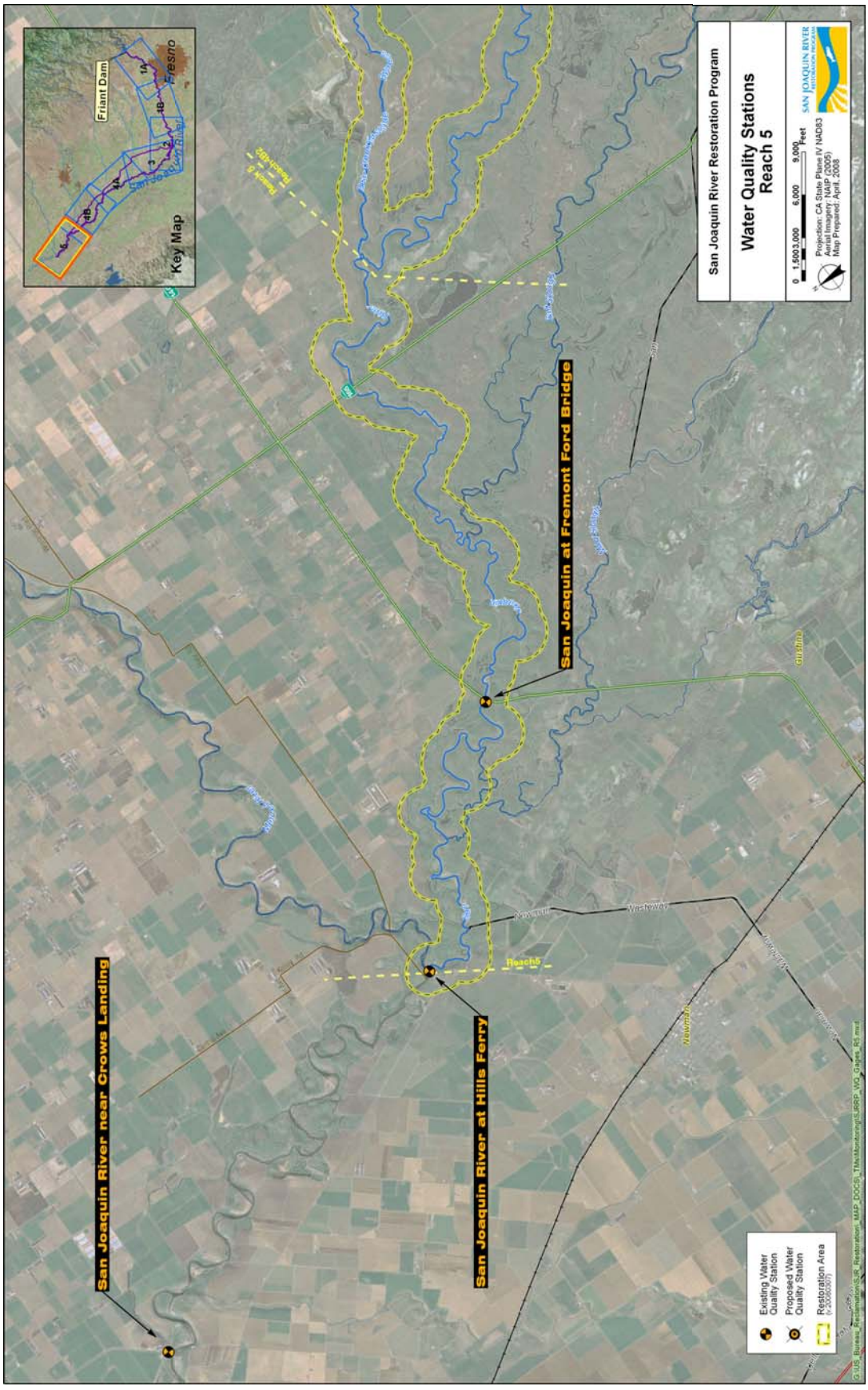

Figure 8.
Reach 5 and San Joaquin River Below Merced River Water Quality Monitoring Station

4.6.6 San Joaquin River Below Merced River

Table 14 describes a San Joaquin River water quality monitoring location located below the Merced River confluence, downstream from Reach 5. This water quality monitoring station is shown in Figure 7.

Table 14.
San Joaquin River at Crows Landing

Description	San Joaquin River below Merced River (Grassland Bypass Project Station N).
Purpose	Assess net benefit to lower San Joaquin River from SJRRP; compare with long history of flow and water quality data.
Responsible Agency	Flow, EC, temperature: USGS Water quality: Central Valley RWQCB (GBP)
Existing Equipment	GOES station, linked to CDEC, autosampler on dock.

Note: Water quality separately funded by Reclamation and Central Valley RWQCB. Based on available funds, the Grasslands Bypass Project will continue to monitor flow, salinity, temperature, selenium, nutrients, and other parameters here. These data will be incorporated in this Monitoring Plan.

4.7 Data Management

Each agency and contractor collecting data for the 2009-2013 Interim Flows Water Quality Monitoring Plan shall be responsible for its own data reduction (analysis), internal data quality control, data storage, and data reporting. Each will provide its data to the independent data management organization (DMO) for compilation, publication, and distribution of printed copies.

The DMO will specify the format for all reports, data tables, graphics, and charts. The DMO will specify how raw data will be presented by the collecting agencies, and how the final reports will be published (e.g., Adobe PDF). Reclamation will coordinate with participating agencies and the DMO to ensure compliance with suggested data dissemination procedures and formats.

All data collected under this Monitoring Plan will be compatible with the 2005 Surface Water Ambient Monitoring Program (SWAMP) Information Management Plan.

Data will be labeled according to accuracy and degree of verification:

- Real-Time – Raw data from in-situ sensors; preliminary and subject to change upon review and calibration by the collecting agency
- Provisional Data - Data that have been reviewed by the collecting agency but still may be changed pending reanalysis or statistical review
- Laboratory Data – Data produced by the laboratory following laboratory QA/QC protocols and verified by the QA Officer.

5.0 Coordination and Review Strategy

5.1 Interagency Streamflow and Water Quality Monitoring Subgroup

The SJRRP Interagency Streamflow and Water Quality Monitoring Subgroup consists of representatives from the following agencies:

- Central Valley Regional Water Quality Board
- U.S. Fish and Wildlife Service
- U.S. Environmental Protection Agency
- California Department of Water Resources
- National Marine Fisheries Service
- California Department of Fish and Game
- U.S. Bureau of Reclamation

The SJRRP Streamflow and Water Quality Monitoring Subgroup was started to coordinate data and provide for real-time management of results at the start of release of Interim Flows from Friant Dam on October 1, 2009. The Subgroup will continue to have regular conference calls to discuss updates and data related to the release of flows from Friant Dam and the related information collected from the San Joaquin River as water moves through the existing channel during Interim Flow releases. Compilations of data will be reviewed by the Subgroup to identify trends and justify changes to this Monitoring Plan to allow for real-time management. An annual meeting will occur with Interagency staff to review collected water quality monitoring data, to analyze the general trends, and to write an annual report that summarizes the findings.

5.2 Items to be Addressed During Information Collection

As this Monitoring Plan is developed and analysis is completed and disseminated to appropriate agencies, it is anticipated that elements of this Monitoring Plan may change in order to adapt to changing conditions, new policy, and suggested improvements to specific procedures.

Several existing outstanding items that are not addressed specifically in this report, but are anticipated to be developed through coordination with appropriate agencies are the following:

- Assessment questions identified in the SWAMP assessment framework that monitoring will address.
- Determination of a possible link to statewide monitoring framework components,
- Integration of project data into the 305(b)/303(d) reporting cycle

6.0 Quality Assurance

Quality control (QC) is the overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that stated requirements are met.

Quality assurance (QA) is an integrated system of management activities involving, planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer.

A Quality Assurance Project Plan will be written for this Monitoring Plan. The QAPP will be administered by the Quality Control Officer for Reclamation. QA objectives will be used to validate the data for this project. The data will be accepted, rejected, or qualified based on how sample results compare to established acceptance criteria[9].

The precision, accuracy, and contamination criteria will be used by the QCO to validate the data for this project. The criteria will be applied to the blind external duplicate/split, blank, reference, or spiked samples submitted with the production samples to the analytical laboratories by the participating agencies to provide an independent assessment of precision, accuracy, and contamination.

Laboratories analyze their own QC samples with the client's samples. Laboratory QC samples, including laboratory fortified blanks, matrix spikes, duplicates, and method blanks, assess precision, accuracy, and contamination. Laboratory QC criteria are stated in the analytical methods or determined by each laboratory. Since internal control ranges are often updated in laboratories based on instrumentation, personnel, or other influences, it is the responsibility of the QCO to verify that these limits are well documented and appropriately updated during system audits. The preferred method of reporting the QC results is for the laboratory to provide a QC summary report with acceptance criteria for each QC parameter of interest.

For water and sediment results, the QCO will use a statistical program to determine if current concentrations for parameters at given sites are consistent with the historical data at these sites. A result is determined to be a historical outlier if it is greater than 3 standard deviations from the average value for the site. The presence of an outlier could indicate an error in the analytical process or a significant change in the environment.

Samples must be prepared, extracted, and analyzed within the recommended holding time for the parameter. Data may be disqualified if the sample was analyzed after the holding time expires.

Completeness refers to the percentage of project data that must be successfully collected, validated, and reported to proceed with its intended use in making decisions.

[9] U.S. Bureau of Reclamation, Mid-Pacific Region. May 2001. Standard Operating Procedures for Environmental Monitoring. Sacramento.

Constraints with regard to time, money, safety, and personnel were some of the factors in choosing the most representative sites for this project. Monitoring sites have been selected by considering the physical, chemical, and biological boundaries that define the system under study.

Sites also were selected to be as representative of the system as possible. However, the ad hoc Data Collection and Review Team (DCRT) will continue to evaluate the choice of the sites with respect to their representativeness and will make appropriate recommendations to the Water Quality Monitoring Group given a belief or finding of inadequacy.

Comparability between each agency's data is enhanced through the use of Standard Operating Procedures (SOP) that detail methods of collection and analysis. Each agency has chosen the best available protocol for the sampling and analyses for which it is responsible based on the agency's own expertise. Audits performed by the QCO will reinforce the methods and practices currently in place and serve to standardize techniques used by the agencies.

7.0 Reporting

Preliminary real-time flow data will be posted on the CDEC. The purpose of this data is to provide an instant estimate of field conditions. Real-time flow data will be posted on the Web site as preliminary, subject to change. The data will be available for 5 years, after which the data will be archived by Reclamation and provided on request.

The DMO will prepare quarterly data compilation reports that will list mean daily available flow and temperature at the monitoring locations, plus all available water quality results. The report will include summary calculations, charts, and graphics to show cumulative effects. The data will be subject to revision. The purpose of these data is to provide reliable information for analyzing trends and changes in water quality in the river. The DMO will maintain a database for download by interested parties. Reclamation will coordinate with participating agencies and the DMOto ensure compliance with suggested data dissemination procedures and formats.

Final data will be completely verified by the respective collecting agencies and published in the Annual Technical Report. The Interagency Streamflow and Water Quality Monitoring Subgroup will collaborate to prepare information for the Annual Technical Report, which will synthesize all flow and water quality monitoring data for the SJRRP, and will provide a scientific review of the data to determine how the SJRRP is meeting its objectives.

Appendix A
Excerpts from Paragraph 15 of the Settlement Agreement

15. Prior to the commencement of full Restoration Flows pursuant to this Settlement, the Parties agree that the Secretary shall begin a program of interim flows, which will include releases of additional water from Friant Dam commencing no later than October 1, 2009, and continuing until full Restoration Flows begin. Flows released according to the provisions of this Paragraph 15 shall be referred to as "Interim Flows." The Restoration Administrator, in consultation with the Technical Advisory Committee, the Secretary, and other appropriate Federal, State and local agencies, shall develop and recommend to the Secretary implementation of a program of Interim Flows in order to collect relevant data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture and reuse. Such program shall include releasing the flows identified in Exhibit B for the appropriate year type to the extent that such flows would not impede or delay completion of the measures specified in Paragraph 11(a), or exceed existing downstream channel capacities. To the extent that any gauging locations identified in Paragraph 13(g) are not available to measure flows due to in-channel construction related to Paragraph 11 improvements and until such gauging locations are installed, Interim Flows will be measured by establishing any necessary temporary gauging locations or by manual flow measurements for the purposes of collection of relevant data. The Parties anticipate that a program of Interim Flows would include:

(a) In 2009, release flows from October 1 through November 20 of a timing and magnitude as defined in the appropriate year type hydrograph [flow schedule] specified in Exhibit B, and without exceeding the then existing channel capacities;

(b) In 2010, release flows from February 1 through December 1 of a timing and magnitude as defined by Exhibit B for the appropriate year type, and without exceeding the then existing channel capacities;

(c) In 2011 and 2012, assuming in-channel construction begins May 1, release flows from February 1 through May 1 of a timing and magnitude as defined by Exhibit B for the appropriate year type, and without exceeding the then existing channel capacities. From May 1 through September 1, release flows to wet the channel down to the Chowchilla Bifurcation Structure to collect information regarding infiltration losses; and

(d) In subsequent years, if the highest priority channel improvements identified in Paragraph 11(a) are not completed, release flows for the entire year of a timing and magnitude as defined by Exhibit B for the appropriate year type, without exceeding the then existing channel capacities or interfering with any remaining in-channel construction work on the highest priority Paragraph 11 improvements.

(e) For purposes of implementing the Interim Flows specified in 15(a) through 15(d), the Secretary, in consultation with the Restoration Administrator, shall determine the then existing channel capacity and impact of Interim Flows on channel construction work."

Appendix B
Excerpts from Condition 22 of the Water Rights Order

22. Reclamation shall collect baseline information to evaluate potential impacts to Mendota National Wildlife Refuge and other resources associated with the temporary transfer. For this effort, Reclamation shall collect sediment and water quality information at the locations and for the parameters specified in Table 1. Samples shall be collected at least one week before interim flows reach the respective monitoring station to capture baseline data. If sediment sample concentrations are below criteria identified by the Deputy Director for Water Rights, then no additional sediment, organo-chlorine or pyrethroid sampling shall be required during the fall 2009 interim flow. If samples exceed the proposed criteria, Reclamation shall continue all sampling specified in Table 2 developed by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) and Reclamation. Approximately one week after interim flows reach the respective monitoring station, water samples shall be collected at each location and analyzed for organic and inorganic water quality parameters as specified in Table 2. Reclamation shall compile real-time data from sites listed in Table 3 to monitor flow and physical parameters during the study period.

By January 1, 2010, Reclamation shall develop a monitoring plan, acceptable to the Deputy Director for Water Rights, for the releases beginning after February 1, 2010. Prior to submitting the plan to the Division of Water Rights, Reclamation shall obtain the written comments of the Central Valley Water Board, U.S. Fish and Wildlife Service, and California Department of Fish and Game. The plan is subject to review, modification and approval by the Deputy Director for Water Rights.

Until approval of a final monitoring plan, samples collected as part of this project must include field duplicates at a rate of 5% of the total project sample count at sites that includes all parameters to be analyzed. Additional quality assurance samples may be required by specific analytical methods.

Results from all water quality monitoring must be submitted to the Central Valley Water Board and Division of Water Rights within two months of data collection. Results shall include: laboratory name where results were analyzed, analytical result, analytical method, field duplicate results, and laboratory quality control, including laboratory blanks, reference material, matrix spikes, and laboratory duplicates.

At a minimum, analyses for each parameter group will include the following:

• *TSS =Total suspended solids*

• *Nutrients: TN, NH4, N02, N03, TKN, TP, P04, chlorophyll*

• *TOC/DOC: total and dissolved organic carbon*

• *Bacteria: Fecal coliform and E. coli*

• *Trace Elements/minerals: cations (Ca. Mg, K, Na); anions (CI, C04, HC03); total TE (copper, chromium, lead, nickel, zinc, arsenic, mercury)*

• *Pesticides: water column pre-release scans (carbamates and organophosphates); post-release scans (carbamates, organophosphates, and dependent on sediment results addition of organochlorines and pyrethroids)*

• *Bed Sediment: TOC, Trace elements (copper, chromium, lead, nickel, zinc, arsenic, mercury), organochlorine scan, pyrethroid scan, toxicity*

Appendix C
Excerpts from Page 6 and 7 of the Draft Fishery Management Plan, June 2009

Monitoring Objectives

Provide water-quality conditions suitable for Chinook salmon and other native fishes completing their life cycle without lethal or sublethal effects.

Monitoring Requirements

Constituents such as pesticides and other urban and agricultural wastes may affect water quality parameters such as DO and turbidity, creating habitat unsuitable for Chinook salmon. Sources of adverse water-quality conditions and whether or not discharge conditions will improve water quality are unknown. Evaluating and taking management actions for these conditions may be necessary to successfully meet the Restoration Goal.

Three species toxicity testing (Central Valley Water Board/EPA standards) has not been done, so it is unknown what water quality could be considered a limiting factor in Reaches 1 and 2. Water quality in Reaches 3 through 5 is considered of moderate importance because it experiences a significant amount of agricultural return flows, but effects on Chinook salmon are largely unknown.

Objectives, MCLs

To meet the SJRRP Restoration Goal, water quality should meet minimum standards for protection of aquatic resources. Because of the lack of information on the effects of many water quality constituents on Chinook salmon and other fishes, the water quality objectives for beneficial uses defined by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) are used to establish water-quality goals.

The temperature objectives are based on a DFG proposal to assess temperature impairment (DFG 2007b), U.S. Environmental Protection Agency (EPA) guidelines (EPA 2003) and a report on temperature impacts on fall-run Chinook salmon and steelhead (Rich and Associates 2007).

Water-quality objectives are “the limits or levels of water quality constituents or characteristics established for the reasonable protection of beneficial uses of the water or the prevention of a nuisance in a specific area” (California Water Code Section 13050(h)).Water-quality standards consist of the designated beneficial uses and water quality objectives set forth by the State Water Resources Control Board (SWRCB) and the Central Valley Water Board and are contained in the Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin (Basin Plan). For the San Joaquin River system, including the Restoration Area, SWRCB has set

a goal to be free from toxic substances in surface water (Central Valley Water Board 1998). Selenium, DO, and ammonia objectives are based on the Central Valley Water Board and SWRCB standards described above. Additional water-quality criteria are defined in Exhibit B.

Water temperatures for spring-run Chinook salmon adult migrants should be less than 68 °F in Reaches 3, 4, and 5 during March and April, and less than 64°F in Reaches 1 and 2 during May and June (Exhibit A, Table A-1).

Water temperatures for spring-run Chinook salmon adult holding should be less than 59°F in holding areas between April and September (Exhibit A, Table A-1).

Water temperatures for spring-run Chinook salmon spawners should be less than 57°F in spawning areas during August, September, and October (Exhibit A, Table A-1).

Water temperatures for spring-run Chinook salmon incubation and emergence should be less than 55°F in spawning areas between August and December (Exhibit A, Table A-1).

Water temperatures for spring-run Chinook salmon juveniles should be less than 64°F in the Restoration Area when juveniles are present (Exhibit A, Table A-1).

Selenium levels should not exceed 0.020 milligrams per liter (mg/L) or a 4-day average of 0.005 mg/L in the Restoration Area (Exhibit B, Table B-3).

DO concentrations should not be less than 6.0 mg/L when Chinook salmon are present (Exhibit B, Table B-3).

Total ammonia nitrogen should not exceed 30-day average of 2.43 milligrams nitrogen per liter (mg N/L) when juvenile Chinook salmon are present or exceed a 1-hour average of 5.62 mg N/L when Chinook salmon are present (Exhibit B, Table B-9). (FMP Page 3*-13)

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- Habitat Objective 5 – To provide appropriate flow timing, frequency, duration and magnitude, enabling the viability of 90 percent of all life-history components of spring-run Chinook salmon.

  – Recommended monitoring and evaluation – An analysis of streamflow and fish distribution and survival is recommended. Flow and stage measurement will occur real-time, according to procedures based on the USGS publication *Stream-Gaging Program of the U.S. Geological Survey – U.S. Geological Survey Circular 1123* (Wahl, Thomas, and Hirsch 1995). Population Monitoring Objectives 1, 2, and 6 described above will provide spring-run Chinook salmon viability.

- Habitat Objective 6 – Water temperatures for spring-run Chinook salmon adult migrants should be less than 68°F in Reaches 3, 4, and 5 during March and April and less than 64°F in Reaches 1 and 2 during May and June (Exhibit A, Table A-1).
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  - Recommended monitoring and evaluation – Water temperature will be monitored real-time at two locations in Reach 1, two locations in Reach 2, one location in Reach 3, two locations in Reach 4, and two locations in Reach 5.

- Habitat Objective 7 – Water temperatures for spring-run Chinook salmon holding adults should be less than 59°F in holding areas between April and September (Exhibit A, Table A-1).

  - Recommended monitoring and evaluation – Water temperature will be monitored real-time at two locations in Reach 1, two locations in Reach 2, one location in Reach 3, two locations in Reach 4, and two locations in Reach 5.

- Habitat Objective 8 – Water temperatures for spring-run Chinook salmon spawners should be less than 57°F in spawning areas during August, September, and October (Exhibit A, Table A-1).

  - Recommended monitoring and evaluation – Water temperature will be monitored real-time at two locations in Reach 1, two locations in Reach 2, one location in Reach 3, two locations in Reach 4, and two locations in Reach 5.

- Habitat Objective 9 – Water temperatures for spring-run Chinook salmon incubation and emergence should be less than 55°F in spawning areas between August and September (Exhibit A, Table A-1).

  - Recommended monitoring and evaluation – Water temperature will be monitored real-time at two locations in Reach 1, two locations in Reach 2, one location in Reach 3, two locations in Reach 4, and two locations in Reach 5.

- Habitat Objective 10 – Water temperatures for spring-run Chinook salmon juveniles should be less than 64°F in the Restoration Area when juveniles are present (Exhibit A, Table A-1).

  - Recommended monitoring and evaluation – Water temperature will be monitored real-time at two locations in Reach 1, two locations in Reach 2, one location in Reach 3, two locations in Reach 4, and two locations in Reach 5.

- Habitat Objective 11 – Selenium levels should not exceed 0.020 mg/L or a 4-day average of 0.005 mg/L in the Restoration Area (Exhibit B, Table B-3).

  - Recommended monitoring and evaluation – Selenium levels will periodically be monitored in 5 locations as part of a short list of water quality parameters using laboratory analysis.

- Habitat Objective 12 – DO concentration should not be less than 5.0 mg/L when Chinook salmon are present (Exhibit B, Table B-3).

  - Recommended monitoring and evaluation – DO will be monitored real-time at the same locations as water temperature: two locations in Reach 1, two locations in Reach 2, one

location in Reach 3, two locations in Reach 4, and two locations in Reach 5. Additional sampling sites for DO may be added, as needed.

- Habitat Objective 13 – Total ammonia nitrogen should not exceed 30-day average of 2.43 mg N/L when juvenile Chinook salmon are present or exceed a 1-hour average of 5.62 mg N/L when Chinook salmon are present (Exhibit B, Table B-9).

  – Recommended monitoring and evaluation – Total ammonia nitrogen will be monitored weekly to every other week in two locations in cooperation with the Grassland Bypass Project. Additional sampling sites for ammonia nitrogen may be added, as needed.