2010 Annual Technical Report

SAN JOAQUIN RIVER
RESTORATION PROGRAM

April 2011

Table of Contents

Figures and Tables

Attachment

Appendices

Abbreviations and Acronyms

ADCP	Acoustic Doppler Current Profiler
ATR	Annual Technical Report
CCID	Central California Irrigation District
CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
cfs	cubic feet per second
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
DMC	Delta-Mendota Canal
DWR	California Department of Water Resources
EC	electrical conductivity
FMP	Fisheries Management Plan
FMWG	Fisheries Management Work Group
NMFS	National Marine Fisheries Service
PG&E	Pacific Gas and Electric Company
RA	Restoration Administrator
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RM	River Mile
RWQCB	Regional Water Quality Control Board
Settlement	Stipulation of Settlement in *NRDC, et al. v. Kirk Rodgers, et al.*
SJRRP	San Joaquin River Restoration Program
SMN	San Joaquin River above Merced River near Newman
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TAF	thousand acre-feet
TSC	Technical Services Center
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Services
USGS	U.S. Geological Survey
WR	Water Right
WY	water year

1.0 Introduction

The San Joaquin River Restoration Program (SJRRP) is a comprehensive long-term effort to restore flows and a self-sustaining Chinook salmon fishery to the San Joaquin River from Friant Dam to the confluence of Merced River, while reducing or avoiding adverse water supply impacts. More information on the SJRRP is available at http://www.restoresjr.net.

This Annual Technical Report (ATR) presents an incremental update for monitoring and analysis results from 2010 and builds on a draft released in August 2010 which reported on the first half of 2010. The ATR along with the Monitoring and Analysis Plan (formerly known as Agency Plan) are SJRRP annual reporting and planning documents. These documents play a role in the development of SJRRP adaptive management, which links monitoring and analysis efforts to the decision making processes they are designed to support, forming the scientific basis for San Joaquin River operations downstream from Friant Dam. The ATR tracks long-term strategies for SJRRP implementation in problem statements and identifies information needs as uncertainties to be resolved in order to implement the Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.* (Settlement). The ATR allows the Implementing Agencies to present to stakeholders the status and results of technical work to address SJRRP needs.

1.1 Report Organization

The main body of the ATR summarizes monitoring and analysis results from the past year of SJRRP. The ATR is supported by three types of appendices: problem statements/information needs, reports, and data. Some appendices include data atlases as attachments. Appendix A introduces problem statements, which track long-term implementation approaches and are supported by information needs describing specific knowledge gaps to be addressed through studies. The modular format of Appendix A allows technical challenges to be addressed as new information becomes available, and removed from further analysis when they have been resolved. Data reports present raw data from monitoring activities. Reports are stand-alone documents providing updated monitoring and analysis results. Atlases provide monitoring results and the monitoring network for a particular resource area. A brief description of the document organization is presented in the bullets below.

- **Section 1.0 Introduction** – the purpose and structure of the Annual Technical Report.
- **Section 2.0 2010 Summary** – key monitoring and analysis results from 2010.
- **Section 3.0 Monitoring Network** – a description of the components monitored and presentation of monitoring locations.

- **Section 4.0 Models and Analytical Tools** – a description of available numerical models for analysis.
- **Section 5.0 Conclusions** – a description of results and revised understanding of physical and biological systems based upon monitoring data.
- **Appendix A. Problem Statements and Information Needs** –problem statements and information needs for 2010 including:
  - Gravelly Ford Flow Targets,
  - Unexpected Seepage Losses Downstream from Gravelly Ford
  - Seepage Management
  - San Joaquin River Channel Capacity Management
  - Mature Spawners
  - Healthy Fry Production
  - Smolt Outmigrants
  - Smolt Survival
  - Adult Recruits
  - Adult Passage.
- **Appendix B. Reports** – describing 2010 monitoring and analysis results.
- **Appendix C. Surface Water Stage and Flow** – a description of monitoring methodology and presentation of surface water stage and flow data (15-min./hourly stream gage data and periodic manual measurements).
- **Appendix D. Surface Water Quality** – a description of monitoring methodology and presentation of surface water quality data (15-min./hourly sensor data and periodic manual measurements).
- **Appendix E. Sediment** – a description of monitoring methodology and presentation of suspended sediment data, and bed mobility data.
- **Appendix F. Groundwater** – a description of monitoring methodology, groundwater levels, record of hotline calls, daily seepage evaluations, and flow bench evaluations.
- **Appendix G. Surveys** – a description of methodology and survey data.
  - Bathymetric Surveys

    - Monitoring Sections
        - Topographic Surveys
        - Sample Lines and Section Views
    - Water Surface Profiling
        - Water Surface Elevations
        - Discharge Measurements
        - Bed Profile Surveys
    - Habitat Mapping
    - Aerial Photos [placeholder, atlas development in progress]
    - Vegetation Surveys [placeholder]
- **Appendix F. Fisheries Data**– [placeholder]

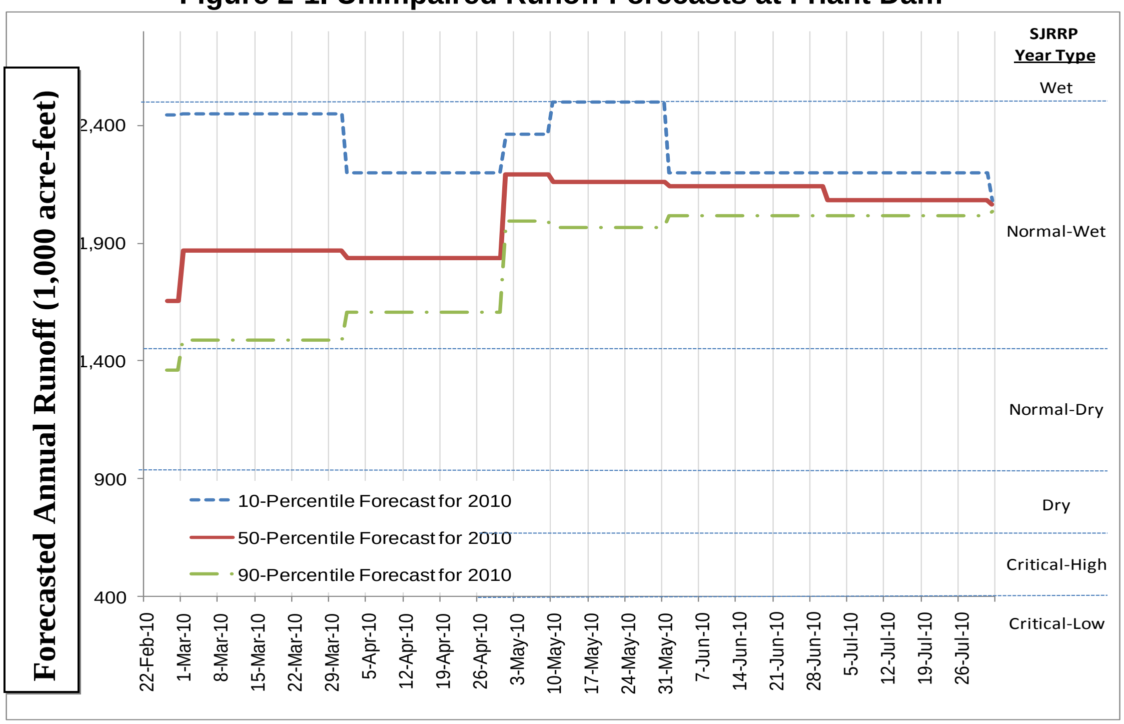
2.0 2010 Summary

The Settlement requires a period of Interim Flows prior to full Restoration Flows in order to collect relevant data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture and reuse. Results from monitoring during Interim Flows contribute to the scientific basis for San Joaquin River operations downstream of Friant Dam, and support decisions on implementation.

2.1 Allocation

The flow schedule for Interim Flows depends on the annual unimpaired runoff at Friant Dam. At the start of the restoration year on March 1, the water supply is unknown and requires forecasting. U.S. Department of the Interior, Bureau of Reclamation (Reclamation) water supply forecasts include 10 percent, 50 percent, and 90 percent exceedance estimates for total unimpaired runoff at Friant Dam. Reclamation may declare a water supply between the 50 and 90 percent probability for use in scheduling flows. The February forecast resulted in a Normal-Dry year-type, increased to a Normal-Wet year-type by March, and remained Normal-Wet through June as illustrated in **Figure 2-1**. Channel capacity constraints limit the amount of water released for the SJRRP. The final WY2010 water supply allocation for SJRRP was on June 1, 2010 for a total of 377 thousand acre-feet.

Figure 2-1. Unimpaired Runoff Forecasts at Friant Dam



2.2 Flow

SJRRP releases Interim Flows based on Settlement flow targets and consistent with SJRRP environmental documents. The SJRRP Restoration Administer (RA) issued 2010 Interim Flow Recommendations for flow release rates and durations February 1 – December 1, 2010. Before changing releases from Friant Dam, Reclamation conducted flow bench evaluations to determine if downstream constraints permitted releases according to the RA Recommendations. Constraints to 2010 Interim Flows included channel capacities, groundwater elevations, Mendota Pool water quality, and Mendota Pool water user demand. Friant Dam flow changes during 2010 Interim Flows are displayed in **Table 2-1** below.

Table 2-1 2010 Interim Flow Releases

Release Date	Friant Dam Release (cfs)	Comment
February 1	350	Begin Calendar Year 2010 Interim Flows
February 11	400	Adjusted to meet Gravelly Ford flow target due to prior riparian demands
February 26	350	Adjusted to meet Gravelly Ford flow target, due to inflows from Little Dry Creek and Cottonwood Creek
March 1	500	Adjusted to meet RA flow target
March 16	800	Adjusted to meet RA flow target
March 29	1,100	Adjusted to meet RA flow target
April 12	1,500	Adjusted to meet RA flow target
April 13	1,250	Adjusted to meet target of 700 cfs downstream of Sack Dam, and Mendota Pool Demand
April 17	1,350	Adjusted to meet target of 700 cfs downstream of Sack Dam, and Mendota Pool Demand
April 19	1,100	Adjusted because of water quality concerns in Mendota Pool
April 23	1,350	Adjusted to meet RA flow target and not to exceed 700 cfs downstream of Sack Dam
May 1	1,550	Adjusted to meet RA flow target and Mendota Pool Demand
May 28	800	Adjusted to meet RA flow

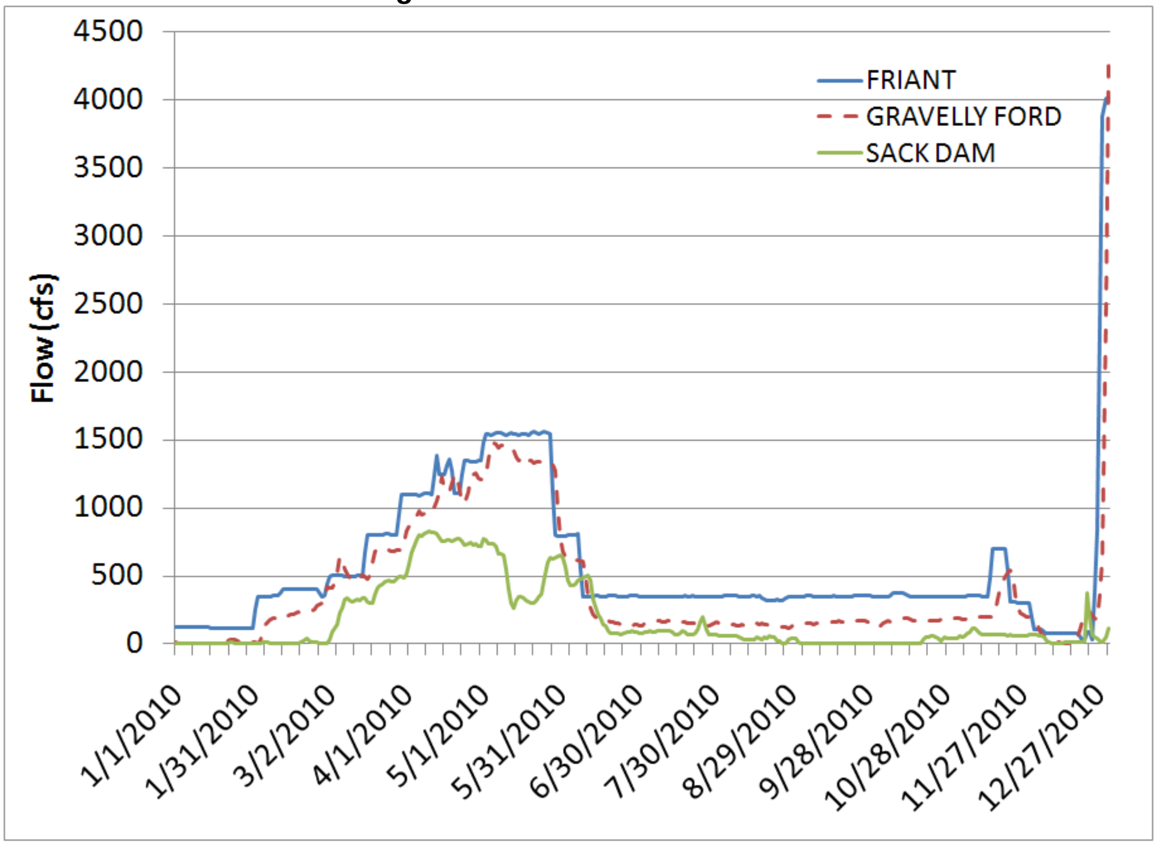
Release Date	Friant Dam Release (cfs)	Comment
		target
June 8	350	Adjusted to meet RA flow target
August 19	325	Reduced flows for Gravelly Ford compliance following a period of exceeding flow targets
August 28	350	Resumed 350 cfs releases from Friant after August 19 reduction for Gravelly Ford compliance
November 15	700	WY 2011 Fall Pulse
November 22	300	No Interim Flows released between November 22, 2010 and February 1, 2011.

During 2010 Reclamation tested releases from Friant Dam and the resulting ability to meet targets at Gravelly Ford. Downstream of San Mateo Avenue the San Joaquin River channel is again used to convey both water deliveries (from the Delta Mendota Canal) and Interim Flows. Mendota Dam is a second point of flow control in the Restoration Area and is operated by Central California Irrigation District for water deliveries to Arroyo Canal and Interim Flows targets at Sack Dam. **Figure 2-2** below displays flow records for Friant Dam, Gravelly Ford, and Sack Dam.

Shallow groundwater near the Sand Slough Control Structure on the south side of Reach 4A, as well as the adjacent north side of the Eastside Bypass, limited flows below Sack Dam because of potential impacts to downstream lands. For two weeks during May 2010, SJRRP studied surface-groundwater interactions in this key area by reducing and holding Sack Dam flow targets to 300 cfs before increasing back to the prior 700 cfs flow target. During June 2010, SJRRP responded to landowner input by limiting flows below Sack Dam to 80 cfs. **Section 2.4** below contains discussion of groundwater monitoring results.

The addition of Interim Flows to the San Joaquin River led to increased operational complexity at Mendota Pool. Recapture of a portion of Interim Flows by water users at Mendota Pool enabled Reclamation to release Interim Flows up to the full channel capacity in Reach 2 without exceeding the Sack Dam flow limits. During April 2010 operators decreased DMC deliveries to Mendota Pool to accommodate recapture of Interim Flows. Without dilution from DMC flows, water quality in Fresno Slough declined to the point where it was no longer acceptable for irrigation deliveries. Reclamation responded by reducing the Friant Dam release to 1,100 cfs while local agencies sent water through the Firebaugh Wasteway into Reach 3 to restore Fresno Slough water quality.

Figure 2-2 2010 Interim Flows



Source: QA/QC flow records
CDEC codes: Friant (Reclamation)= MIL; Gravelly Ford (Reclamation)= GRF; Sack Dam (DWR)= SDP

The SJRRP continued and expanded monitoring during spring 2010 with several stage and flow monitoring efforts. The U.S. Geological Survey (USGS), Reclamation, and the California Department of Water Resources (DWR) took manual streamflow measurements to support development of continuous flow records at stream gage sites, including the development of rating curves at the Sack Dam and Washington Road gages. Additional manual streamflow measurements were made at certain sites that do not have stream gages. Reclamation conducted water surface and bathymetric surveys in Reaches 3 – 5. DWR installed stage recorders, conducted water surface profile and cross-section surveys, and made manual streamflow measurements. Methods and data from these monitoring efforts are presented in Reports and Data Appendices.

2.3 Channel Capacity

2.3.1 Water Surface Elevation

The Department of Water Resources (DWR) continued several monitoring efforts during 2010 in support of the Channel Capacity Problem Statement. DWR conducted water surface profile surveys at an average spacing of approximately 0.5-mile in Reaches 1-3, and discharge measurements throughout the restoration reaches (refer to **Table 2-2**).

Water levels were recorded at the top and bottom of hydraulic controls, at upstream and downstream of discharge sites, and at every half foot of drop. The number, spacing and exact location of the points were prioritized based on hydraulic conditions, resources, access, and GPS coverage.

A preliminary comparison of the surveyed and computed water surface profiles based on the current 1-D HEC-RAS model indicates that the majority of significant hydraulic controls were sufficiently characterized by the survey data, and that noticeable gaps in the data do not exist. Preliminary comparisons of the survey data and current model results also indicate that additional model calibration is necessary and can now be performed in numerous locations where previous calibration data didn't exist. **Table 2-2** shows the number of discharge sites in each reach and the flows being released from Friant Dam during the discharge measurement. The eleven sites in Reach 1A included runoff from a spring storm. Additional details including the split flow measurements and duplication of D11 are in the Report 6.0 **Discharge Measurements** in **Appendix B**. Recorded flow measurements generally indicate a decrease in total discharge in the downstream direction.

Table 2-2. 2010 DWR Discharge Measurement Site Distribution

Reach	Friant Dam (cfs)	Discharge Measurements
1A	1100	11*
1B	1100	2
2A	1350	2
2B	1350	2
3	1350	5

* sites include spring storm runoff
Discharge measurements made with Acoustic Doppler Current Profiler (ADCP)
Refer to Appendix B, Section 6.0 Discharge Measurements Report

2.3.2 Water Level Recorders

Six additional water level recorders (WLRs) were installed at key locations in Reaches 1A and 1B from September 2009 through January 2010 in order to provide additional data to calibrate the hydraulic and flow-routing models (see 2009 ATR for more information). Water stage data are being collected by the recorders at 15 minute intervals and saved in the data logger from the date of installation. These data are periodically downloaded and processed for reporting.

The stage data were converted to water surface elevations using survey information and are displayed in the **Additional Water Level Recorders Report** in **Appendix B**. Generally, the water level recorder results correlated well with the water surface profile survey.

2.3.3 Effects of Sand Mobilization on Water Surface Elevation

DWR monitored scour chains and conducted bed profile surveys during five interim flow release benches from Friant Dam that ranged from 800 to 1,550 cfs. Two monitoring sites in Reach 2A (M6.5 and M10) were selected and one cross section per each site was monumented for monitoring activities.

Four scour chains at each site were installed in fall 2009 and monitored after each seasonal interim flow release. The selected sites have been visited and changes recorded after each seasonal flow release from Friant Dam since fall 2009 flows began.

During spring 2010 interim flow releases, total deposition observed ranged from 0.08 to 1.31 feet at Site M6.5 and from 0.98 to 1.96 feet at Site M10. However, there was not much local scour in the vicinity of chains at both sites. Please refer to the **Scour Chains** report in **Appendix B**.

Cross sectional and longitudinal profiles at the sites were repeatedly surveyed using a cataraft-mounted echo sounder linked to survey-grade GPS rover during the Interim Flow release benches. Each bed profile survey includes a corresponding discharge measurement using Acoustic Doppler Current Profiler (ADCP) and multiple water surface elevation measurements using an Auto Level.

Cross-section and longitudinal profiles collected at both selected sites during various flow release benches were compared and the results presented in the **Bed Profile Surveys Report** in **Appendix B** and data in **Appendix E**. General scour was not observed over the range of survey flows. Local man-made influences at the two sites make it very difficult to measure general scour.

2.3.4 Sand Storage Assessment

DWR conducted a sand storage assessment by locating primary supply sand storage, and performing topographic surveys of four in-channel pits (refer to **Appendix B**, report 10.0 **Sand Storage in Reach 1** and **Attachment 1: Evaluation of Sand Supply, Storage, and Transport in Reaches 1A and 1B**.

Reach 1, from Friant Dam to Hwy 145, was visited three times, once in November 2009 (700cfs), a second time in March 2010 (600cfs) and a third time in July 2010 (350cfs). The field visits were done by boat. During the visits, numerous sand sources were identified. Pictures were taken of the sources and depths were measured with a 10-foot long piece of quarter inch rebar. At some sites, sand samples were gathered for later processing to determine gradations.

Four gravel mining pits were selected as having the potential to inhibit sand transport and were surveyed in April 2010 and again in June 2010. From April 2010 to June 2010 Reach 1 experienced at least 30 days of 1600cfs flows. Sand deposition was calculated through comparison of April and June surveys in the four pits.

2.3.5 Monitoring Cross-Section Re-surveys

In July 2009, DWR conducted monitoring cross-section surveys at 12 sites in Reach 1B and Reach 2A. Monitoring included performing a topographic survey patch that was as wide as the river from levee to levee and about 75 feet long, and collecting at least one sand bed sample at each site. In January 2010, those 12 sites were re-surveyed and three additional sites (one being in Reach 2B) were added. In October 2010, the 15 sites were re-surveyed for a second time.

DWR calculated net scour or deposition at each location by comparing surfaces generated from the topography surveys. From the surfaces, we were able to calculate volume changes. From July 2009 to January 2010, seven sites showed net deposition, and five sites showed a net scour. The largest scour was at M6 with a cut of 197 cubic yards. The largest deposition was at M8 with a fill of 524 cubic yards. From January 2010 to October 2010, six sites showed a net deposition and nine sites showed a net scour. The largest deposition was at M9 with a fill of 1,123 cubic yards. The largest scour was at M2 with a cut of 637 cubic yards. Please refer to the **Topographic Surveys Report**.

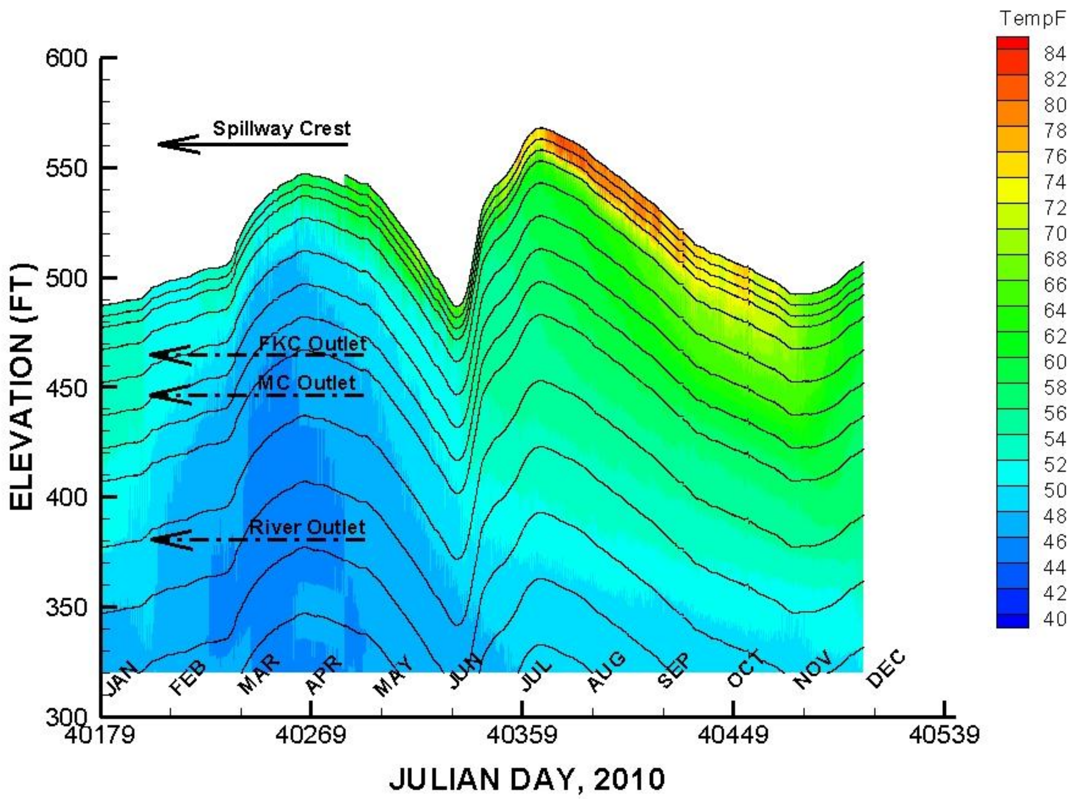
2.3.6 Bed Material Sampling

DWR collected bed material samples in January and October 2010 during topographic surveys (see above). The results were compared with earlier samples and presented in the **Bed Sampling Report**. The comparison showed that some sites exhibited significant changes in material size while others showed slight or no change. No general patterns in change of material size were observed between each seasonal interim flow release.

2.4 Temperature

Reclamation collected temperature data at several Millerton Lake locations during 2010. **Figure 2-3** below displays 2010 temperature profile results from the monitoring string deployed upstream from Friant Dam. The Friant Dam release temperature to the San Joaquin River varied from 45-55°F during 2010. The **Millerton Lake Temperature Monitoring Report 2005-2010** in **Appendix B** provides an update on temperature string results, and the **Temperature Monitoring Atlas** attached to **Appendix D** includes results from this study.

Figure 2-3. 2010 Friant Dam Forebay Temperature Profiles

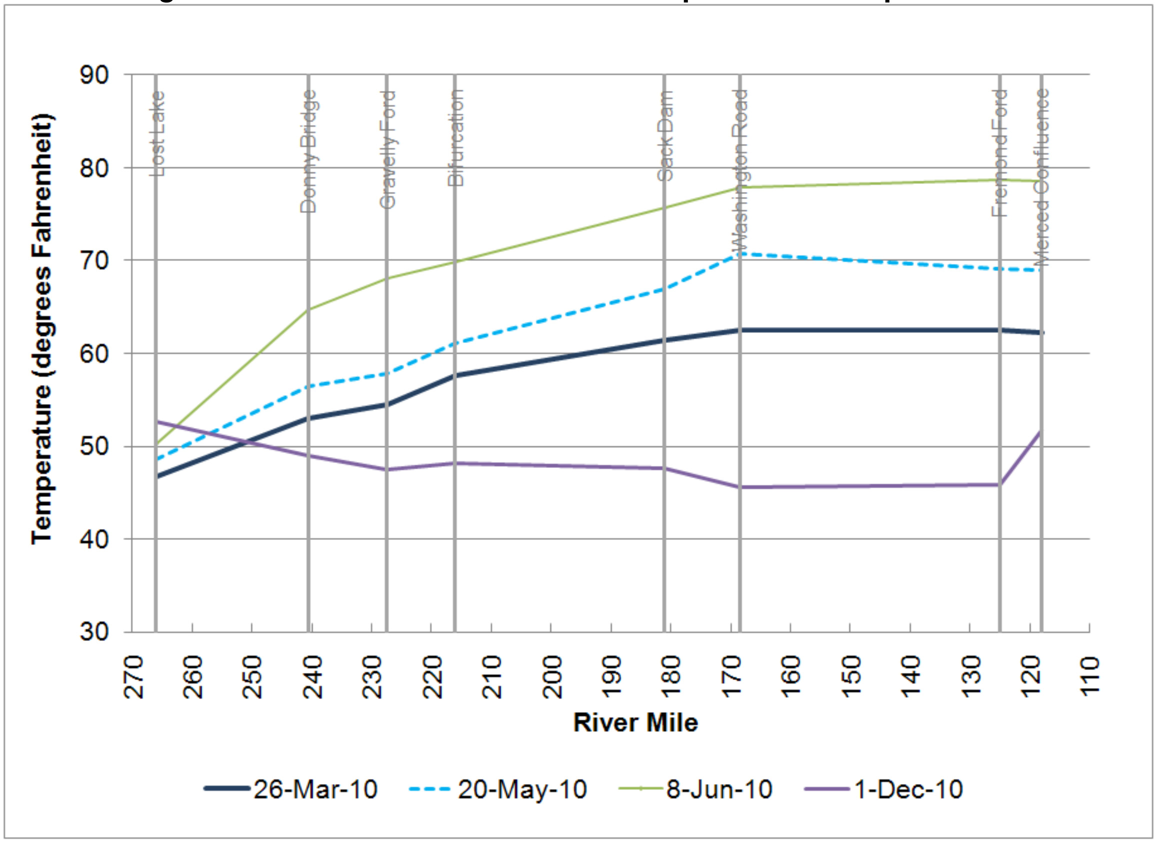


Temperature profile results indicate a relationship between high flow years (2005, 2006, 2010 Interim Flows) and the hypolimnetic temperatures in Millerton Reservoir. When flood releases are made through the river outlets (El. 380 ft) the coldest water is released and it is replaced by SJR inflows to Millerton Reservoir. During 2010 Interim Flow releases the river outlet releases temperature exceeded 50 deg F on June 8.

Water Year 2010 was a Normal-Wet year type with late spring rains, an above-average and persistent snow pack, and low air temperatures. **Figure 2-4** displays San Joaquin River temperatures for key time periods during 2010.

The California Department of Fish and Game (CDFG) continued to manage a network of temperature sensors in Reaches 1 – 5 during 2010 Interim Flows to support fisheries studies. Please refer to the **Temperature Monitoring Atlas** attached to **Appendix D**.

Figure 2-4. 2010 Interim Flows San Joaquin River Temperatures



Temperature monitoring allows SJRRP to improve understanding of factors that influence river temperatures, including Friant Dam release temperature and rate, and ambient air temperature. Refer to **Appendix D** for spring 2010 air temperature data near Firebaugh. On May 28 when Interim Flows reduced from 1,550 cfs to 800 cfs at Friant Dam, the river temperature at Gravelly Ford was below 60 degrees. During the following 10 days, the Friant Dam release temperature reached approximately 50°F, but river temperature at Gravelly Ford reached nearly 70°F. River temperature at Gravelly Ford continued to climb with and follow ambient air temperature in excess of 80°F during summer flows (350 cfs) while the Friant Dam release temperature increased to approximately 55°F.

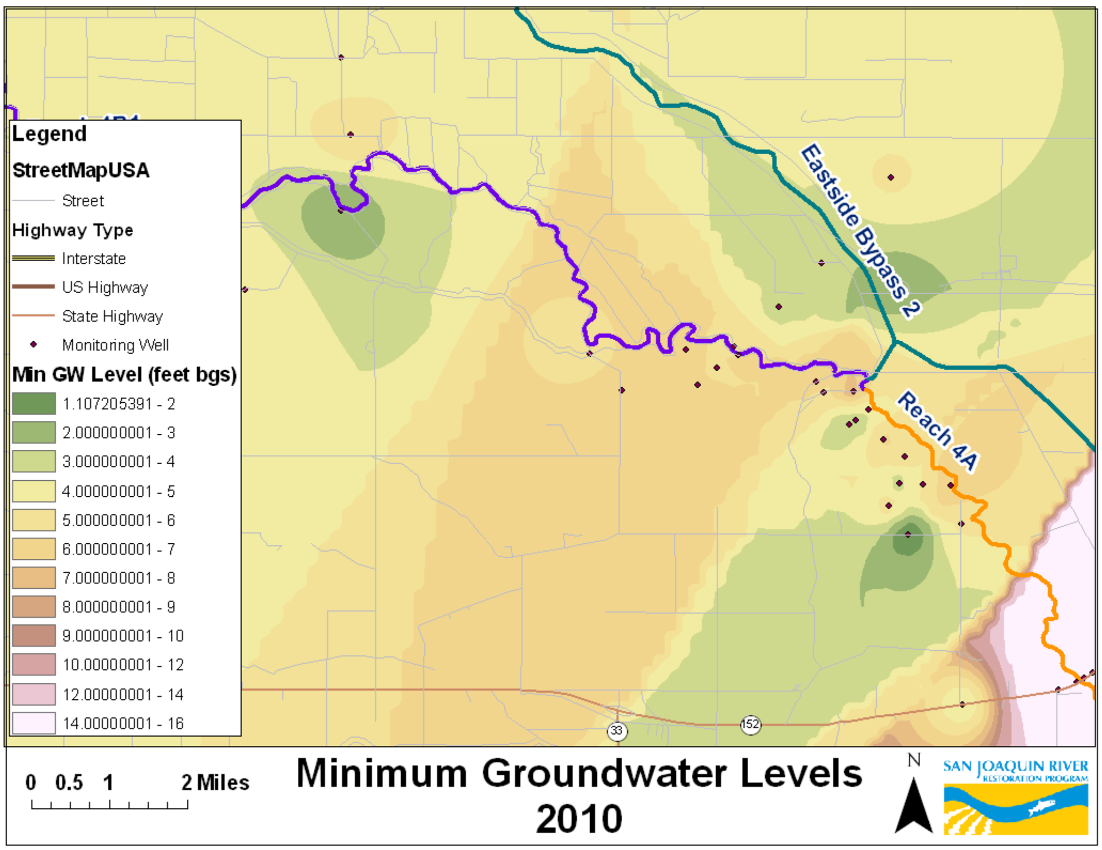
2.5 Seepage

SJRRP continued to implement the Seepage Monitoring and Management Plan to reduce or avoid material adverse seepage impacts during 2010. Reclamation expanded the monitoring well network to 123 wells and collaborated with Central California Irrigation District to produce a single atlas that reports groundwater levels for 245 wells (refer to the **Monitoring Well Atlas**). SJRRP monitors key wells weekly and conducts daily evaluations when flows exceed 475 cfs in Reaches 2A and 3 to make sure groundwater levels do not exceed thresholds designed to prevent encroachment into crop root zones. A Seepage Hotline allows landowners to provide input in real-time to supplement information from the monitoring well network. Hotline calls prompt a site visit to inform flow management decisions.

Approximately 50 soil salinity surveys conducted during spring 2010 established baseline salinity levels and improved understanding of the influence of Interim Flows on soil salinity levels. The availability of soil salinity data is pending a complete analysis.

Seepage management includes identification of projects to address seepage issues which constrain Interim and Restoration Flow releases. During 2010 SJRRP began evaluating a site near River Mile 170 for factors that could influence groundwater levels and crop yields. **Figure 2-5** displays minimum groundwater depths near Reach 4A. **Appendix F** includes a compilation of seepage data, including a monitoring well atlas, a record of hotline calls, daily seepage evaluations, and flow bench evaluations.

Figure 2-5. 2010 Minimum Depth to Groundwater near Reach 4A



2.6 Water Quality

The water quality monitoring program for the 2010 SJRRP Interim Flows included 16 real-time monitoring stations and seven sites where water samples are measured monthly for total suspended solids, nutrients, total and dissolved carbon, bacteria, trace elements, and pesticides based on recommendations by the Regional Water Quality Control Board

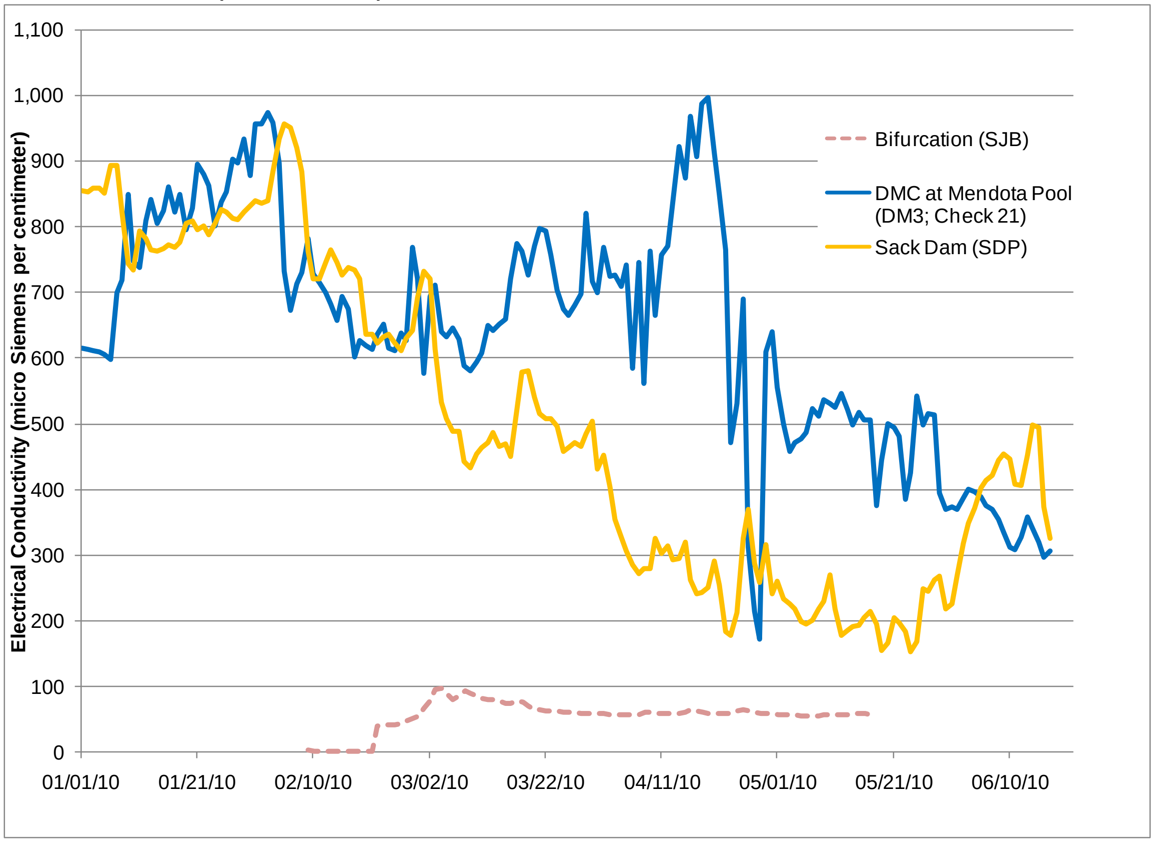
(RWQCB) and the SJRRP FMWG. **Appendix D** provides a complete list of parameters, constituents, and results for 2010.

Figure 2-6 illustrates measurements of electrical conductivity (EC) measured during the spring 2010 Interim Flows. The California Data Exchange (CDEC) electrical conductivity sensor at stream gage DM3 recorded a spike in Mendota Pool salinity because of the introduction of Sacramento-San Joaquin Delta (Delta) water from the Delta-Mendota Canal (DMC) that has higher salinity water than Friant Dam. From April 22 through 28, recaptured SJRRP flows and low irrigation demands at Mendota Pool reduced Delta deliveries. Seepage drainage water returned to the DMC resulted in EC levels that would not permit the Mendota Pool pump-in program. The water delivered to the Mendota Pool from the DMC did not thoroughly mix with low-salinity releases from Friant Dam and resulted in higher salinity water in Fresno Slough and the irrigation canal headworks, than desired by irrigators. Reclamation, the San Luis and Delta-Mendota Water Authority, and the San Joaquin River Exchange Contractors Water Authority adjusted operations to close the DMC at Check 21, meet Arroyo Canal demands through the Firebaugh Wasteway, and dilute high salinity in Mendota Pool/Fresno Slough with low-salinity San Joaquin River water. Reclamation met demands at Mendota Pool with deliveries from Friant Dam. Water quality monitoring included telemetered EC readings and grab samples, as reported in **Appendix D**.

FMWG developed the **Water Quality and Fish Report** as an assessment of SJRRP water quality monitoring in terms of sampling frequency, sampling locations, sampling methods, and detection levels. This review interprets water quality monitoring results for possible effects to Chinook salmon and other fish native to the San Joaquin River. Some notable findings and recommendations thus far include:

- Bifenthrin in sediment samples at concentrations with potential to cause mortality in certain organisms and transfer up the food web via bioaccumulation.
- A total of 42 water quality samples with copper exceeding the EPA aquatic-life chronic benchmark for invertebrates, and 30 samples exceeding the acute benchmark for invertebrates.
- Storm inflow monitoring could potentially reveal toxic concentrations from surface runoff.
- Tissue samples or semi-permeable membranes could help address uncertainty regarding bioaccumulation and food web transfer.
- Some laboratory detection limits are above concentrations of sub-lethal effects (parts per trillion range), which have been shown to affect growth, swimming behavior, reproduction, and immune system response in aquatic fish and invertebrates.

Figure 2-6. Electrical Conductivity of Surface Water at the Chowchilla Bifurcation station, Sack Dam, and the Delta Mendota Canal at Mendota Pool

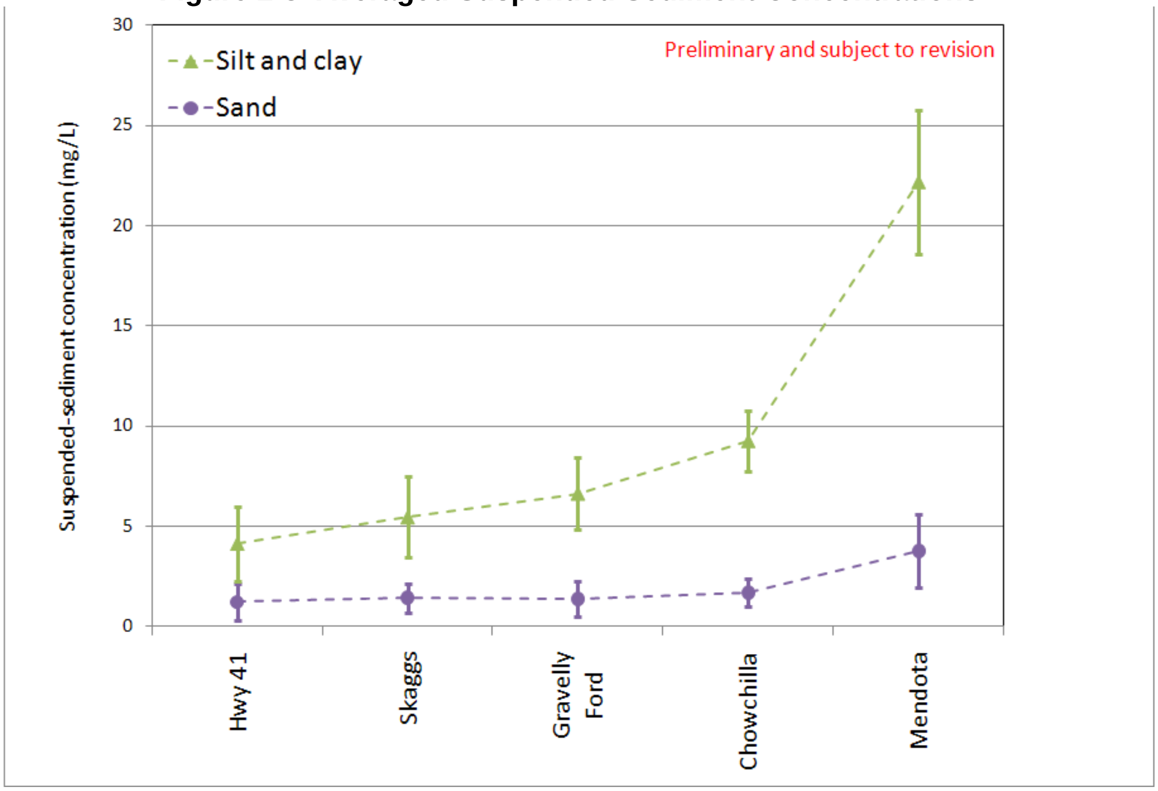


2.7 Sediment

SJRRP collected sediment data for channel capacity and fisheries studies. Please refer to ATR **Section 2.3** for a summary of the California Department and Water Resources sediment monitoring. During March-May 2010 USGS collected suspended sediment, bedload, and discharge data eight times at five locations: Highway 41, Skaggs Bridge, Gravelly Ford, Chowchilla Bifurcation Structure, and below Mendota Dam. Friant Dam releases ranged from 500 to 1,550 cfs during sediment sampling (refer to **Appendix C**).

At upstream sites, suspended-sediment concentrations were low (<10 mg/L) and as flow increased, suspended-sediment concentration decreased, which indicates a sediment supply limitation. At lower sites, suspended-sediment concentrations increased or were nearly constant with flow; thus, sediment supply appears to increase with distance downstream from Friant Dam, as expected. Increasing sediment supply led to increasing suspended-sediment concentrations, for both silt/clay and sand fractions, in the downstream direction (refer to **Figure 2-8**).

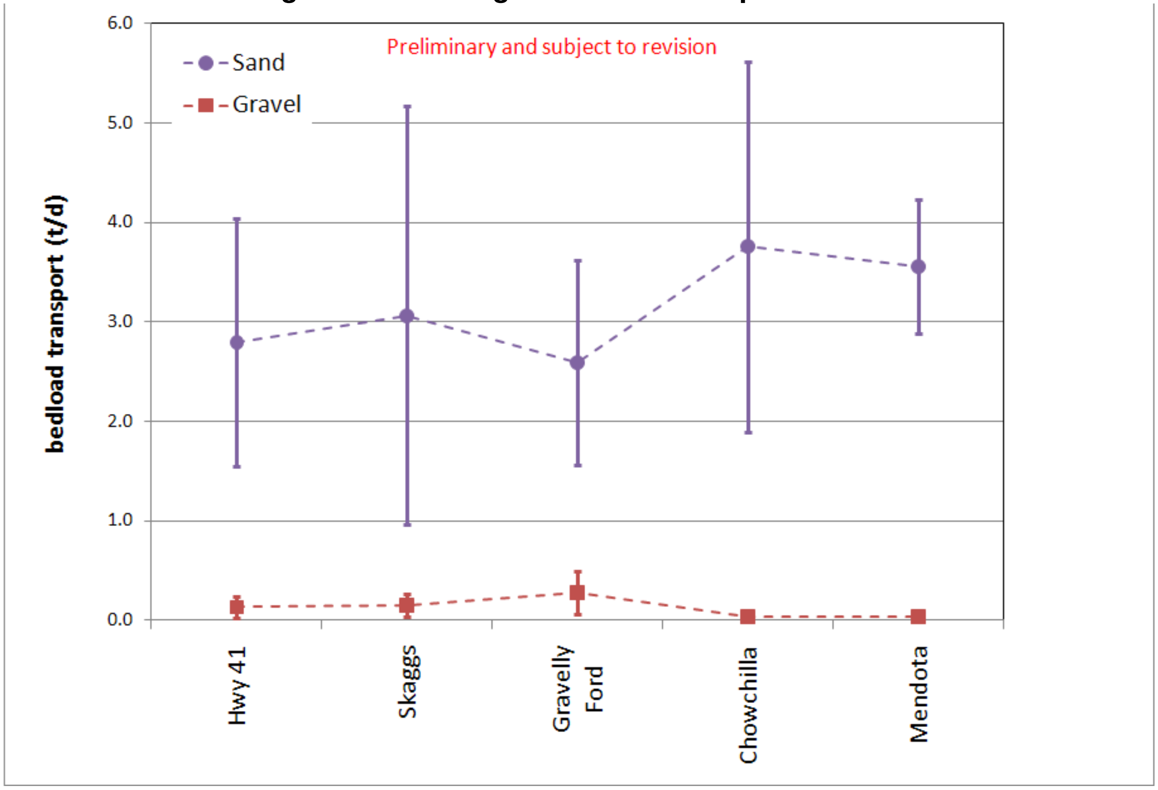
Figure 2-8. Averaged Suspended Sediment Concentrations[1]



1. Suspended sediment concentrations averaged over the entire period at the USGS sampling sites. Vertical bars denote ± one standard deviation in the measurements at each site (i.e. they are not error bars but rather represent the range in concentration measured at each site).

Bedload measurements also suggest that sediment supply increases downstream, though the trends are not as clear as for suspended sediment. Average bedload transport rates increased downstream for sand; whereas gravel bedload transport rates were small at all sites indicating that flows were not high enough to entrain very much gravel (refer to **Figure 2-9**). The median grain size of bedload decreased from about 0.7 mm at Hwy 41 to about 0.4 mm at Mendota, again indicating that the supply of fine sand increases downstream with distance away from Friant Dam.

Figure 2-9. Average Bedload Transport Rates[1]



1. Bedload transport rates averaged over the entire period at the USGS sampling sites. Vertical bars denote ± one standard deviation in the measurements at each site (i.e. they are not error bars but rather represent the range in concentration measured at each site).

SJRRP continues to collect data in order to manage channel capacity through development of an annual sediment hydrograph for the Restoration Area. Next steps for this effort include regular monitoring at the five established locations, addition of a bed material component as part of the regular monitoring, and investigation of sediment contributions from tributaries in Reach 1A to the San Joaquin River.

2.8 Aerials Analysis and Inundation Modeling

SJRRP conducted five aerial flights during 2010 Interim Flows to collect 2-foot color-infrared imagery of the Restoration Area. The flights acquired information for vegetation mapping during phenological periods optimal for species identification, and information for fisheries habitat studies at different flow rates (see **Table 2-3**).

Table 2-3. San Joaquin River Flows (cfs) on Aerial Flight Dates

Flight	Date	Friant Dam	Donny Bridge	Skaggs Bridge	Gravelly Ford	Bifurcation	Sack Dam	Washington Road
1	3/22/2010	804	760	735	707	495	426	(no data)
2	4/7/2010	1,100	1,056	1,003	952	805	789	693
3	4/24/2010	1,352	1,144	1,223	1,035	950	730	700
4	5/6/2010	1,552	1,463	1,365	1,468	1,271	724	798
5	6/25/2010	351	241	224	135	76	78	42

Key
cfs = cubic feet per second

Analysis of 2010 aerial imagery to produce waterlines provides contiguous inundated area estimates for assessment of current San Joaquin River fisheries habitat conditions (refer to **Table 2-4**).

Table 2-4. San Joaquin River Preliminary Contiguous Inundated Acres from Aerial Imagery

Flight	Date	Friant Dam (cfs)	Reach 1A	Reach 1B	Reach 2A	Reach 2B	Reach 3	Reach 4A	Reach 4B1	Eastside Bypass 2	Eastside Bypass 3	Mariposa Bypass	Reach 5
1	3/22/2010	804	514	269	319	312	320	232	81	366	120	4	386
2	4/7/2010	1,100	Analysis in progress.										
3	4/24/2010	1,352											
4	5/6/2010	1,552											
5	6/25/2010	351											

Vegetation maps produced from this imagery will include elderberry (*Sambucus sp.*) to establish a baseline for future consultation with the U.S. Fish and Wildlife Service (USFWS); the presence of five invasive species, including giant reed (*Arundo donax*), sponge plant (*Limnobium spongia*), Chinese tallow (*Sapium sebiferum*), red sesbania (*Sesbania punicea*), salt cedar (*Tamarix sp.)* with potential to compromise successful implementation of SJRRP; and a base vegetation-type map of the Restoration Area.

Analysis of one-dimensional HEC-RAS inundation modeling results is in progress. Complete results from the aerial imagery will allow for further validation of modeled results.

2.9 Fisheries

The Fisheries Management Plan describes life-history strategies and requirements within each stage for both spring and fall-run Chinook salmon. **Attachment 1** displays life stages, life stage outcomes, and existing and future SJRRP monitoring to address fisheries problem statements.

2.9.1 Spawning Environment (in the Hyporheic Zone)

Invertebrates that might impact salmon eggs or alevins were not detected in gravels sampled with hyporheic pots. Dissolved oxygen concentrations at various possible redd locations measured at the 30 cm depth indicated that seven out of nine potential redd sites experienced at least one DO reading below 8 mg/L (criterion for protection of early life stages) with most (six of nine) below 6 mg/L. Percent sand (2 mm particle size) collected from hyporheic samplers averaged 4.76 % in September 2010 and 6.68 % in December 2010, and was less than the 13% above which negative impacts may occur. Predicted Chinook salmon emergence success from a regression using gravel sizes from collected samples averaged 46%. Early results indicate that there are a few redd sites suitable for egg and alevin survival in this section of the San Joaquin River. It also appears that intragravel DO may be a limiting factor in this portion of the river.

2.9.2 Hills Ferry Barrier Evaluation

Hills Ferry Barrier is designed to inhibit passage of migrating adult, fall-run Chinook salmon into the currently unsuitable habitat of the San Joaquin River upstream of the San Joaquin-Merced River confluence. The Hills Ferry Barrier is a hybrid Alaskan-Sliding Pipe weir design used to exclude and/or trap large migrating fish from swimming upstream while allowing water and other smaller species to pass. The soft, sandy river substrate was observed to erode around the support structures and base of the conduit bars, resulting in scouring holes underneath the barrier footings and along the shoreline.

The evaluation included surveys under high turbidities with a DIDSON acoustic camera to locate and observe scouring, missing pickets, and gaps in the barrier. The near-video quality images of the DIDSON allow detailed underwater inspections of the barrier and substrate; however the angle of the weir and the surface reflection posed some difficulties on the downstream side of the barrier. Carp, catfish, striped bass, threadfin shad, and Chinook salmon were identified, especially on the downstream side were the barrier was inhibiting their movement up-river or providing structure. Chinook salmon and carp were observed to move along the barrier looking for holes in the barrier and passage opportunity. The DIDSON provided an interesting observation of an unidentifiable species (most likely a carp), using its body to attempt to burrow under the conduit pickets in the substrate at the barrier’s base, accelerating the erosion process.

Sonic telemetry was employed to monitor adult Chinook salmon behavior, primarily on the downstream side of the Hills Ferry Barrier to assist in determining the effectiveness of the barrier at inhibiting passage and movement patterns in the proximity of the Hills Ferry Barrier and San Joaquin-Merced River Confluence. In addition, fish at Sack Dam, Mendota Pool, and the base of Friant Dam were caught and esophageally implanted with sonic tags. The fish trap at Hills Ferry Barrier proved to be ineffective at catching Chinook salmon but did capture carp and catfish. The trap captured only two salmon during the study duration which were immediately released without a sonic tag due to fish condition and logistical restrictions. In November 2010, two male Chinook were captured upstream of the barrier that had apparently bypassed the barrier during cleaning (excessive water hyacinth loads and vegetative debris become lodged against the sliding pipes and require their removal for a short period to allow the plant matter to travel downstream), through scour holes at the base, or barrier gaps along the shore, and traveled upstream. These fish were netted while swimming along the upstream side of the barrier looking for passage back downstream, tagged with a sonic transmitter, and released downstream of the barrier. Fish were tracked with five pre-positioned receivers placed at strategic locations and a hand-held mobile receiver to provide details on local movements. These two fish were detected only on receivers below the weir and confluence and did not re-ascend the San Joaquin or the Merced Rivers.

Fishermen and San Luis Canal Company (SLCC) staff alerted Reclamation and Department of Fish and Game (CDFG) staff to approximately four fish below Sack Dam where one female was later tagged with a sonic transmitter and released upstream of the dam. This fish was later tracked downstream of Mendota Pool. CDFG biologists, along with the San Luis Canal Company (SLCC) staff, reconfigured the stop logs in the Sack Dam fish ladder to allow passage of other fish that had made it past the Hills Ferry Barrier. Biologists from Implementing Agencies collaborated in trap and haul operations to relocate salmon from several locations. Biologists later observed several salmon (~12) below the base of Mendota Dam and CDFG sonically tagged a few females and released them into Mendota Pool. Two other males were captured in an irrigation canal, tagged, and transported to the base of Friant Dam and released. Fish observed on the upstream side of the barrier, below Sack and Mendota Dams, and in irrigation canals successfully bypassed Hills Ferry Barrier. Erosion of the unstable substrate will remain a problem until the temporary barrier is redesigned with significant changes to restrict salmon passage.

2.9.3 Fish Passage Evaluation

The Department of Water Resources (DWR) conducted Fish Passage Evaluations along the San Joaquin River and flood bypasses from Friant Dam to the Merced River confluence to identify passage impediments to migration of juvenile and adult salmon and other native fish. Initial assessments (First Pass) in July and August 2010 of structures included identification of potential fish passage impediments, field evaluations of these structures, and development of passage criteria. Each structure is rated as a barrier, not a barrier, or an impediment to fish passage. 45 of 68 potential barriers were surveyed. Structures along the Chowchilla Bypass and upper Eastside Bypass were not surveyed.

First Pass surveys included measurement of the structure length, outlet drop, slope, elevation of the tailwater control relative to structure inlet, outlet, pool invert, ratio of structure width to channel width, and channel substrate continuity over or through the structure. Fish Passage Inventory Data collected at all locations included a description of the type and condition of each structure, structure dimensions, stream habitat, GPS waypoints, a site sketch, and photographs.

Stream crossing evaluations relied on criteria developed by the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service (NMFS). These criteria were generally based on the flow velocities within the structure, jump height to enter a structure, drop distance at the exit of a structure, and pool depths upstream and downstream of a structure. The initial evaluation of each structure categorizes each structure as Green/Gray/Red as it relates to fish passage:

- Green – The location is assumed adequate for passage of all salmonid species throughout all salmonid life stages and stream flows.

- Gray – The location may not be adequate for all salmonid species at all their life stages and stream flows. More information is needed to evaluate the structure.
- Red – The location will likely fail to meet CDFG and NMFS passage criteria at all flows for strongest swimming species presumed present.

Further fish passage evaluation (Second Pass) of Gray sites will include topographic surveys and hydraulic modeling. Red sites require no additional analysis and will be placed onto the list of structures to be removed or modified. Cumulative effects of each structure on fish migration were not evaluated during this study. The First Pass identified 28 structures as Green, 13 structures as Gray, and 8 structures as Red. The First Pass data collection and fish passage assessments are included in a draft Technical Memorandum currently in review.

2.9.4 Habitat Mapping

The Department of Fish and Game completed habitat mapping in Reaches 1B, 2, and 4A. Please refer to **Appendix G**.

2.9.5 Reach 1A Bed Mobility

This study includes several measurement components to assess the ability of flows to mobilize the stream bed in Reach 1A, targeting anticipated Chinook salmon spawning areas. At two sites monitoring of the bed provides information that will assist in calibrating and validating a model to predict Reach 1A flow and sediment transport conditions. At each site 5 cross-sections were monumented for monitoring over time. The individual measurement components of this task include channel topography, bed material sampling, bed photography, gravel tracer, force gauge, and flow profiling surveys. All of these components were measured at both study sites and all but one was used at each site’s 5 cross-sections. Force gauge surveys were not performed along the downstream most cross-section at either site.

There is measureable variability in the ability of the bed to become mobilized between the two sites, between cross-sections, and along cross-sections. Tracer results demonstrate that mobility occurs at 700 cfs flows at one site while at the same flow levels the other site remains immobile. Tracer movement during 700 cfs flows suggests mobility is limited to portions of the channel close to the thalweg within the riffle and absent in the upstream pool/glide tail and downstream pool head. During the monitoring period a 1,700 cfs flow occurred. Survey results suggest that approximately 20% more tracers were mobilized as compared to the 700 cfs flow. Comparing travel distance measurements between the two flow levels are inconclusive due to difficulty in deciphering between cumulative distances versus event specific distances.

Channel alteration was observed to result from the 1,700 cfs flow. Measurements recorded bed scour by as much as 1.5 ft, deposition by as much as 1 ft, and at least 6 ft of bank erosion. The same flow induced erosion of bank material and drift of large woody debris into the channel. The result of which was a local addition of approximately 4,000 ft^3 of sand, gravel, and cobble sediment to the channel. Future monitoring efforts will investigate (1) the role of the sediment supplied to alter local bed mobility as well as (2) trends in channel geometry. The consequences of these will be applied to predict flow variables such as velocity and depth and proactively assess their impact to aquatic habitat needs.

3.0 Monitoring Network

The monitoring network for the SJRRP was developed to address problem statements presented in Appendix A, and to refine or strengthen conceptual models and assumptions. The monitoring network shown in Figure 3-1 includes sites currently monitored. The number of sites currently monitored, are presented by physical parameter in Table 3-1. The locations included in bathymetric, water surface profile, and cross section surveys are shown in figures presented in Appendices D and F. Additional information regarding the locations for aerial and biological surveys is not currently available.

Appendices B through F describe the monitoring methodology used for each of the physical parameters that were monitored and surveys that were conducted during the spring 2010 Interim Flows.

Table 3-1. Number of Monitoring Locations by Reach

Reach	Flow and Stage	Groundwater Levels and Temperature	Surface Water Temperature	Surface Water Quality	Sediment
1A	6	4	20	3	3
1B	2	11	3	1	1
2A	5	20	4	2	13
2B	2	10	3	1	1
3	1	13	4	2	1
4A	1	21	5	2	2
4B1	2	15	2	1	0
4B2	0	0	3		0
5	3	4	7	4	1
Bypasses	1	0	11	0	2
Tributaries				3	

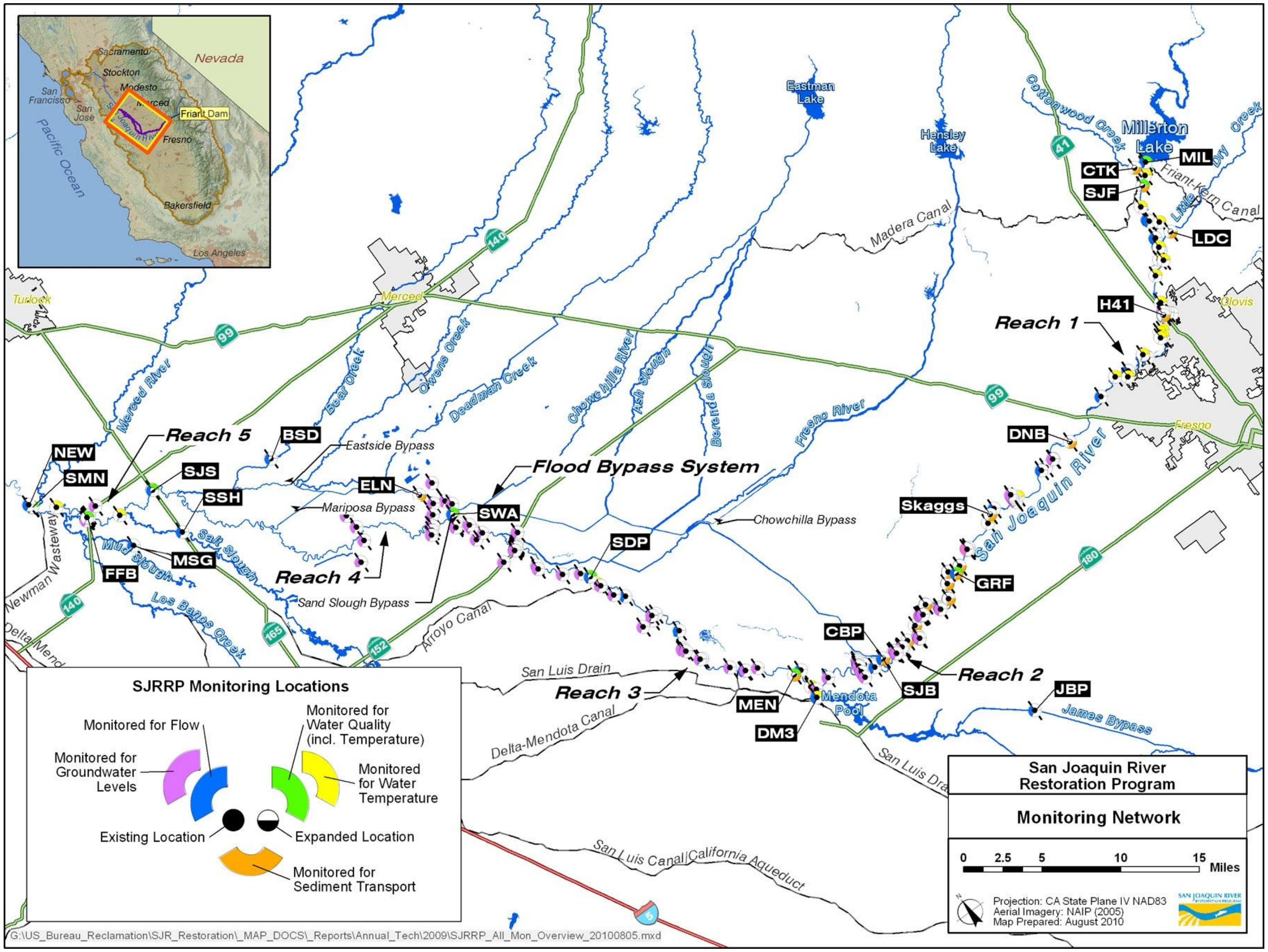


Figure 3-1. Monitoring Locations in Reaches 1 Through 5

4.0 Models and Analytical Tools

Modeling provides a numerical representation of conceptual models to assist in understanding and predicting conditions that may help formulate operations as well as other studies and plans. Improving models of the physical conditions in and around the San Joaquin River may support in resolving problem statements identified in **Appendix A**.

Table 4-1. Analytical Tools for SJRRP

Model	Type	Purpose	Status	Model Application
HEC-RAS	Hydraulic (1D)	Water surface (Inundation mapping)		Terrain updates
SRH-2D	Hydraulic	Depth/velocity/habitat mapping		
SRH-2D	Sediment	Transport/habitat mapping		
SRH-2D	Temperature	Habitat mapping		
SRH-1D	1D mobile boundary sediment	Transport		Update based on new terrain data.
HEC-5Q	1D hydraulic routing, temperature	San Joaquin River temperature		Validation using 2010 monitoring data. Modeling for proposed hydrographs to aid flow scheduling.
CE-QUAL-W2	Temperature (vertical 2D)	Millerton cold water pool	Complete	
SRH-1DV	Cross section vegetation	Vegetation response to flow and sediment conditions		Support for design work on Reach 2B and Reach 4B site-specific projects
CVHM	Groundwater	Groundwater flow	CVHM has 1-mile-square grids for Central Valley	Preliminary simulations related to Reach 2B proposed alignments right now, using current version and input from HEC-RAS model
EDT	Fisheries	Population response to habitat conditions	Under development	

5.0 Conclusions

2010 was a Normal-Wet year which provided an opportunity to release Interim Flows to collect monitoring data, begin analysis efforts, and develop some conclusions. During this first year of Interim Flows SJRRP gained insight into operation of Friant Dam to achieve downstream flow targets. Friant Dam was operated responsive to seepage constraints, Mendota Pool demand, and water quality near Mendota Pool. Flow benches of approximately 14 days appeared to allow sufficient time for conditions in the Restoration Area to stabilize.

During fall 2009, water quality monitoring resulted in non-detection or concentrations below maximum contaminant levels for all parameters of concern to the SWRCB and SJRRP. The current water quality monitoring program is based on the 2009-2013 Water Quality Monitoring Plan, which may be refined to adjust frequency of measurements or adjust the number of required monitoring sites with input from SWRCB and FMWG.

Results from stream gage temperature monitoring indicate that ambient air temperature is an important factor influencing river temperature downstream to the Merced River confluence. Further study may be required to support this conclusion and to study the temperature influences on upstream San Joaquin River temperatures.

2010 monitoring identified several areas of shallow groundwater near the river. Analysis to understand the factors affecting shallow groundwater near the river will continue. Thresholds may be refined based on lateral groundwater gradients below fields. Data collected during 2010 may be used to calibrate models.

Analysis of data collected by the 2010 Interim Flows monitoring network is ongoing and results will continue to appear in future reports.

6.0 References

Central Valley Operations Office (CVOO). 2010. 2009 Reservoir Operations Reports. Available at < http://www.usbr.gov/mp/cvo/rpt_09.html>.

San Joaquin River Restoration Program (SJRRP). 2009a. Draft Fisheries Management Plan: A Framework for Adaptive Management in the San Joaquin River Restoration Program. Available at <http://restoresjr.net/>.

San Joaquin River Restoration Program (SJRRP). 2009b. Draft Seepage Management Plan.

San Joaquin River Restoration Program (SJRRP). 2011. Restoration Flow Guidelines.