

**Draft Summary Recommendations of the
San Joaquin River Water Quality Management Group for Meeting the Water
Quality Objectives for Salinity Measured at Vernalis and Dissolved Oxygen in the
Stockton Deep Water Ship Channel**

1. Introduction

The purpose of this paper is to summarize the work of the San Joaquin River Water Quality Management Group during the period from May, 2004 to January, 2005. The ideas, information and concepts contained in this paper will be used to assist policy makers in deciding what actions will be implemented strategies to meet water quality objectives in the San Joaquin River, specifically salinity at Vernalis and dissolved oxygen in the Stockton Deep Water Ship Channel. Once agreement among policymakers has been reached regarding what action(s) will be then taken to meet the objectives it is anticipated that an agreement and appropriate environmental review will occur. relative to the recommendations herein, a final report of the Group will be prepared detailing its investigations supporting these recommendations.

2. Objectives of the San River Water Quality Management Group

The Lower San Joaquin River (LSJR) is listed on the Federal Clean Water Act's 303(d) list of water quality impaired water bodies for salinity and boron. The Stockton Deep Water Ship Channel portion of the LSJR is on the list for depressed dissolved oxygen (DO). The 303(d) listings require the development of Total Maximum Daily Load targets (TMDLs) to provide a basis to regulate discharges of salinity and boron and oxygen demanding substances. The Regional Water Quality Control Board, Central Valley Region (RWQCB) has been developing TMDLs for both salinity and boron and dissolved oxygen.¹ The RWQCB has adopted a TMDL and amendments to Water Quality Control Plan implementing the TMDL for Salinity and Boron. A TMDL has been adopted for Dissolved Oxygen and Basin Plan amendments are scheduled for a January 2005 hearing.

As discussed in the TMDLs and adopted and proposed amendments to the Water Quality Control Plan, the water quality problems of the LSJR are complex. Due to the highly modified nature of the San Joaquin River solutions to both salinity/boron and DO are not readily available through approaching the problem through a load reduction strategy alone. Additionally, the RWQCB cannot regulate flow and thus its ability to effect solutions is limited to load-based solutions. Flow regulation is the domain of the State Water Resources Control Board.

The San Joaquin River Water Quality Management group is an informal group of stakeholders coming together to develop cooperative solutions to achieve the water quality objectives targeted by the TMDLs.² Participants within the Group can affect

¹ See the RWQCB's website at http://www.swrcb.ca.gov/~RWQCB_Central_Valley_Region5/programs/tmdl for TMDL documents.

² Participants in the Group include: •U.S. Bureau of Reclamation Department of Water Resources•Central California Irrigation District•Friant WaterUsers Authority•Grassland Water District•James Irrigation District•Merced Irrigation

water quality in the River with tools and strategies beyond the RWQCB's authorities in a TMDL.

The water quality objectives this Plan intends to address are shown in Table 1.

Table 1 Water Quality Objectives Addressed by the San Joaquin River Water Quality Management Plan	
Salinity and Boron : San Joaquin River at Airport Way Bridge, Vernalis, CA	Maximum <u>30 day running average</u> of Electrical Conductivity (EC) (<i>mmhos/cm</i>), All water year types: April-August 0.7 EC Sept.-March 1.0 EC
Dissolved Oxygen: San Joaquin River between Turner Cut and Stockton	Minimum DO (mg/l), all water years types, 6.0 mg/l September-November, 5.0 mg/l December- August

Simply stated, the primary objective of the Group is to:

Prepare an alternative plan to the TMDLs for Salt/Boron and Dissolved Oxygen that meet the water quality objectives in coordination with CALFED Stage I objectives³

3. Secondary Objectives of the San Joaquin River Water Quality Management Group:

Recognizing the interconnected nature of water quality, water supply and wildlife and wildlife habitat protection issues, members of the Group also want to see the primary objective accomplished in ways compatible with the following secondary objectives. Each member of the Group does not necessarily share these secondary objectives, nor do they accept responsibility for their respective implementation. They are listed here to provide information relative to expectations in the community of stakeholders relative to improving water quality in the lower San Joaquin River. Several of these objectives focus on meeting water quality needs of the south Delta and/or providing supplemental flows for agricultural and fisheries purposes on the lower San Joaquin River.

District•Modesto Irrigation District•Oakdale Irrigation District•San Luis Canal Company, Exchange Contractor•San Joaquin County and Delta Water Quality Coalition•San Joaquin County RCD•San Joaquin River Exchange Contractors Water Authority•San Joaquin Valley Drainage Authority•San Joaquin River Group•San Luis and Delta Mendota Water Authority•South San Joaquin Irrigation District•State Water Contractors•Tranquility Irrigation District•Turlock Irrigation District•Venice Island RD 2023•California Farm Bureau•Western Growers

³ This plan incorporates real-time management elements and other strategies contemplated in but not able to ordered under the RWQCB's TMDLs. It is consistent with the real time management strategy discussed in the Salinity TMDL.

The following list of secondary objectives list is not in any priority nor is it necessarily all-inclusive. Certain of these objectives may be aided by the incidental flow benefits afforded by recirculation or through use of New Melones water savings resulting from reduced dilution flow requirements associated with Westside salt load reductions.

- a. Implement the Delta Improvements Package (DIP).
- b. Minimize Delta water losses that impact CVP-SWP exports.
- c. Maintain adequate flows and water levels in the San Joaquin River between Vernalis and the head of Old River to support diverters.
- d. Maintain adequate water levels in the south Delta.
- e. Improve Delta water quality through DIP actions such as Franks Tract levee restoration
- f. Maintain viability of wildlife refuges and irrigated agriculture
- g. Reduce demands on New Melones Reservoir to achieve water quality and flow objectives, including but not limited to Vernalis salinity and flow, and dissolved oxygen.

The Group also recognizes that there are established water quality objectives that have not been explicitly identified as being targeted by the Group to be addressed but are related to the Group's primary objectives. Resolving salinity issues at Vernalis, in conjunction with SDIP barrier operations, should in most instances resolve salinity issues at the Brandt Bridge and other south Delta compliance locations. Flow objectives have only been addressed relative to resolution of Stockton DO issues.

4. Summary Nature of the Salinity Problem

The spatial and temporal nature of the salinity problems in the LSJR at Vernalis and downstream are described in the Regional Water Quality Control Board, Sacramento Regions' TMDL reports. However, this description did not include recent flow information as a result of physical changes in drainage areas and changes in water flows brought about through implementation of the Central Valley Project Improvement Act, an in particular, newly available refuge supplies.⁴ In brief, the salinity problem for the LSJR is a lack of river flow combined with relatively high loadings of agricultural and urban sources of dissolved solids. Although in dry years, April-Sept flow at Vernalis is now only about two percent less than flows were prior to 1944. High salinity levels threaten beneficial use of water in the LSJR for agricultural uses during the growing season.

⁴ See also discussion under 6. a. Baseline of Violations, Salinity.

Table 2. Additional Water Quality Control Plan Flow and Salinity Objectives		
Flow Standards: San Joaquin River at Airport Way Bridge, Vernalis, CA – Minimum Monthly Average ⁵	Feb-Apr 14 And May 16-Jun	Wet and AN 2,130 or 3,420 cfs
		BN, Dry – 1,420 or 2,280 cfs
		Critical – 710 or 1,140 cfs
	Apr 15-May 15	Wet 7,330 or 8,620 cfs
		AN 5,730 or 7,020 cfs
		BN 4,620 or 5,480 cfs
		Dry 4,020 or 4,880 cfs
	Critical 3,110 or 3,540 cfs	
October	All	
Delta Salinity Standard: San Joaquin River at Brandt Bridge and other South Delta locations	All Years: April-August 0.7 EC Sept-March 1.0 EC (1.0 at all times after installation of in-delta barriers)	

5. Summary Nature of the Dissolved Oxygen Problem.

The dissolved oxygen problem had been described in detail in the RWQCB’s TMDL reports on dissolved oxygen issues in Stockton Deep Water Ship Channel. In sum, the dissolved oxygen problem is described as a three-way interaction of low river flows, the presence of an unnaturally deep channel structure (Stockton Deep Water Ship Channel), creating a slack-water zone with low light penetration and resulting anoxic conditions, and loadings of oxygen demand substances from upstream urban and agricultural sources. Low dissolved oxygen is thought to be a problem for resident and anadromous fish migration.

⁵ Partial months are averaged for that period. For example, the flow rate for April 1-14 would be averaged over 14 days. The 7-day running average shall not be less than 20% below the flow rate objective, with the exception of the April 15-May 15 pulse flow period when this restriction does not apply. The water year classification will be established using the best available estimate of the 60-20-20 San Joaquin Valley Water Year Hydrologic Classification at the 75% exceedence level. The higher flow objective applies when the 2-pt isohaline (measured as 2.64 mmhos/cm surface salinity) is required to be at or west of Chipps Island.

6. Baseline of Violations

a. Salinity

San Joaquin River watershed hydrology and operations are derived from a preliminary baseline study that was developed as part of Reclamation's on-going CALSIM refinement effort. This on-going effort is updating a 1980s-vintage depiction of numerous San Joaquin watershed attributes, including:

- Land-use based diversion requirements for East-side tributary systems
- East-side tributary system and Friant Division operations
- West-side return flows, inclusive of current wildlife area water supplies and operations
- Current regulatory and institutional operational objectives
- Linked Node approach to water quality modeling (disaggregation of water quality elements)

The refined baseline is substantially different from the earlier baseline. In particular, the refined baseline shows higher Vernalis flows and a dramatic change in San Joaquin River water quality in the summer months. New Melones dilution requirements now occur during winter, spring and summer months, in contrast to the earlier baseline depiction that suggested that dilution requirements were generally limited to summer months. This paradigm shift results from tracking known flow sources and their associated water quality (based on recent records) as opposed to using flow-salinity relationships (based on older records). The summer dilution requirement is much lower in the refined baseline, apparently a reflection of changed conditions within the watershed.

The earlier baseline depicted a Vernalis salinity objective that was exceeded in approximately one-third of all years. The refined baseline characterizes Vernalis salinity violations as follows:

- 13 monthly violations occur over the 73-year period of analysis. These violations occur during 7 different water years.
- 11 of these monthly violations occur during 5 years of the 1987-92 drought.
- 5 of these monthly violations occur during summer months (July-September).

b. Dissolved Oxygen

Low dissolved oxygen generally occurs in the Stockton Deep Water Ship Channel up to about Turner Cut. The point of greatest DO depletion tends to shift downstream with increased flow rates. Low dissolved oxygen is rarely a problem when flows exceed about 1,500 cfs. Worst months for DO tend to be June through October of dryer years with excursions about a third of the time during this period. Exceedences can also occur, however, in winter months of dryer years when flow is low.

7. Solution Tools Evaluated

A variety of flow augmentation and pollution reduction tactics or tools were evaluated in the development of the San Joaquin River Water Quality Management Plan. The following table briefly describes the results of individual analysis of each tool. Promising tools were combined and their effects modeled as described in the following section.

Table 3. Solution Tools Evaluated

Tools	Evaluation Findings
Flow Tools	
Recirculation	Highly effective when capacity is available to effect salinity reduction and improve river flows. Available July- Sept., with potential availability Oct.-Dec.
Transfers	Up to 12,000 of water upstream in San Joaquin River Watershed may be available on an interim basis for strategic transfer and targeted salinity improvements needs.
HORB Operations	Planned HORB operations in conjunction with an SDIP will improve lower San Joaquin River flows. Expanded operation ability for the Barrier should be sought (e.g. June-Sept).
Load Reduction/Management	
West Side Regional Drainage Plan Actions	Ongoing and planned programs will create large salt reductions and associated dissolved oxygen load reductions.
Interception of saline groundwater at river	Expensive relative to other load reduction techniques available.
Storage for agricultural discharges	Expensive relative to other load reduction techniques available. Attractive nuisance issues for waterfowl. Potential strategic application.
Re-management of wildlife area discharges	Unknown potential. Continued evaluation necessary
Urban recycling/exchanges for High quality river flows	Minimal potential
Increased wastewater treatment	Adopted ammonia load reductions for Stockton WWTP will lower dissolved oxygen loading
Other: Dissolved Oxygen Aerator	Demonstration Project Aerator should proceed and be studied in conjunction with other tools implemented.

8. SANMAN Model and Modeling

The SANMAN Model Detailed Assumptions Paper, January 7, 2005, summarizes the logic used in SANMAN to estimate water quality effects of the various San Joaquin River Salinity Management actions. The SANMAN model represents salinity actions only. It is not a dynamic dissolved oxygen model capable of initially calculating effects of salinity management actions and then applying dissolved oxygen solution actions. It

can, however, calculate resultant flow from salinity control actions which can be useful in addressing flow-related aspects of dissolved oxygen impairment.

a. Baseline CALSIM Studies

Because a CALSIM study with an updated San Joaquin River basin hydrology and operations fully integrated into a system-wide hydrology and operations is not currently available, two CALSIM studies are therefore employed to characterize Delta and San Joaquin River baselines in SANMAN.

Hydrology and operations for the Delta and Sacramento River watershed are based on the final (Environmental Water Account) step of Reclamation's OCAP CALSIM Study #5 dated January 21, 2004. Assumptions include, among other things, a 2020 level of development, Banks Pumping Plant at a permitted capacity of 8500 cfs, a 400 cfs DMC-California Aqueduct intertie, SWP and CVP water transfers, EWA and JPOD actions, and Cross Valley Canal wheeling. The SANMAN period of analysis approximates the CALSIM 73-year hydrologic sequence, including the period March 1922 thru September 1994. The analysis uses a monthly time step except during the April-May period, when a split-month time step is used.

Hydrology and operations for the San Joaquin River watershed are derived from a preliminary baseline study developed as part of Reclamation's on-going CALSIM refinement effort. Refinement or revision of watershed attributes, include East-side land-use and tributary operations, Friant Division operations, West-side return flows, current wildlife area supplies and operations, disaggregation of various water quality elements and current regulatory and institutional objectives.

b. Vernalis Salinity Objective

The baseline Vernalis salinity objective is in accordance with D-1641: 0.7 mS/cm during April thru August and 1.0 mS/cm during September thru March. To allow post-analysis of changing San Joaquin River conditions, SANMAN removes the baseline New Melones operation provided by CALSIM to determine the New Melones baseline releases that could be modified and re-operated in reaction to changed water quality conditions in the San Joaquin River, and to provide a "without New Melones water quality release" depiction of flow and quality at Vernalis. SANMAN then re-operates New Melones to meet Vernalis water quality objectives in accordance with SANMAN computations of water quality mass balance.

c. Delta Conditions

Delta export water quality at Banks and Tracy is assumed to correlate with CALSIM-derived water quality at Rock Slough. The Delta is assumed to be in balance under base and action conditions. This assumption is used in the computation of water cost associated with salinity management actions. Stockton flow, a surrogate measure of dissolved oxygen conditions, is estimated as a function of Vernalis flow, barrier

operations at the Head of Old River, and San Joaquin River consumptive use between Vernalis and Stockton.

d. Interim Operations Plan

New Melones baseline water quality and dissolved oxygen releases were removed and re-introduced in accordance with the Interim Operations Plan. Annual accounting of New Melones water quality releases follows a March thru February water year and is linked to five water supply classifications.

e. Delta Pumping Capacity Availability for DMC Re-circulation

The following pumping capacity priorities have been established to arrive at the net capacity available for recirculation operations:

- The priority for Tracy pumping capacity is as follows: (1) CVP contract deliveries, (2) export of additional CVP stored water, (3) CVP water transfers, (4) SWP exports through JPOD, and (5) DMC re-circulation.
- The priority for Banks capacity is as follows: (1) SWP contract deliveries, including a July through September EWA reservation up to 500 cfs, (2) SWP water transfers, (3) additional EWA reservation, (4) CVP exports through JPOD, and (5) DMC re-circulation.
- Availability of Delta pumping capacity at Banks and Tracy is constrained by the maximum export-to-inflow (E/I) ratio as specified in D-1641. SANMAN allows the user to define DMC re-circulation alternatives that “purchase” additional pumping capacity by releasing additional Delta inflow, thereby “paying” the E/I cost.

Other assumptions related to exports for contract deliveries, additional export of CVP stored water, water transfers, the Environmental Water Account, JPOD and “lumped” summer capacity are contained in the SANMAN Model Detailed Assumptions Paper, January 7, 2005.

**Table 3
Model Runs Executed
In Development of SJRWQMP Recommendations**

Scenario	Description
ISOLATED ACTION STUDIES	
IA1	No Action
IA2	SJR Improvement Project
IA3a	20% Drain Reduction: Exchanger Region
IA3b	50% Drain Reduction: Exchanger Region
IA3c	20% Drain Reduction: Upper DMC Regions
IA3d	50% Drain Reduction: Upper DMC Regions
IA5a	Refuge Return Flow Storage Retention: 5 TAF
IA5b	Refuge Return Flow Storage Retention: 10 TAF
IA6	Mid-Priority DMC Re-circulation: Jul-Sep
IA7	High-Priority DMC Re-circulation: Jul-Sep
COMPOSITE ACTION STUDIES	
CA1	IA2 + Targeted Re-circulation & New Melones
CA2	Refuge Retention + High-Priority Recirc: Jul-Sep
SENSITIVITY STUDIES	
S1	High-Priority DMC Re-circulation: Year Round
S2	High-Priority Recirc: Year Round w/ Flow Targets
S3	High-Priority Recirc: Jul-Sep w/o DO Releases
DRAFT PREFERRED ALTERNATIVE	
	<ul style="list-style-type: none"> ▪ Phased implementation of SJRIP (10-100%) ▪ Strategic water transfers ▪ DMC re-circulation
MP-10 thru MP-100	Mid priority re-circulation with modified Stanislaus DO compliance
HP-10 thru HP-100	High priority re-circulation with modified Stanislaus DO compliance
MP-10DO thru MP-100DO	Mid priority re-circulation with existing Stanislaus DO compliance
HP-10DO thru HP-100DO	High priority re-circulation with existing Stanislaus DO compliance

9. Modeling Results and Recommendations

a. Short Term Actions

Modeling of the various tools evaluated by the Group has shown that stand out as having a robust ability to improve salinity conditions on the LSJR. Foremost among these tools are elements of the West Side Regional Drainage Plan. One element of this Plan, the San Joaquin River Improvements Project or SJRIP had sufficient detail to allow quantification of its effects. Full implementation of the SJRIP alone can eliminate salinity violations. However, implementation of the SJRIP and the West Side Regional Drainage Plan will take nearly a decade and use of recirculation and transfer tools can supplement efforts to eliminate exceedences of water quality objectives in the interim while the Drainage Plan is implemented over time.

The elements of an interim strategy to comply with Salinity objectives at Vernalis are as follows:

- Permitted Banks Pumping Plant capacity at 8,500 cfs (allows for recirculation capacity)
- High priority recirculation of water via the Delta Mendota Canal and released into the Newman wasteway leading to the LSJR during July-September.⁶
- Phased implementation of the West Side Regional Drainage Plan and the SJRIP
- Strategic water transfers during dry and critically dry years from the San Joaquin River Group members not to exceed 12,000 af/yr when water is otherwise unavailable at New Melones Reservoir.
- Modified Stanislaus River dissolved oxygen compliance location to preserve New Melones Storage.⁷

Additional measures to assist in meeting Dissolved Oxygen objectives include:

- Operable barriers in the south Delta and expanded use of a Head of Old River Barrier to be available April-November.
- Phased implementation of the City of Stockton's ammonia removal project
- Installation of the demonstration aeration project in the Stockton Deep Water Ship Channel

⁶ Under mid-priority recirculation, releases from New Melones reservoir to meet Vernalis water quality would be used before recirculation. High priority reverses this priority. Each have policy implications as discussed in Section 10

⁷ This objective is for protection of steelhead salmon and should be moved from Ripon to Orange Blossom Bridge, where the habitat for steelhead is on the Stanislaus to better represent the protection sought. This change is not considered controversial.

As soon as the recirculation capacity and Head of Old River barrier is in place, compliance can be assured for salinity at Vernalis and Brandt Bridge by primarily relying on recirculation flows, New Melones storage and some water transfers in the driest years. As the West Side Regional Plan elements are phased in, there is a diminishing need for water transfers and use of recirculation in order to achieve the water quality objectives as shown in Table 4.

Table 4
Use of Recirculation and Transfers Relative to Increased
Implementation of West Side Drainage Plans⁸

Percent of Implementation of SJRIP portion of West Side Regional Drainage Plan	Critical Year Costs & Benefits (TAF)		Water Transfers	
	Recirc	New Melones Savings	Frequency (Years)	Max Annual (TAF/yr)
0	0	0	7	23
10	84	45	2	22
20	72	49	2	16
30	60	53	1	10
40	48	57	1	5
50	38	61	0	0
60	27	65	0	0
70	16	68	0	0
80	9	71	0	0
90	4	74	0	0
100	1	75	0	0

Elimination of dissolved oxygen excursions cannot be similarly assured, however, due to the more dynamic nature of that problem. However, an operable Head of Old River barrier coupled with recirculation in summer months can increase flows in the lower San Joaquin River, to the point where dissolved oxygen rarely seems to be a problem. Additional flexibility in use of the barrier in winter months of dryer years would be necessary to augment flows in conjunction with transfers to reduce or eliminate those more rare excursions in those months. Coupled with the City of Stockton's ammonia removal project and the availability of an aerator which can artificially supplement channel oxygen levels, it is believe that dissolved oxygen excursions can be significantly reduced and likely eliminated. Operation of these tools on a real time basis will allow experience to be developed in refining how the tools can be applied over time given various circumstances.

⁸ Incorporates modification of Stanislaus River DO monitoring location

b. Longer Term Actions

Over the longer term, 5-10 years, continued implementation of the West Side Regional Drainage Plan will diminish the need for recirculation and transfer demands. Additional improvements could be made through modified management of wildlife refuge water releases, delaying storage releases and timing releases in combination with assimilative capacity. Additional water quality improvements could be achieved through modification of Frank's tract levees, which has been shown to be able to reduce salts exported into West side drainage areas by about 20% in late summer and fall months of dryer years. This would have an unknown yet beneficial impact on the amount of salt eventually returning to the LSJR.

As operational experience is gained combining recirculation, HORB operations, reductions of salt and dissolved oxygen load and operation of a demonstration aerator, adjustments can be made to increase the availability of the HORB and recirculation provided other impacts can be successfully addressed. Experience will also improve the ability to utilize the aerator and evaluate trade-offs between use of the aerator and other tools.

10. Implementation Issues

There are a number of physical and institutional issues that arise in pursuing the recommended strategy for resolving salinity and dissolved oxygen problems as discussed herein. The following summarizes these issues and offers approaches to address them.

- a. **Lowered flows/flow maintenance on LSJR.** As shown in Figure 1, the recommended alternative at the point where full implementation of the SJRIP portion of the West Side Drainage Plan has the effect of reducing flow during critical periods along the LSJR. Flows below 1,000 cfs are a potential problem for diverters on the LSJR, with water levels being potentially insufficient to allow pumping to occur. As this would occur in summer months of these year types, recirculation could be increased to provide for additional flow. This additional flow would also have the added benefit of reducing potential dissolved oxygen problems during these periods.