CENTRAL VALLEY REGIONAL
WATER QUALITY CONTROL BOARD

PROPOSED AMENDMENTS TO THE WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER BASINS

TO

ESTABLISH SALINITY WATER QUALITY OBJECTIVES IN THE LOWER SAN JOAQUIN RIVER (MOUTH OF MERCED TO VERNALIS)

DRAFT STAFF REPORT

FEBRUARY 2017, AMENDED MAY 2017

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Edmund G. Brown Jr., Governor

California Environmental Protection Agency
Matthew Rodriquez, Secretary for Environmental Protection

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

11020 Sun Center Drive #200
Rancho Cordova, CA95670

Phone: (916) 464-3291
email: info5@waterboards.ca.gov
Web site: http://www.waterboards.ca.gov/centralvalley/

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This publication is a report by staff of the California Regional Water Quality Control Board, Central Valley Region. This report contains the evaluation of alternatives and technical support for the adoption of a Basin Plan Amendment to the Water Quality Control Plan for the Sacramento and San Joaquin River Basins. Mention of specific products does not represent endorsement of those products by the Central Valley Water Board.

Proposed Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins

To Establish Salinity Water Quality Objectives in the Lower San Joaquin River (Mouth of Merced to Vernalis)

Draft Staff Report

February 2017, Amended May 2017

Regional Water Quality Control Board
Central Valley Region

California Environmental Protection Agency

Acknowledgments

Thank you to the participants of the Lower San Joaquin River Committee and the Central Valley Salinity Alternatives for Long Term Sustainability (CV-SALTS) initiative for their commitment and work on this project.

EXECUTIVE SUMMARY

The purpose of this Staff Report is to provide the rationale and supporting documentation for proposed amendments to the Water Quality Control Plan (Basin Plan) for the Sacramento River Basin and San Joaquin River Basin (Central Valley Water Board, 2016a) that would establish salinity water quality objectives (WQOs) in Reach 83 of the Lower San Joaquin River (LSJR), which is defined as the LSJR from the mouth of the Merced River to the Airport Way Bridge near Vernalis. This report proposes amendments to the Basin Plan that would:

1 Define salinity WQOs that are protective of beneficial uses in the LSJR. The proposed Basin Plan amendments would establish a WQO that would require that electrical conductivity (EC) at 25 degrees Celsius[1] not exceed 1,550 micro Siemens per centimeter (µS/cm) as a 30-day running average, except during Extended Dry Periods,[2] when the WQO would require that EC not exceed 2,470 µS/cm as a 30-day running average and 2,200 µS/cm as an annual average using at a minimum the previous four consecutive quarterly samples.

2 Incorporate an implementation program into the Basin Plan to achieve proposed salinity WQOs.

3 Set an EC performance goal of 1,350 µS/cm during certain months and water-year types, based on modeling results of expected water quality.

4 Require the implementation of a monitoring and surveillance program to evaluate the effectiveness of the implementation program.

These proposed amendments would set water quality objectives for EC that would be protective of the ~~two~~ beneficial uses in the LSJR ~~that are most sensitive to salinity impacts:~~ including Agricultural Supply (AGR) and Municipal and Domestic Supply (MUN). In addition, setting an EC performance goal will promote achievement of the best

[1] An EC measurement made or corrected to 25 °C is equivalent to specific conductance

[2] An Extended Dry Period is defined using the State Water Board's San Joaquin Valley "60-20-20" Water Year Hydrologic Classification to assign a numeric indicator to a water year type as follows:

- Wet – 5
- Above Normal – 4
- Below Normal – 3
- Dry – 2
- Critically Dry – 1

The indicator values will be used as follows to determine when an Extended Dry Period is in effect:

- An Extended Dry Period shall begin when the sum of the current year's 60-20-20 indicator value and the previous two year's 60-20-20 indicator values total six (6) or less.
- An Extended Dry Period shall be deemed to exist for one water year (12 months) following a period with an indicator value total of six (6) or less.

The method for determining the San Joaquin Valley Water Year Hydrologic Classifications is defined in the State Water Board Revised Water Right Decision 1641, March 2000, Figure 2, page 189. This method uses the best available estimate of the 60-20-20 San Joaquin Valley water year hydrologic classification at the 75% exceedance level using the best available data published in the California Department of Water Resources' ongoing Bulletin 120 series.

possible water quality under variable conditions. The proposed amendments do not change or replace the EC WQOs for the San Joaquin River at the Airport Way Bridge near Vernalis which was set by the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) for water entering the southern Delta (State Water Resources Control Board, 2006).

In Revised *Water Right Decision 1641*, the California State Water Resources Control Board (State Water Board) directed the Central Valley Regional Water Quality Control Board (Central Valley Water Board) to develop and adopt salinity objectives and a program of implementation for the main stem of the San Joaquin River upstream of Vernalis (State Water Resources Control Board, 2000). In 2004, the Central Valley Water Board adopted the Control Program for Salt and Boron Discharges into the Lower San Joaquin River (Control Program) that included a Total Maximum Daily Load (TMDL) to address EC in the LSJR and meet the WQOs in the Bay-Delta Plan at the Airport Way Bridge near Vernalis. The Control Program and TMDL were subsequently approved by the United States Environmental Protection Agency (US EPA) in 2006. The TMDL is implemented through waivers of waste discharge requirements (WDRs) or WDRs that apportion load allocations to different geographic subareas in the valley. As an alternative to the load allocations, the TMDL allows discharger participation in a Central Valley Water Board approved real-time management program as a means to attain salinity WQOs, while maximizing the export of salts out the watershed to help protect the region's agricultural production and long term sustainability. The Control Program also required a second phase to establish and implement new salinity and boron objectives for the San Joaquin River upstream of Vernalis.

The Central Valley Water Board held an initial California Environmental Quality Act (CEQA) scoping meeting for a basin planning effort to develop the upstream WQOs on 11 May 2005. After preliminary studies, the Central Valley Water Board held a second CEQA scoping meeting on 30 March 2009, to limit the geographic scope of the project to the section of the river upstream of the Airport Way Bridge near Vernalis to the Merced River. Central Valley Water Board staff subsequently released a draft report, *Salt Tolerance of Crops in the Lower San Joaquin River (Merced to Stanislaus River Reaches)* (LSJR Salt Tolerance Report) in March 2010 that presented the application of crop salt sensitivity parameters needed to establish EC water quality criteria in the LSJR (Central Valley Water Board, 2010a). At that same time, the Central Valley Water Board requested that the Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS) initiative continue the effort on the upstream San Joaquin River beneficial use and salt and boron objectives evaluation and to continue to work on the policy and science to develop a basin plan amendment that would address those issues. CV-SALTS is a collaborative stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley.

The proposed WQOs herein are the result of a stakeholder-driven effort led by the LSJR Committee, which is a subcommittee of the CV-SALTS. It includes members of irrigation, water, and resource conservation districts, city, county, state and federal agencies, producers, growers, irrigators, water quality and watershed coalitions, managed wetlands, drainage authorities, clean water and wastewater associations, consultants of various organizations and other interested parties.

Between May 2010 and the end of 2015, the LSJR Committee developed recommendations for EC WQOs that are protective of beneficial uses in the LSJR, EC Performance Goals that may be achievable, and recommendations for a program to implement the WQOs and Performance Goals for consideration by the Central Valley Water Board. The Committee began by conducting reviews of beneficial uses and water quality data for the LSJR, including white papers on Aquatic Life (Buchwalter, David, Ph.D., North Carolina State University, 2014) and Stock Watering sensitivity to salinity (Kennedy/Jenks Consultants, 2013), and concluded that ~~the~~additional work was needed to determine reasonable protection of Agricultural Supply (AGR) ~~beneficial use is the most sensitive to salinity, followed by the~~and potential Municipal and Domestic Supply (MUN) beneficial uses. The Committee also decided there was not enough information available to support a change from the current boron WQOs for the LSJR, and instead focused their efforts on the EC WQOs and EC Performance Goals. Next, the Committee developed guidelines for determining reasonable protection of AGR to assist with development of EC WQOs and vetted them with the CV-SALTS Executive Committee. The guidelines recommend key components to consider when determining reasonable protection of AGR and include a leaching fraction to represent irrigation practices when site-specific data are not available, crop yield values acceptable to stakeholders under certain conditions, and metrics for identifying the most salt sensitive commercial crop that requires protection. In addition, an Extended Dry Period definition was developed to assist with establishing reasonable salinity objectives in the LSJR during time periods when water supplies are constrained.

The LSJR Committee then developed EC water quality criteria for consideration as WQOs protective of AGR for this Basin Plan Amendment by entering existing and recently acquired scientific data, and applying the recommended guidelines into the Hoffman Model, a steady-state soil-water salinity model. This model had been peer reviewed during the State Water Board's salinity review of the Bay-Delta (State Water Resources Control Board, 2012) and used in the 2010 draft and the finalized LSJR Salt Tolerance Report (Central Valley Water Board, 2016b). The proposed EC WQO of 1,550 µS/cm is derived from the Hoffman model for the LSJR by utilizing a leaching fraction of 15 percent and protecting for a 95 percent almond crop yield, during a 5th percentile annual rainfall year (all but 5% of the driest years from 1951-2013) In conformance with the WQOs and sampling regimes established in the San Joaquin

River at Vernalis for the protection of agricultural uses of water entering the Bay-Delta, the LSJR Committee recommended maintaining the same water quality compliance period of a 30-day running average of mean daily EC (State Water Resources Control Board, 2000). The proposed WQO likewise falls within the recommended range (900 to 1600 µS/cm) of Title 22 of the California Code of Regulation's Secondary Maximum Contaminant Level (SMCL) for specific conductance, which is considered reasonably protective of the MUN use in the Basin Plan.

The preferred project alternative also incorporates separate EC WQOs for Extended Dry Periods. These Extended Dry Period EC WQOs were developed using the Hoffman model to protect a lower almond crop yield expectation of at least 75 percent. During these periods, an EC WQO of 2,470 µS/cm as a maximum 30-day running average is proposed as reasonably protective of irrigation supply water. A concurrent EC WQO of 2,200 µS/cm as an annual average (using at a minimum the previous four consecutive quarterly samples) is also proposed for an Extended Dry Period to reasonably protect the potential MUN beneficial use because such a value is equivalent to the short term Title 22 SMCL for specific conductance.

The Watershed Analysis Risk Management Framework (WARMF) watershed modeling tool, using historical conditions to simulate salt loading in the LSJR, was applied to evaluate the ability of different implementation strategies to meet the proposed salinity WQOs. The compliance point for the evaluation was the LSJR at Crows Landing, a point upstream of freshwater dilution flows from the Tuolumne and Stanislaus Rivers. The preferred implementation plan selected by the LSJR Committee includes the execution of current and currently planned activities to manage irrigation return flows to the LSJR. Modeling of this implementation strategy indicated that the proposed salinity objectives would be met at Crows Landing.

The LSJR Watershed drains approximately 2.9 million acres, which includes approximately 1.4 million acres of acricultural land use. A key activity within the selected implementation plan is the ~~the~~ Grassland Bypass Project~~''s, plan to achieve~~ achieving zero discharge of subsurface agricultural return flows by the end of 2019. The discharge is from 97,000-acre~~'~~s of the Grassland Bypass Project area to tributaries of the LSJR. The planned activities in the watershed are predicted to result in the LSJR reaching compliance with the proposed EC and existing boron WQOs for this stretch of the river by the end of 2019. The proposed objectives and implementation program are also predicted to improve (decrease) salinity levels over historic conditions and reduce the reliance on New Melones fresh water releases while continuing to meet the salt objectives downstream at the Airport Way Bridge near Vernalis.

The WARMF watershed modeling analyses also suggested that the selected implementation program will result in the attainment of an EC value of 1,350 µS/cm in the LSJR during certain seasons or water-year types. These findings were not conclusive and, as a result, the LSJR Committee stakeholders recommended that an EC value of 1,350 µS/cm be established as an implementation performance goal during specific months of the irrigation season of certain water-year types to promote the best possible water quality. The Staff Report includes a proposed monitoring plan to verify compliance with the LSJR EC and boron WQOs and attainment of the EC performance goal. The LSJR Committee proposed that the Central Valley Water Board use future monitoring data to reevaluate the EC WQOs ten years after adoption of the Basin Plan Amendment and determine whether or not an adjustment to lower the WQOs is appropriate.

This Staff Report also evaluates the proposed Basin Plan Amendment's consistency with existing federal and state laws, regulations and policies, contains an environmental analysis that complies with the applicable requirements of the California Environmental Quality Act (CEQA), and includes antidegradation and economic analyses that evaluate potential impacts of this project. The Board's Basin Planning Program is considered a certified regulatory program, which means that the Board is exempt from the requirement to prepare an environmental impact report for basin planning activities under the California Environmental Quality Act. (Pub. Res. Code, § 21080.5; Cal. Code Regs., tit. 14, § 15251(g).) The Board's environmental review of the proposed Basin Plan Amendments is instead contained in this Staff Report, which is considered to be part of the "substitute environmental documentation" or "SED".

Proposed Basin Plan Amendment Language

The proposed changes to the Basin Plan are as follows. Text additions to the existing Basin Plan language are underlined. Text deletions to the existing Basin Plan are in ~~strikethrough~~.

CHAPTER 1 INTRODUCTION

Modify the Basin Plan under the heading, "3. East Valley Floor" (page I-3.00), as follows:

3. East Valley Floor

This subarea includes approximately 413 square miles of land on the east side of the LSJR that drains directly to the LSJR between the Airport Way Bridge near Vernalis and the Salt Slough confluence. The subarea is largely comprised of the land between the major east-side drainages of the Tuolumne, Stanislaus, and Merced Rivers. This subarea lies within central Stanislaus County and north-central Merced County. Numerous drainage canals~~, including the Harding Drain~~ and natural drainages~~, drain~~ occur in this this subarea. The subarea is comprised of the following minor subareas:

CHAPTER III WATER QUALITY OBJECTIVES

Modify the Basin Plan under the heading, "Salinity" (page III-6.02), as follows:

Electrical Conductivity and Total Dissolved Solids-- Special Cases in the Sacramento and San Joaquin River Basins Other Than the Delta

The objectives for electrical conductivity and total dissolved solids in Table III-3 apply to the water bodies specified. To the extent of any conflict with the general Chemical Constituents water quality objectives, the more stringent shall apply, with the exception of the electrical conductivity water quality objectives for Reach 83 of the San Joaquin River, which the Board has determined to be protective of all beneficial uses within Reach 83.~~.~~

~~Electrical conductivity water quality objectives for Reach 83 of the San Joaquin River are set to protect the Agricultural Supply (AGR) and the potential Municipal and Domestic Supply (MUN) beneficial uses.~~

Modify the Basin Plan under the heading, “Salinity” (Table III-3 on page III-7.00), as follows:

Table III-3

ELECTRICAL CONDUCTIVITY AND TOTAL DISSOLVED SOLIDS

PARAMETER	WATER QUALITY OBJECTIVES	APPLICABLE WATER BODIES
Electrical Conductivity (at 25°C)	Shall not exceed 230 micromhos/cm (50 percentile) or 235 micromhos/cm (90 percentile) at Knights Landing above Colusa Basin Drain; or 240 micromhos/cm (50 percentile) or 340 micromhos/cm (90 percentile) at I Street Bridge, based upon previous 10 years of record.	Sacramento River (13, 30)
	Shall not exceed 150 micromhos/cm (90 percentile) in well-mixed waters of the Feather River.	North Fork of the Feather River (33); Middle Fork of the Feather River from Little Last Chance Creek to Lake Oroville (36); Feather River from the Fish Barrier Dam at Oroville to Sacramento River (40)
	Shall not exceed 150 micromhos/cm from Friant Dam to Gravelly Ford (90 percentile).	San Joaquin River, Friant Dam to Mendota Pool (69)
	Shall not exceed 1550 micromhos/cm (as a 30-day running average), except during Extended Dry Periods[3], when concentrations shall not exceed 2470 micromhos/cm (as a 30-day running average) and 2200 micromhos/cm (as an annual average using at a minimum the previous four quarterly samples)	San Joaquin River between the Mouth of Merced River and the Airport Way Bridge near Vernalis (83)
Total Dissolved Solids	Shall not exceed 125 mg/l (90 percentile)	North Fork of the American River from the source to Folsom Lake (44); Middle Fork of the American River from the source to Folsom Lake (45); South Fork of the American River from the source to Folsom Lake (48, 49); American River from Folsom Dam to Sacramento River (51)
	Shall not exceed 100 mg/l (90 percentile)	Folsom Lake (50)
	Shall not exceed 1,300,000 tons	Goose Lake (2)

[3] See Chapter IV-32.00 for definition of an Extended Dry Period

CHAPTER IV IMPLEMENTATION

Modify the Basin Plan under the heading, “Control Program for Salt and Boron Discharges into the Lower San Joaquin River (LSJR)” (pages IV-32.00 through IV-32.07), as follows:

Control ~~p~~Program for Salt and Boron Discharges into the Lower San Joaquin River (LSJR)

The goal of the salt and boron control program is to achieve compliance with salt and boron water quality objectives without restricting the ability of dischargers to export salt out of the San Joaquin River basin.

For the purpose of this control program, nonpoint source land uses include all irrigated lands and nonpoint source discharges are discharges from irrigated lands.

Irrigated lands are lands where water is applied for producing crops and, for the purpose of this control program, includes, but is not limited to, land planted to row, field and tree crops as well as commercial nurseries, nursery stock production, managed wetlands, and rice production.

This control program is phased to allow for implementation of existing water quality objectives, while providing the framework and timeline for implementing future water quality objectives.

The salt and boron control program establishes ~~salt load limits~~ 1) a method for determining the maximum allowable salt loading to the LSJR from discharges to achieve compliance with salinity water quality objectives (WQOs) at the Airport Way Bridge near Vernalis ~~with salt and boron water quality objectives for the LSJR~~ and 2) WQOs and an implementation program for salinity between the mouth of the Merced River and the Airport Way Bridge. ~~The Regional Water Board establishes a method for determining the maximum allowable salt loading to the LSJR. Load allocations are established for nonpoint sources and waste load allocations are established for point sources.~~

Salt Loading and the Vernalis Salinity Control Program

Load allocations to specific dischargers or groups of dischargers are proportionate to the area of nonpoint source land use contributing to the discharge. Control actions that result in salt load reductions will be effective in the control of boron.

Load allocations are established for nonpoint sources and waste load allocations are established for point sources.

~~The salt and boron control program establishes timelines for: 1) developing and adopting salt and boron water quality objectives for the San Joaquin River upstream of the Airport Way Bridges near Vernalis; 2) a control program to achieve these objectives; and 3) developing and adopting a groundwater control program.~~

Per the amendments to the Basin Plan for control of salt and boron discharges into the ~~lower San Joaquin River (~~LSJR~~)~~ basin, approved by the Regional Water Board in Resolution No. 88-195, Resolution No. 2004-0108, and Resolution No.

R5-2017-XXX and incorporated herein, the Regional Water Board will take the following actions, as necessary and appropriate, to implement this control program:

1. The Regional Water Board shall use waivers of waste discharge requirements or waste discharge requirements to apportion load allocations to each of the following seven geographic subareas that comprise the LSJR:

   a. San Joaquin River Upstream of Salt Slough
   b. Grassland
   c. Northwest Side
   d. East Valley Floor
   e. Merced River
   f. Tuolumne River
   g. Stanislaus River

   These subareas are described in Chapter 1 and in more detail in Appendix 41.

2. Dischargers of irrigation return flows from irrigated lands are in compliance with this control program if they meet any of the following conditions:

   a. Cease discharge to surface water
   b. Discharge does not exceed 315µS/cm electrical conductivity (based on a 30-day running average)
   c. Operate under waste discharge requirements that include effluent limits for salt
   d. Operate under a waiver of waste discharge requirements for salt and boron discharges to the LSJR

3. The Regional Water Board will adopt ~~a~~ waivers of waste discharge requirements or waste discharge requirements for salinity management, or incorporate into ~~an~~ existing agricultural waivers or waste discharge requirements, the conditions required to participate in a Regional Water Board approved real-time management program. Load allocations for nonpoint source dischargers participating in a Regional Water Board approved real-time management program are described in Table IV-4.4. Additional waiver conditions or waste discharge requirements will include use of Regional Water Board approved methods to measure and report flow and electrical conductivity. Participation in a Regional Water Board approved real-time management program and attainment of salinity water quality objectives at the Airport Way Bridge near Vernalis will constitute compliance with this control program.

4. The Regional Water Board will adopt waste discharge requirements with fixed monthly base load allocations specified as effluent limits for nonpoint source discharges that do not meet conditions specified in ~~a~~ waivers of waste discharge requirements or waste discharge requirements for salinity management. Entities operating under ~~WDRs~~ waste discharge requirements, or that will be required to operate under ~~WDRs~~ waste discharge requirements in order to comply with other programs, may participate in a Regional Water Board approved real-time management program in lieu of additional ~~WDRs~~ waste discharge requirements for salinity if they meet the conditions specified in the waiver of ~~WDRs~~ waste discharge requirements for salinity management, as described in item 3.

5. Fixed monthly base load allocations and the method used to calculate real-time load allocations are specified in Table IV-4.4.

6. Waste Load Allocations are established for point sources of salt in the basin. NPDES permitted discharges shall not exceed the salinity water quality objectives established for the LSJR at the Airport Way Bridge near Vernalis unless the discharger is a member of a Regional Water Board-approved real time management program or a pollutant trading program consistent with the Control Program for Salt and Boron Discharges into the LSJR The Regional Water Board will revise NPDES permits to incorporate ~~TMDL allocations~~ the requirements of the Control Program when the permits are renewed or reopened at the discretion of the Regional Water Board.

7. Supply water credits are established for irrigators that receive supply water from the Delta Mendota Canal (DMC) or the LSJR between the confluence of the Merced River and the Airport Way Bridge near Vernalis as described in Table IV-4.4.

8. Supply water Load Allocations are established for salts in irrigation water imported to the LSJR Watershed from the Sacramento/San Joaquin River Delta as described in Table IV-4.4.

   Per Resolution No. R5-2014-0150, ~~T~~the Regional Water Board ~~will attempt to enter into~~ adopted a revised Management Agency Agreement (MAA) with the U.S. Bureau of Reclamation, replacing a 2008 MAA to address salt imports from the DMC to the LSJR watershed. The MAA ~~shall~~ includes provisions requiring the U.S. Bureau of Reclamation to:

   a. Meet DMC load allocations; or
   b. Provide mitigation and/or dilution flows to create additional assimilative capacity for salt in the LSJR equivalent to DMC salt loads in excess of their allocation.

   The Regional Water Board shall request a report of waste discharge from the U.S. Bureau of Reclamation to ~~address~~ meet DMC ~~discharges~~ load allocations if a MAA ~~is not established by 28 July 2008~~ meeting the provisions identified above does not remain in place.

9. The Regional Water Board will review and, if necessary, update the load allocations and/or waste load allocations by 28 July 2012 and every 6 years thereafter. Any changes to waste load allocations and/or load allocations can be made through subsequent amendment to this control program. Changes to load allocations will be implemented through revisions of the applicable waste discharge requirements or waivers of waste discharge requirements. Changes to waste load allocations will be implemented through revisions of the applicable NPDES permits.

10. The Regional Water Board encourages real-time water quality management and pollutant trading of waste load allocations, load allocations, and supply water allocations as a means for attaining salt and boron water quality objectives while maximizing the export of salts out of the LSJR watershed. This control program shall in no way preclude basin-

wide stakeholder efforts to attain salinity water quality objectives in the LSJR so long as such efforts are consistent with the control program.

11. The established waste load allocations, load allocations, and supply water allocations represent a maximum allowable level. The Regional Water Board may take other actions or require additional reductions in salt and boron loading to protect beneficial uses.

12. Salt loads in water discharged into the LSJR or its tributaries for the express purpose of providing dilution flow are not subject to load limits described in this control program if the discharge:

    a. complies with salinity water quality objectives for the LSJR at the Airport Way Bridge near Vernalis;
    b. is not a discharge from irrigated lands; and
    c. is not provided as a water supply to be consumptively used upstream of the San Joaquin River at the Airport Way Bridge near Vernalis.

13. Entities providing dilution flows, as described in item 12, will obtain an allocation equal to the salt load assimilative capacity provided by this flow. This dilution flow allocation can be used to: 1) offset salt loads discharged by this entity in excess of any allocation or; 2) trade, as described in item 10. The additional dilution flow allocation provided by dilution flows will be calculated as described in Table IV-4.4.

~~14. It is anticipated that salinity and boron water quality objectives for the San Joaquin River from Mendota Dam to the Airport Way Bridge near Vernalis will be developed and considered for adoption in the second phase of this TMDL, according to time schedule in Table IV-4.1.~~

~~**Table IV-4.1: Schedule for developing water quality objectives for salt and boron in the LSJR from Mendota Dam to the Airport Way Bridge near Vernalis**~~

~~Milestone~~	~~Date~~
~~Staff report on criteria needed to protect beneficial uses~~	~~October 2004~~
~~Staff report and Regional Water Board workshop on water quality objectives that can reasonably be achieved~~	~~June 2005~~
~~Draft second phase TMDL with water quality objectives and program of implementation for LSJR from Mendota Dam to Airport Way Bridge near Vernalis~~	~~September 2005~~
~~Board Hearing for consideration of adoption~~	~~June 2006~~

Compliance with Water Quality Objectives Upstream of the Airport Way Bridge near Vernalis

~~15. Salinity and boron water quality objectives for the San Joaquin River from Mendota Dam to the Airport Way Bridge near Vernalis will be implemented using the implementation framework described in this 'Control Program for Salt and Boron Discharges into the Lower San Joaquin River' or other implementation mechanisms, as appropriate.~~

1. Per the amendments to the Basin Plan for control of salt and boron discharges into the LSJR basin between the Airport Way Bridge near Vernalis and the mouth of the Merced River, approved by the Regional Water Board in Resolution No. 88-195 and Resolution No. R5-2017-XXXX, and incorporated herein, the following actions will be implemented:

   a. The Regional Water Board will determine nonpoint source discharge compliance with electrical conductivity and boron WQOs using data collected at Crows Landing and Maze Road. Daily average electrical conductivity data will be utilized to calculate the 30-day running averages for electrical conductivitycompliance; weekly boron concentration data will be utilized to calculate the monthly average and maximum boron concentrations for compliance.
   b. The Regional Water Board has established a non-regulatory performance goal for the LSJR that represents a potentially-achievable 30-day running average that is lower than the WQO. As the Salt and Boron Control Program is implemented, the Regional Water Board will continue to evaluate whether this performance goal is achievable during the irrigation seasons of Wet, Above Normal, Below Normal, and Dry Water Years, as specified in Table IV-4.1.

Table IV-4.1: Electrical Conductivity Performance Goal Periods (except during Extended Dry Periods)

WY Type	Irrigation Season		Non-irrigation Season
	Mar-Jun	Jul-Sept	Oct-Feb
Wet	1350 µS/cm		
Above Normal	1350 µS/cm		
Below Normal	1350 µS/cm		
Dry	1350 µS/cm		
Critical			

   c. Attainment of the electrical conductivityPerformance Goal will be evaluated using data collected at Crows Landing and Maze Road.
   d. Ten years after Regional Water Board's adoption of the Basin Plan Amendment, and based on the evaluations described in the subparagraphs above, the Regional Water Board will consider reopening the Basin Plan to potentially revise the LSJR electrical conductivityWQOs.
   e. During an Extended Dry Period, the electrical conductivity WQO will be 2470 µS/cm (30-day running average) to protect the AGR beneficial use. In addition, during an Extended Dry Period, the electrical conductivity WQO for protection of the potential MUN beneficial use shall be 2200 µS/cm as the average of the previous four (4) consecutive quarterly samples at a minimum.

An Extended Dry Period is based in part on the water year type numeric indicator identified in the State Water Board's San Joaquin Valley "60-20-20" Water Year Hydrologic Classification[4] as follows:

- Wet – 5
- Above Normal – 4
- Below Normal – 3
- Dry – 2
- Critically Dry – 1

The indicator values will be used as follows to determine when an Extended Dry Period is in effect:

- An Extended Dry Period shall begin when the sum of the current year's 60-20-20 indicator value and the previous two year's 60-20-20 indicator values total six (6) or less.
- An Extended Dry Period shall be deemed to exist for one water year (12 months) following a period with an indicator value total of six (6) or less.

2. ~~Considerations~~ In addition to meeting the requirements of the Vernalis Salinity Control Program, considerations for NPDES permitted discharges to the LSJR are as follows: ~~hat meet the Vernalis Salinity Control Program requirements are as follows:~~

   a. When evaluating whether an NPDES point source discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion of the EC WQOs for the Lower San Joaquin River, the Regional Water Board should consider available dilution of the effluent in the receiving water, and may consider dilution as determined down to the first downstream diversion that provides AGR irrigation supply or MUN beneficial use.
   b. If an NPDES point source discharge is deemed to have reasonable potential to cause or contribute to an instream excursion above the EC WQOs, water quality-based effluent limits shall be required. For publicly-owned treatment works (POTWs), the water quality-based effluent limitations may be established in terms of EC concentration or total dissolved solids (TDS) loading to account for site-specific consideration of dry weather versus wet weather conditions. However, concentration and loading limits shall not be applied at the same time. When establishing water quality-based effluent limitations for POTWs in terms of TDS loading, an EC to TDS ratio of 0.64 shall be used to convert EC concentrations to TDS concentrations, unless a discharger-specific ratio can be demonstrated. The design average dry weather flow of the POTW shall be used to calculate the TDS loading limits.
   c. For NPDES point source discharges, if water quality-based effluent limits are required:
      i. effluent limitations for protection of AGR beneficial uses shall be expressed as monthly averages instead of thirty-day running averages;
      ii. effluent limitations for protection of MUN beneficial uses should be expressed as an annual average.

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4 The method for determining the San Joaquin Valley Water Year Hydrologic Classifications is defined in the State Water Board Revised Water Right Decision 1641, March 2000, Figure 2, page 189. This method uses the best available estimate of the 60-20-20 San Joaquin Valley water year hydrologic classification at the 75% exceedance level using the best available data published in the California Department of Water Resources' ongoing Bulletin 120 series.

a. When evaluating whether an NPDES point source discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion of the EC WQOs for the Lower San Joaquin River, the Regional Water Board shall consider available dilution of the effluent in the receiving water, as determined at the first downstream diversion that provides AGR irrigation supply or MUN beneficial use.

b. If an NPDES point source discharge is deemed to have reasonable potential to cause or contribute to an instream excursion above the EC WQOs at the first diversion that occurs downstream that provides AGR irrigation supply or MUN beneficial use, water quality-based effluent limits shall be required. For publicly-owned treatment works (POTWs) the water quality-based effluent limitations may be established in terms of EC concentration or total dissolved solids (TDS) loading to account for site-specific consideration of dry weather versus wet weather conditions. However, concentration and loading limits shall not be applied at the same time. When establishing water quality-based effluent limitations for POTWs in terms of TDS loading, an EC to TDS ratio of 0.64 shall be used to convert EC concentrations to TDS concentrations, unless a discharger-specific ratio can be demonstrated. The design average dry weather flow of the POTW shall be used to calculate the TDS loading limits.

c. For NPDES point source discharges, a receiving water limitation shall be required stating that the discharge shall not cause an exceedance of the EC WQOs in the receiving water, with compliance to be determined based on monthly average concentrations at the first downstream diversion that provides AGR irrigation supply or MUN beneficial use.

d. The Regional Water Board will incorporate the requirements of the EC water quality objectives for the Lower San Joaquin River when the NPDES permits are renewed or reopened at the discretion of the Regional Water Board.

16. A groundwater control program for sources of salt discharges into the LSJR will be developed by June 2020 if water quality objectives in the LSJR are not being attained.

Implementation Priority and Schedules

Salt Loading and the Vernalis Water Quality Objectives

17.The Regional Water Board will focus control actions on the most significant sources of salt and boron discharges to the LSJR. Priority for implementation of load allocations to control salt and boron discharges will be given to subareas with the greatest unit area salt loading (tons per acre per year) to the LSJR (Table IV-4.2). The priorities established in Table IV-4.2 will be reviewed by 28 July 2012 and every 6 years thereafter.

Table IV-4.2: Priorities for implementing load allocations[1]

Subarea	Priority
San Joaquin River Upstream of Salt Slough	Low
Grassland	High
Northwest Side	High
East Valley Floor	Low
Merced River	Low
Tuolumne River	Medium
Stanislaus River	Low
Delta Mendota Canal[2]	High

[1] Priorities based on the unit area salt load from each subarea and mass loading from the DMC

[2] Delta Mendota Canal is not a subarea

~~*Time Schedules for Implementation*~~

~~18~~1. The Regional Water Board will incorporate base load allocations into waste discharge requirements and real-time load allocations into conditions of waiver of waste discharge requirements by 28 July 2008. Dischargers regulated under a waiver of waste discharge requirements for dischargers participating in a real-time management program for the control of salt and boron in the LSJR shall comply with the waiver conditions within 1 year of the date of adoption of the waiver.

~~19~~2. Existing NPDES point source dischargers are low priority and subject to the compliance schedules for low priority discharges in Table IV-4.3. New point source discharges that begin discharging after the date of the adoption of this control program must meet the requirements of the Control Program for Salt and Boron Discharges into the ~~Lower San Joaquin River~~ LSJR upon the commencement of the discharge.

Table IV-4.3: Schedule for Compliance with the load allocations for salt and boron discharges into the LSJR

Priority	Year to implement[1]	
	Wet through Dry Year Types	Critical Year Types
High	8	12
Medium	12	16
Low	16	20

[1]number of years from the effective date [28 July 2006] of this control program

~~16~~3. A groundwater control program for sources of salt discharges into the LSJR will be developed by June 2020 if water quality objectives in the LSJR are not being attained.

Water Quality Objectives Upstream of the Airport Way Bridge near Vernalis

1. The electrical conductivity water quality objectives for the San Joaquin River between its confluence with the Merced River and the Airport Way Bridge near Vernalis will be implemented by 1 January 2020.

Table IV-4.4 Summary of Allocations and Credits

BASE SALT LOAD ALLOCATIONS

Base Load Allocations (thousand tons of salt)

	Month / Period												
Year-type[1]	Jan	Feb	Mar	Apr 1 to Apr. 14	Pulse Period [2]	May 16 to May 31	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet	41	84	116	23	72	31	0	0	5	45	98	44	36
Abv. Norm	44	84	64	26	71	14	0	0	0	44	58	35	32
Blw. Norm	22	23	31	11	45	8	0	0	0	38	41	34	30
Dry	28	39	25	5	25	1	0	0	0	25	31	27	28
Critical	18	15	11	0	0	0	0	0	0	19	30	26	23

REAL-TIME SALT LOAD ALLOCATIONS

Nonpoint source dischargers operating under waiver of waste discharge requirements or waste discharge requirements must participate in a Regional Water Board approved real-time management program and meet real-time load allocations. Loading capacity and real-time load allocations are calculated for a monthly time step. The following method is used to calculate real-time load allocations. Flows are expressed in thousand acre-feet per month and loads are expressed in ~~thousand~~ tons per month.

Loading Capacity (LC) in ~~thousand~~ tons per month is calculated by multiplying flow in thousand acre-ft per month by the salinity water quality objective in µS/cm, a unit conversion factor of 0. 8293, and a coefficient of 0.85 to provide a 15 percent margin of safety to account for any uncertainty.

$LC = Q * WQO * 0.8293 * 0.85$ where:
LC = total loading capacity in ~~thousand~~ tons per month
Q = flow in the San Joaquin River at the Airport way Bridge near Vernalis in thousand acre-feet per month
WQO = salinity water quality objective for the LSJR at Airport Way Bridge near Vernalis in µS/cm

The sum of the real-time Load Allocations (LA) for nonpoint source dischargers are equal to a portion of the LSJR's total Loading Capacity (LC) as described by the following equation:

$LA = LC - L_{BG} - L_{CUA} - L_{GW} - \Sigma WLA$ Where:
LA = sum of the real-time Load Allocations for nonpoint source dischargers
L_{BG} = loading from background sources
L_{CUA} = consumptive use allowance
L_{GW} = loading from groundwater
ΣWLA = sum of the waste load allocations for all point sources

Background loading in ~~thousand~~ tons is calculated using the following equation: $L_{BG} = Q *$

85 µS/cm * 0.8293

Table IV-4.4 Summary of Allocations and Credits (continued)

Consumptive use allowance loading is calculated with the following equation:

$$L_{CUA} = Q * 230\ \mu S/cm * 0.8293$$

Monthly groundwater Loading (L_{GW}) (in thousand tons)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
15	15	30	32	36	53	46	27	16	13	14	15

Waste load allocations for individual point sources are calculated using the following equation:

$$WLA = Q_{PS} * WQO * 0.8293$$

where:

WLA = waste load allocation in ~~thousand~~ tons per month

Q_{PS} = effluent flow to surface waters from the NPDES permitted point source discharger (in thousand acre-feet per month)

WQO = salinity water quality objective for the LSJR at Airport Way Bridge near Vernalis in μS/cm

APPORTIONING OF SALT LOAD ALLOCATION

An individual discharger or group of dischargers can calculate their load allocation by multiplying the nonpoint source acreage drained by the load allocation per acre.

$$LA\ per\ acre = \frac{LA}{nonpoint\ \ source\ \ acreage}\ Total$$

As of 1 August 2003, the total nonpoint source acreage of the LSJR Basin is 1.21-million acres. Nonpoint source land uses include all irrigated agricultural lands (including managed wetlands). Agricultural land includes all areas designated as agricultural or semi-agricultural land uses in the most recent land use surveys published by the California Department of Water Resources. California Department of Water Resources land use surveys are prepared and published on a county-by-county basis. Multiple counties or portions of counties may overlay a given subarea. The land use surveys must be used in combination with a Geographic Information System to quantify the agricultural land use in each subarea. Nonpoint source land areas will be updated every 6 years though an amendment to the Basin Plan if
updated California Department of Water Resources land use surveys have been published. The following land use surveys (or portions thereof) are used to quantify agricultural land use in the LSJR watershed.

County	Year of most recent land use survey[1]
Merced	1995
Madera	1995
San Joaquin	1996
Fresno	1994
Stanislaus	1996
[1]-as of 1 August 2003	

Acreage of managed wetlands is based on the boundaries of the federal, private and state owned wetlands that comprise the Grassland Ecological Area in Merced County. Agricultural lands (as designated in DWR land uses surveys) within the Grassland Ecological Area are counted as an agricultural land use and not as managed wetlands. All other lands within the Grassland Ecological Area are considered to be managed wetlands.

CONSUMPTIVE USE ALLOWANCE

In addition to the base load allocations or real-time load allocations shown above, a consumptive use allowance (L_{CUA}) is provided to each discharger:

L_{CUA} in tons per month = discharge volume in thousand acre-feet per month * 230 μS/cm * 0.8293

Table IV-4.4 Summary of Allocations and Credits (continued)

SUPPLY WATER CREDITS

A supply water credit is provided to irrigators in the Grassland and Northwest Side Subareas that receive water from the DMC. This DMC supply water credit is equal to 50 percent of the added salt load, in excess of background, delivered to Grassland and Northwest Side subareas. The following fixed DMC supply water credits apply to dischargers operating under base load allocations:

DMC supply water credits (thousand tons)

Year-type[1]	Month / Period												
	Jan	Feb	Mar	Apr 1 to Apr. 14	Pulse Period [2]	May 16 to May 31	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NORTHWEST SIDE SUBAREA													
Wet	0.0	0.2	0.0	0.7	1.4	0.7	2.0	2.6	2.6	1.0	0.9	0.6	0.0
Abv. Norm	0.0	0.0	0.0	0.8	1.9	1.0	2.3	2.3	2.6	1.2	0.8	0.3	0.0
Blw. Norm	0.0	0.0	0.0	1.0	2.6	1.5	3.4	4.2	3.3	2.5	1.9	0.8	0.0
Dry	0.0	0.0	0.0	0.1	0.3	0.2	0.3	0.5	0.5	0.2	0.2	0.0	0.0
Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRASSLAND SUBAREA													
Wet	2.1	5.9	13.9	7.8	17.3	8.8	22.6	20.8	23.2	17.2	16.0	10.4	3.7
Abv. Norm	1.2	4.8	9.4	10.4	24.7	13.6	27.6	20.3	24.5	23.9	16.6	7.5	2.6
Blw. Norm	1.4	5.7	13.8	12.5	29.5	15.9	32.6	29.2	29.8	32.9	25.3	12.8	4.5
Dry	2.2	6.7	15.9	11.1	23.4	11.2	22.9	23.1	24.0	28.0	23.7	13.0	5.3
Critical	3.3	8.9	17.2	10.2	24.1	13.3	33.3	32.5	31.8	27.5	28.7	13.6	5.9

The following method is used to calculate real-time DMC supply water credits in ~~thousand~~ tons per month and applies to dischargers operating under real-time load allocations.

Real-time CVP Supply Water Credit = Q_{CVP}* (C_{CVP} - C_{BG}) * 0.8293*0.5

Where:
Q_{CVP} = volume of water delivered from CVP in thousand acre-feet per month[3]
C_{CVP} = electrical conductivity of water delivered from CVP in μS/cm[3]
C_{BG} = background electrical conductivity of 85 μS/cm

For irrigators in the Northwest Side Subarea an additional supply water credit is provided to account for salts contained in supply water diverted directly from the LSJR (LSJR diversion water credit). The LSJR diversion credit is equal to 50 percent of the added salt load (in excess of background) in supply water diverted from the San Joaquin River between the confluence of the Merced River and the Airport Way Bridge near Vernalis. The following fixed LSJR supply water credits apply to dischargers operating under base load allocations:

LSJR supply water credits (thousand tons)

Year-type[1]	Month / Period												
	Jan	Feb	Mar	Apr 1 to Apr. 14	Pulse Period [2]	May 16 to May 31	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet	0.0	0.6	9.2	6.2	9.4	11.0	17.2	23.5	20.5	9.5	1.3	0	0
Abv. Norm	0.0	0.8	5.0	7.4	12.3	11.2	21.8	24.9	20.3	10.7	1.5	0	0
Blw. Norm	0.0	0.6	5.5	7.0	14.4	13.4	27.3	33.1	24.9	13.9	2.4	0	0
Dry	0.0	0.7	5.3	6.4	11.1	10.7	27.5	34.0	20.3	11.4	2.4	0	0
Critical	0.0	0.8	4.5	5.1	14.8	10.6	25.2	28.5	22.3	8.7	2.5	0	0

Table IV-4.4 Summary of Allocations and Credits (continued)

The following method is used to calculate Real-time LSJR supply water credits in ~~thousand~~ tons per month and applies to dischargers operating under real-time load allocations.

Real-time LSJR Supply Water Credit = $Q_{LSJR\ DIV} * (C_{LSJR\ DIV} - C_{BG}) * 0.8293 * 0.5$

Where:

$Q_{LSJR\ DIV}$ = volume of water diverted from LSJR between the Merced River Confluence and the Airport Way Bridge near Vernalis in thousand acre-feet per month[4]

$C_{LSJR\ DIV}$ = electrical conductivity of water diverted from the LSJR in µS/cm[4]

C_{BG} = background electrical conductivity of 85 µS/cm

SUPPLY WATER ALLOCATIONS

The U.S. Bureau of Reclamation DMC load allocation (LA_{DMC}) is equal to the volume of water delivered from the DMC (Q_{DMC}) to the Grassland and Northwest side Subareas at a background Sierra Nevada quality of 85 µS/cm.

$LA_{DMC} = Q_{DMC} * 85\ \mu S/cm * 0.8293$

DILUTION FLOW ALLOCATIONS

Entities providing dilution flows obtain an allocation equal to the salt load assimilative capacity provided by this flow, calculated as follows:

$A_{dil} = Q_{dil} * (C_{dil} - WQO) * 0.8293$

Where:

A_{dil} = dilution flow allocation in ~~thousand~~ tons of salt per month

Q_{dil} = dilution flow volume in thousand acre-feet per month

C_{dil} = dilution flow electrical conductivity in µS/cm

WQO = salinity water quality objective for the LSJR at Airport Way Bridge near Vernalis in µS/cm

[1] The water year classification will be established using the best available estimate of the 60-20-20 San Joaquin Valley water year hydrologic classification (as defined in Footnote 17 for Table 3 in the State Water ~~Resources Control~~ Board's *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*, ~~May 1995~~December 2006) at the 75% exceedance level using data from the Department of Water Resources Bulletin 120 series. The previous water year's classification will apply until an estimate is made of the current water year.

[2] Pulse period runs from 4/15-5/15. Period and distribution of base load allocation and supply water credits between April 1 and May 31 may change based on scheduling of pulse flow as specified in State Water Board Revised Water Rights Decision 1641. Total base load allocation for April 1 through May 31 does not change but will be redistributed based on any changes in the timing of the pulse period

[3] Methods used to measure and report the volume and electrical conductivity of water delivered from the CVP to irrigated lands must be approved by the Regional Water Board as part of ~~the~~ waste discharge requirements or waivers of waste discharge requirements conditions required to participate in a Regional Water Board approved real-time management program

[4] Methods used to measure and report the volume and electrical conductivity of water diverted from the SJR between the confluence of the Merced and the Airport Way Bridge near Vernalis must be approved by the Regional Water Board as part of the waiver conditions required to participate in a Regional Water

CHAPTER V SURVEILLANCE AND MONITORING

Modify the Basin Plan by adding a new heading and text to the bottom of page V-5.00, as follows:

Salt and Boron Discharges into the Lower San Joaquin River

The amendments to the Basin Plan that established boron and electrical conductivity WQOs for discharges into the lower San Joaquin River (LSJR) between the mouth of the Merced River and the Airport Way Bridge near Vernalis were approved by the Regional Water Board in Resolution No. 88-195 and Resolution No. 2017-XXXX, incorporated herein. The Regional Water Board will review data collected at Crows Landing and Maze Road to determine compliance with the LSJR electrical conductivity WQOs and attainment of the Performance Goal. Daily average electrical conductivity measurement calculations will be utilized to calculate the 30-day running average for WQO compliance and Performance Goal attainment. The Regional Water Board will review boron concentration data collected weekly at Crows Landing to determine if the monthly average or maximum boron WQOs are being exceeded. Should the boron objectives be exceeded at Crows Landing, boron analyses should be expanded to weekly sampling at Maze Road and the Airport Way Bridge near Vernalis. To evaluate changing loads into the system that may result from changing management activities and/or changes in hydrology, continuous flow monitoring is recommended in the river at Crows Landing, Maze Road and the Airport Way Bridge near Vernalis.

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LIST OF ACRONYMS AND ABBREVIATIONS

§	Section
µS/cm	Micro Siemens per centimeter
µg/L	Micrograms per liter
AB	Assembly Bill
AGR	Agricultural Supply
Basin Plan	Water Quality Control Plan for the Sacramento River and San Joaquin River Basins
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta Estuary
Central Valley Water Board	California Regional Water Quality Control Board – Central Valley Region
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
Control Program	Control Program for Salt and Boron Discharges into the Lower San Joaquin River
CV-SALTS	Central Valley Salinity Alternatives for Long-term Sustainability
CWA	Federal Water Pollution ControlClean Water Act (Clean Water Act)
CWC	California Water Code
Delta	Sacramento-San Joaquin Delta
EC	Electrical Conductivity at 25 degrees Celsius (an EC measurement made at or corrected to 25° C is equivalent to specific conductance)
LA	Load Allocation
LC	Loading Capacity
LSJR	Lower San Joaquin River
MAA	Management Agency Agreement
MUN	Municipal and Domestic Supply
NPDES	National Pollution Discharge Elimination System
NPS	nonpoint source
Porter-Cologne	Porter-Cologne Water Quality Control Act
RPA	Reasonable Potential Analysis
Salt Tolerance Report	*Salt Tolerance of Crops in the Lower San Joaquin River (Merced to Stanislaus River Reaches*
SJR	San Joaquin River
State Water Board	California State Water Resources Control Board

1 INTRODUCTION

Salinity management has been a long-term issue in the San Joaquin Valley. Upstream irrigation development and instream irrigation return flows in the Lower San Joaquin River (LSJR), coupled with the Valley hydrologic and geologic characteristics, are the principle reasons for the salinity problem in the Valley. In September 2004, the Central Valley Regional Water Quality Control Board (Central Valley Water Board) adopted an amendment to the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan), titled *Control Program for Salt and Boron Discharges into the Lower San Joaquin River* (Control Program). The Control Program was developed in response to directives from the State Water Resources Control Board (State Water Board) in Water Right Decision 1641 (D-1641) (State Water Resources Control Board, 2000). The Control Program established salt load limits in non-point source discharges and waste load allocations in point source discharges to the LSJR in an effort to achieve compliance with electrical conductivity (EC) Water Quality Objectives (WQOs) at the Airport Way Bridge near Vernalis, set by the State Water Board in the Water Quyality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (State Water Board, May 1995). This staff report provides the technical and policy foundation for a proposed amendment to the Control Program intended to meet a State Water Board directive to establish salinity WQOs in the LSJR upstream of Vernalis.

1.1 Background

1.1.1 Salinity Issues in the LSJR

The salt and boron water quality impairment in the LSJR is due, in large part to large-scale water development coupled with extensive agricultural land use and associated agricultural discharges in the watershed. LSJR flows have been severely diminished by the construction and operation of dams and diversions and the resulting consumptive use of water. Most of the natural flows from the Upper San Joaquin River (SJR) and its headwaters are diverted at the Friant Dam via the Friant-Kern Canal to irrigate crops outside the SJR Basin. Diverted natural river flows have been replaced with poorer quality (higher salinity) imported water from the Sacramento-San Joaquin Delta (Delta) that is primarily used to irrigate crops on the west side of the LSJR basin. Surface and subsurface agricultural discharges are the largest sources of salt and boron loading to the LSJR; and river water quality is heavily influenced by irrigation return flows during the irrigation season. Water quality generally improves downstream as higher quality flows from the Merced, Tuolumne, and Stanislaus Rivers dilute salt and boron concentrations in the main stem of the LSJR.

Since the 1940s, mean annual salt and boron concentrations in the LSJR at the Delta Boundary at Vernalis had increased significantly (Lower San Joaquin River Committee, 2013d). However, it was not until May 1991 that WQOs for salinity (EC, total dissolved solids and chloride) in the San Joaquin River near Vernalis were adopted by the State Water Board as part of the San Francisco Bay-Delta (Bay-Delta) Water Quality Control Plan review. These objectives were not however implemented. In 1995 and again in 2006, the State Water Board adopted the Bay-Delta Water Quality Control Plan, both of which included salinity objectives (EC) measured near Vernalis as well at three interior southern Delta sites (State Water Resources Control Board, 1995) (State Water Resources Control Board, 2006).

Adoption of D-1641 in 1999 by the State Water Board, in part, implemented the salinity standards contained in the Bay Delta Plan. The Bay Delta Plan and D-1641 directed the Central Valley Water Quality Board to:

a. Initiate its salt load reduction program to reduce annual salt loads to the San Joaquin River by at least 10 percent and to adjust the timing of discharges from low flow to high flow periods, and
b. Promptly develop and adopt salinity objectives and a program of implementation for the main stem of the San Joaquin River upstream of Vernalis.

In 1998, the San Joaquin River was listed on the federal Clean Water Act (CWA) section 303(d) list as impaired by electrical conductivity and boron (State Board Resolution 1998-055). CWA section 303(d)(1)(C) requires a State to establish a Total Maximum Daily Load (TMDL) for any pollutant causing an impairment of a beneficial use and/or non-attainment of an adopted WQO. Adoption of a TMDL for salt and boron under State Law meant that the Central Valley Water Board needed to develop a program of implementation to reduce salt and boron loading to levels needed to achieve the WQOs identified for the Bay-Delta at Vernalis and incorporate these requirements in a revision to its Basin Plan.

1.1.2 Salt and Boron Control Program

The Central Valley Water Board's 2004 amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) satisfied the first directive of the State Board's D-1641 as well as the CWA's requirement to adopt a TMDL to meet salt and boron water quality standards in the LSJR. The Control Program established salt load limits in non-point source discharges and waste load allocations in point source discharges to the LSJR in an effort to achieve compliance with existing EC WQOs at Vernalis. The Control Program was approved by the US EPA in 2006 and is implemented through waivers of waste discharge requirements (WDRs) or WDRs that apportion load allocations to different geographic subareas in the valley. As an alternative to the load allocations, the Control Program allows discharger participation in a Central Valley Water Board approved real-time management program as a means to attain salinity WQOs, while maximizing the export of salts out the watershed to help protect the region's agricultural production and long term sustainability. A Real Time Management Program (RTMP) was approved by the Central Valley Water Board in December 2014.

To address the State Water Board's second directive in D-1641, the Control Program also required that the Central Valley Water Board establish salinity WQOs in the San Joaquin River, upstream of Vernalis. The objective of this current basin plan amendment is to meet this requirement of the Control Program. This amendment does not propose to make any changes to the current WQOs established at Vernalis to protect beneficial uses in the southern portion of the Bay-Delta.

1.2 **Efforts to Develop Salinity Water Quality Objectives in LSJR**

1.2.1 **Central Valley Water Board Efforts (2006 – 2010)**

The Central Valley Water Board held an initial CEQA scoping meeting for a basin planning effort to develop the upstream WQOs on 11 May 2005. After preliminary studies, the Central Valley Water Board held a second CEQA scoping meeting on 30 March 2009, to limit the geographic scope of the project to the section of the river from its confluence with the Sanislaus River- to its confluence with the Merced River. During this same time frame, Central Valley Water Board staff focused their efforts on evaluating the salt-sensitivity of irrigated crops in the LSJR area. Staff subsequently released a draft report, Salt Tolerance of Crops in the Lower San Joaquin River (Merced to Stanislaus River Reaches) (LSJR draft Salt Tolerance Report) in March 2010 that presented the application of crop salt sensitivity parameters in a steady state soil salinity model to establish EC water quality criteria for the LSJR (Central Valley Water Board, 2010a) to protect irrigated agriculture.

1.2.2 **Lower San Joaquin Committee Efforts (2010 – Current)**

After receiving initial public comments on the LSJR draft Salt Tolerance Report, the Central Valley Water Board requested that the Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS) continue the effort on developing the salinity objectives including the policy and science to develop a basin plan amendment. CV-SALTS is a collaborative stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley.

To conduct the review of beneficial uses and WQOs on the LSJR, CV-SALTS established the Lower San Joaquin River Committee (LSJR Committee) as a stakeholder effort to conduct a review and recommend changes to the Basin Plan that will enable the Central Valley Water Board to use its regulatory tools to assure the protection of beneficial uses and manage salt in the basin. The LSJR Committee includes members of irrigation, water, and resource conservation districts, city, county, state and federal agencies, producers, growers, irrigators, water quality and watershed coalitions, managed wetlands, drainage authorities, clean water and wastewater associations, consultants of various organizations and other interested parties. The LSJR Committee developed a work plan to guide the completion of a Basin Plan Amendment for establishing salinity WQOs and an implementation program to meet those objectives for the LSJR, between the Merced River inflow and the Airport Way Bridge near Vernalis Reach 83).

1.3 **LSJR Committee Work Plan**

In the development of the Work Plan (Lower San Joaquin River Committee, 2012), the LSJR Committee discussed the following goals for the program of establishing WQOs for the LSJR:

a. Reasonable protection of beneficial uses;
b. Maintain the capability to increase the level of beneficial use of the LSJR;
c. Set up a comprehensive plan to achieve salt balance in the river basin which is inclusive of all current and developing water beneficial uses and economic interests;
d. Establish WQOs and implementation mechanisms that not only protect beneficial uses in the LSJR basin but also downstream;
e. Develop objectives and implementation based on sound science;
f. Identify feasible plans for funding the implementation alternatives, projects and follow-up needed to demonstrate success;
g. Develop broad public understanding and ownership of the salt management plan within the LSJR Basin and beyond in the Central Valley;
h. Provide regulatory certainty to encourage capital investment and long-range planning that provides adaptability and flexibility; and
i. Use common language, understanding and decision tools.

The tasks identified to meet these goals included the following:

1) Prepare San Joaquin River Basin description and water use reports

2) Evaluate LSJR beneficial uses
3) Review established salinity objectives and potential water quality criteria
4) Review and select a salinity water quality model that can be used to establish potential WQOs for the LSJR
5) Review and select a water quality model to establish baseline salinity levels in the river
6) Review and select potential management implementation actions to model and assess feasibility and achievability
7) Develop and analyze project alternatives
8) Prepare economic analysis of implementation actions to meet potential alternatives
9) Prepare a program of implementation, including monitoring and surveillance
10) Prepare environmental and CEQA documentation
11) Prepare final recommendations to the Central Valley Water Board

The work described in this Staff Report and the proposed WQOs herein are the result of this stakeholder-driven effort led by the LSJR Committee in coordination with staff from the Central Valley Water Board.

2 PROJECT AREA DESCRIPTION

2.1 Watershed Setting

The Central Valley Water Board is responsible for the water quality of the Central Valley of California. The Central Valley is comprised of two valleys, the Sacramento Valley and the San Joaquin Valley. The San Joaquin Valley is, in turn, divided into two basins, the San Joaquin River Basin and the Tulare Lake Basin. The Tulare Lake Basin is an enclosed basin with no natural drainage. The San Joaquin River drains the San Joaquin River Basin while the Sacramento River drains the Sacramento Valley. Both the Sacramento River and San Joaquin River drain into the Sacramento River and San Joaquin River Delta (Delta) that flows into San Francisco Bay.

The San Joaquin River watershed is bordered by the Sierra Nevada Mountains on the east, the Coast Range on the west, the Delta to the north, and the Tulare Lake Basin to the south. From its source in the Sierra Nevada Mountains, the San Joaquin River flows southwesterly until it reaches Friant Dam. Below Friant Dam, the SJR flows westerly to the center of the San Joaquin Valley near Mendota, where it turns northwesterly to eventually join the Sacramento River in the Delta. The main stem of the entire SJR is about 300 miles long and drains approximately 13,500 square miles.

The major tributaries to the San Joaquin River upstream of the Airport Way Bridge near Vernalis (the boundary of Delta) are on the east side of the San Joaquin Valley, with drainage basins in the Sierra Nevada. The Sierra Nevada is the primary source of both the valley's water supply and the alluvial material that forms the eastern side of the valley floor and along the San Joaquin River as it moves through the valley trough. The major east side tributaries are the Stanislaus, Tuolumne, and Merced Rivers. The Cosumnes, Mokelumne, and Calaveras Rivers flow into the San Joaquin River downstream of the Airport Way Bridge near Vernalis.

In 1945, the headwaters of the San Joaquin River, captured in the Millerton Reservoir after completion of Friant Dam, were diverted to the Tulare Lake Basin through the Friant-Kern Canal. These diversions have resulted in long stretches of the river between Friant Dam and the mouth of the Merced River receiving no fresh water most of the time. Downstream of the Merced River, flows in the San Joaquin River increase and salinity levels decrease somewhat as it picks up higher quality water from the Merced and its other major tributaries, particularly the Tuolumne and Stanislaus Rivers to the east. All of the main eastside river flows are managed by regulated reservoirs.

The Coast Range provides the alluvial material for a major portion of the western side of the river and several smaller, ephemeral streams flow into the SJR from this side of the valley. These streams include Hospital, Ingram, Del Puerto, Orestimba, Panoche, and Los Banos Creeks. All have drainage basins in the Coast Range, flow intermittently, and contribute sparsely to water supplies. Mud Slough (north) and Salt Slough also drain the Grassland Watershed on the west side of San Joaquin Valley. During the irrigation season, surface and subsurface agricultural return flows contribute greatly to these west side creeks and sloughs.

2.2 **Geology and Hydrology**

The geology of the Sierra Nevada Range on the east side of the San Joaquin River Basin and the Coast Ranges on the west side has had a marked influence on the valley floor sediments and salinity. Drainage from the western slope of the Sierra Nevada has created large alluvial fans of low-salinity, well sorted sands and gravels on the eastern side of the Basin. This has resulted in coarse-textured alluvial material on the east side of the San Joaquin River that is low in natural salinity and boron. As one moves westward on the alluvial fans towards the valley trough, this coarse-textured material becomes finer. In contrast, the Coast Ranges are made up of Jurassic and Cretaceous sandstones and shales of marine origin. These are known to be high in salt and boron.

The predominant storm track for the Central Valley is west to east from the Pacific Ocean. This makes the eastern side of the Coast Range (the portion making up the western side of the San Joaquin River Basin) a rain shadow of lower rainfall. In contrast, the western slopes of the high-altitude Sierra Nevada receive considerably more precipitation than the eastern side of the Sierra Nevada. The lower rainfall on the western side of the San Joaquin River Basin has resulted in poorly sorted sediments that, as a general rule, are of lower permeability and higher salinity when compared to those on the eastside.

Typical of a Mediterranean climate, precipitation in the watershed varies annually and seasonally, as well as by watershed elevation. Precipitation in the Basin ranges from as little as 5 inches per year on the valley floor to over 80 inches per year at the higher elevations of the Sierra Nevada (U.S. Geological Survey, 1998). Most of the precipitation falls in the late fall, winter and early spring periods with a prolonged dry period in the remainder of the year. Precipitation is predominately snow above 4 -5,000 feet elevation with rain in the middle and lower elevations of the Sierra Nevada and Coast Range. As a result, natural hydrology reflects a mixed runoff regime, dominated by winter-spring rainfall runoff and spring-summer snowmelt runoff (McBain and Trush, 2002). Snowmelt runoff generates a majority of the flow volume from the watershed with little runoff contributed from the western side of the Basin in the rain shadow of the Coast Ranges.

Historically, wetlands covered a large portion of the San Joaquin River Basin, fed by floods that overflowed the banks of the tributaries and main stem of the San Joaquin River. These floods inundated the valley floor and were caused by rainfall events in the valley and the lower elevations of the Sierra Nevada during the winter and spring months, and by snow melt from higher elevations during the spring and summer months. Over 90 percent of these wetlands were drained and farmed during the latter part of the 19th century and the early 20th. In conjunction with this land use change, the river and most of its tributaries were dammed and the flows stored in reservoirs. This has changed the hydraulics of the valley floor from one predominated by flooding and overbanking of the stream and river channels to one predominated by irrigation applied over much of the valley floor.

Winter or spring rain-on-snow events likely contributed the largest instantaneous flow events and played a major role in channel forming processes while the snow melt period was probably the longest prolonged flow periods and contributed to overbank inundation and high water tables. This created a vast floodplain and wetland habitat that supported large populations of fish and wildlife (McBain and Trush, 2002).

2.3 **LSJR Project Area**

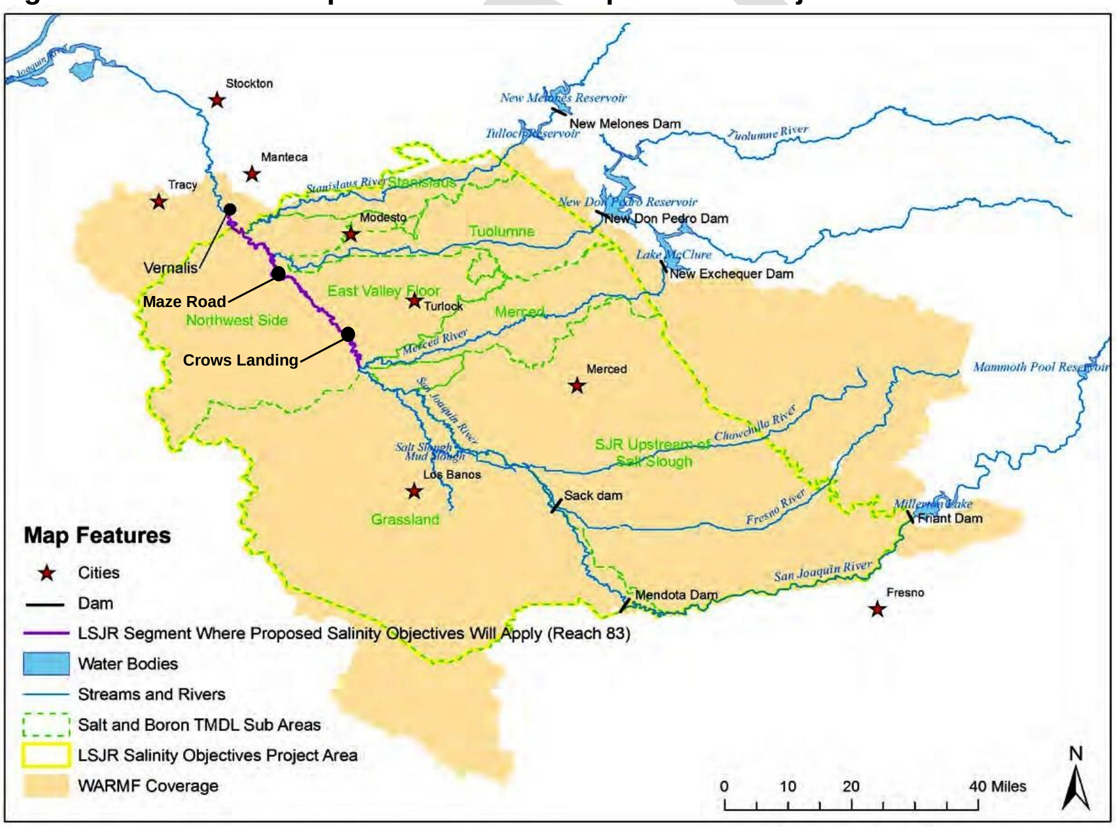
This project addresses water quality in the LSJR watershed, a subset of the San Joaquin River Basin. The LSJR watershed is defined as the area draining to the San Joaquin River from Mendota Dam to the Airport Way Bridge near Vernalis (132.5 miles). The geographic scope of the project area is the LSJR from its confluence with the Merced River to the Airport Way, near Vernalis (46.3 miles). Figure 2-1 shows the LSJR project area. The Basin Plan defines this stretch of the San Joaquin River as Reach 83. The eastern boundary of the LSJR watershed excludes the areas upstream of dams on the major eastside reservoirs including Lake McClure, New Don Pedro, New Melones, and other similar reservoirs in the LSJR system. The southeastern boundary of the project area is formed by the upper San Joaquin River (from Friant Dam to Mendota Dam). Water conditions in the LSJR at its confluence with the Merced River are influenced by the upstream inflows, including Salt Slough and Mud Slough entering from the westside.

The LSJR project area is about 68.5 thousand acres, with over 75% of the area made up of irrigated agriculture and managed wetlands, according to surveys conducted by the Department of Water Resources (DWR) (California Department of Water

Resources, 2009). Those likely to use water for irrigation include individual water right holders and water agencies such as West Stanislaus Irrigation District (ID), Patterson ID, and El Solyo Water District (WD). More information on the type of irrigated crops grown in the LSJR project area is provided in Chapter 5, Water Quality Objectives. The non-irrigated lands in the LSJR Project area include urban areas, water courses, residential properties, open land, dairies and feedlots and farm homesteads.

The LSJR project area includes portions of San Joaquin, Stanislaus, and Merced counties. The reach of the LSJR from the Merced River to Tuolumne River is 34.7 miles in length. The reach includes two commonly used water monitoring sites: Crows Landing and Patterson. The major tributaries draining the eastside of the project area in this reach are the Merced and the Tuolumne Rivers, while Orestimba, Salado, and Del Puerto Creeks drain the west side. The LSJR from the Tuolumne River to the Stanislaus River is 8.4 miles in length and is drained on the west side by Ingram and Hospital creeks, and includes the Maze Road monitoring site. The stretch from the Stanislaus River to the Airport Way Bridge, near Vernalis is 2.7 miles in length.

Figure 2-1 Overview map of Lower San Joaquin River Project Area



2.4 **Historic Salinity Water Quality and Resulting Limitations**

The construction of Friant Dam, the diversion of headwaters to the Tulare Lake Basin, and the replacement of Sierra Nevada flows with Sacramento-San Joaquin Delta diversions, fundamentally changed natural hydrologic conditions within the LSJR Basin. Salinity concentrations for the LSJR between the Merced River and Vernalis became primarily dependent on freshwater flows from the east through the Merced, Tuolumne and Stanislaus Rivers, agricultural drainage from the west, and groundwater accretion. Salinity concentrations measured in the LSJR as electrical conductivity (uS/cm) from 1986 through 2013, are depicted in Figures 2-2 and 2-3 for Crows Landing (augmented with information from the nearby Patterson site) and Maze Road, respectively. These locations are shown on Figure 2-1. The Maze Road site is downstream of both the Merced and Tuolumne Rivers and has overall lower salinity concentrations than the Crows Landing site which is just downstream of the Merced River.

The concentrations at each site vary widely both by season within a water year (from October 1 through September 30) as well as between water year types. Wet water years as defined by the San Joaquin Valley Water Year Index, as defined in State Water Board Revised Water Right Decision 1641 (D-1641) (State Water Resources Control Board, 2000) occurred during 1986, 1993, 1995 through 1998, 2005, 2006, and 2011, and have distinctly lower electrical conductivity than those found during critically dry years such as 1987 through 1992, 2007, 2008 and 2013.

After 1985, more focus was directed at water quality within the LSJR due to recognition of elevated concentrations of selenium entering the river through Mud Slough (north) and Salt Slough from the Grassland Drainage Area (Figure 2-1). Monitoring increased within the river providing a more thorough record for salinity concentrations in addition to the information gathered on selenium. The Grassland Bypass Project (GBP) was initiated in September 1996 and began to progressively reduce the amount of subsurface agricultural drainage from the Grassland Drainage Area entering the LSJR upstream of Crows Landing. The GBP had a notable effect on overall salinity concentrations in the LSJR. Pre-GBP, salinity concentrations at Crows Landing regularly exceeded 2,200 umhos/cm measured as electrical conductivity (EC) and exceeded 2,500 EC during critically dry years such as Water Years 1987 and 1992. Post-GBP, salinity concentrations remain below 2,000 EC even during critically dry Water Years 2007, 2008 and 2013 (Figure 2-2).

The pattern of reduction pre- and post-GBP is also apparent at the Maze Road location, which is downstream of the Tuolomne River. Pre-GBP salinity regularly exceeded 1,600 EC and reached 1,800 EC during critically dry water years, while post-GBP salinity concentrations remained below 1,400 EC (Figure 2-3).

Figures 2-4 and 2-5 show the distinct seasonal patterns as well as overall differences between Water Year types for salinity at both Crows Landing and Maze Blvd., respectively, post-GBP. Relatively elevated salinity levels occur during the irrigation season at both locations between July and October, but peak concentrations tend to occur during the spring, between March and May for all but above normal and wet rainfall years. These peak concentrations correspond to pre-irrigation activities and the draining of seasonal wetlands.

Figure 2-2 Crows-Patterson Historical Daily Average EC

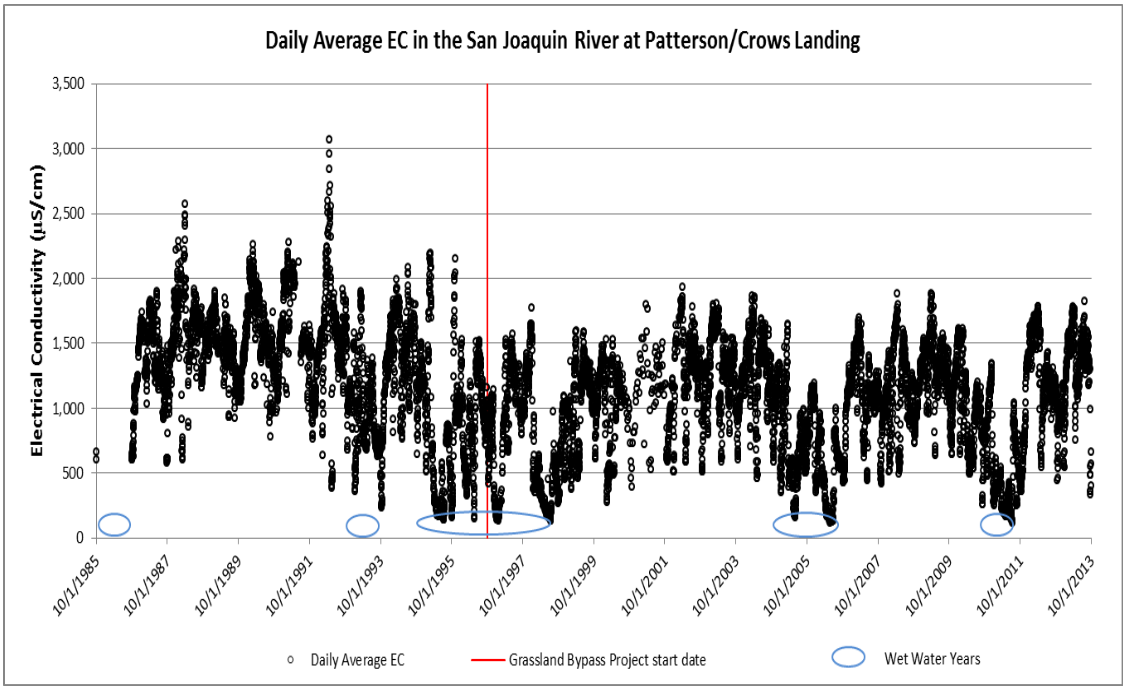


Figure 2-3 Maze Road Historical Daily Average EC

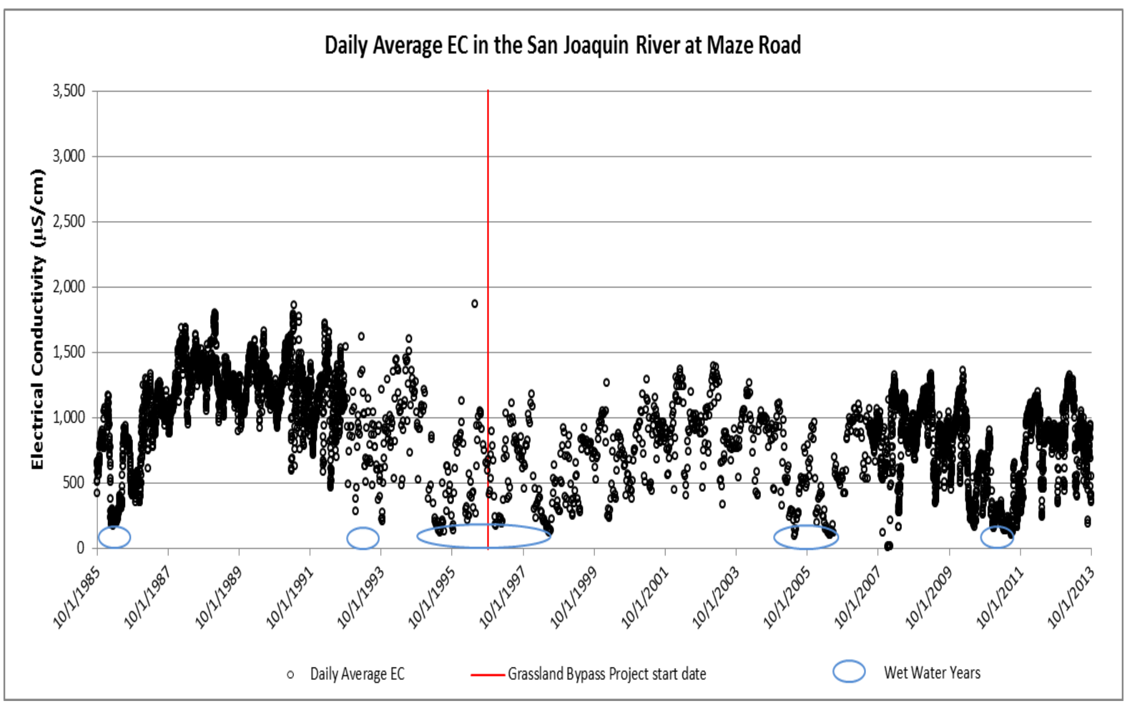


Figure 2-4 Crows-Patterson Historical Daily Average of 30-day Running Average EC by Water Year Type

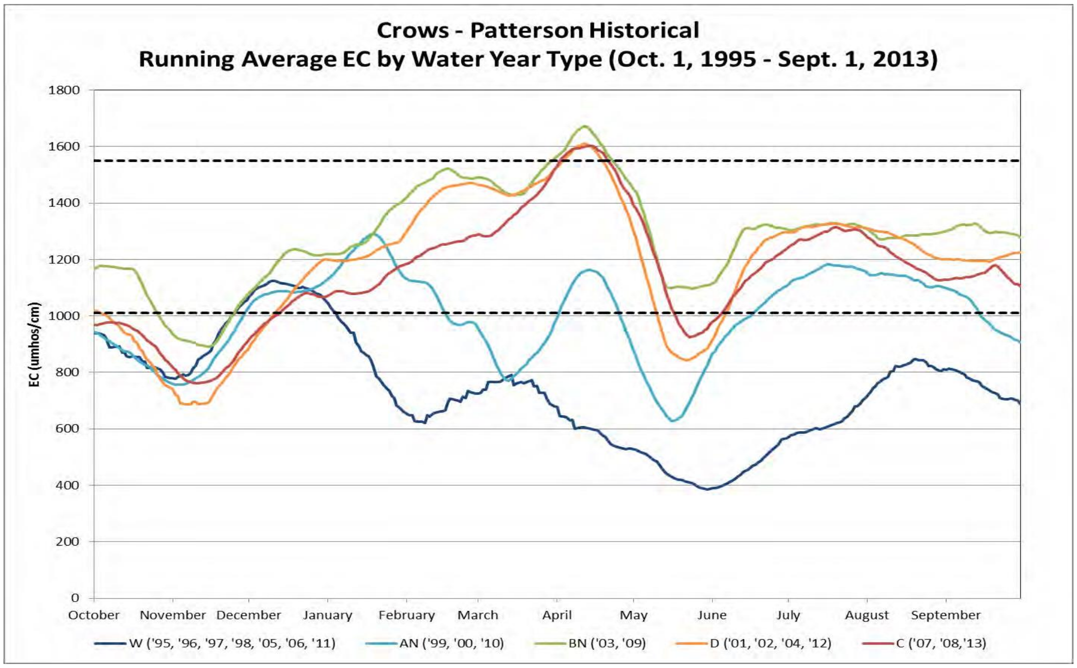
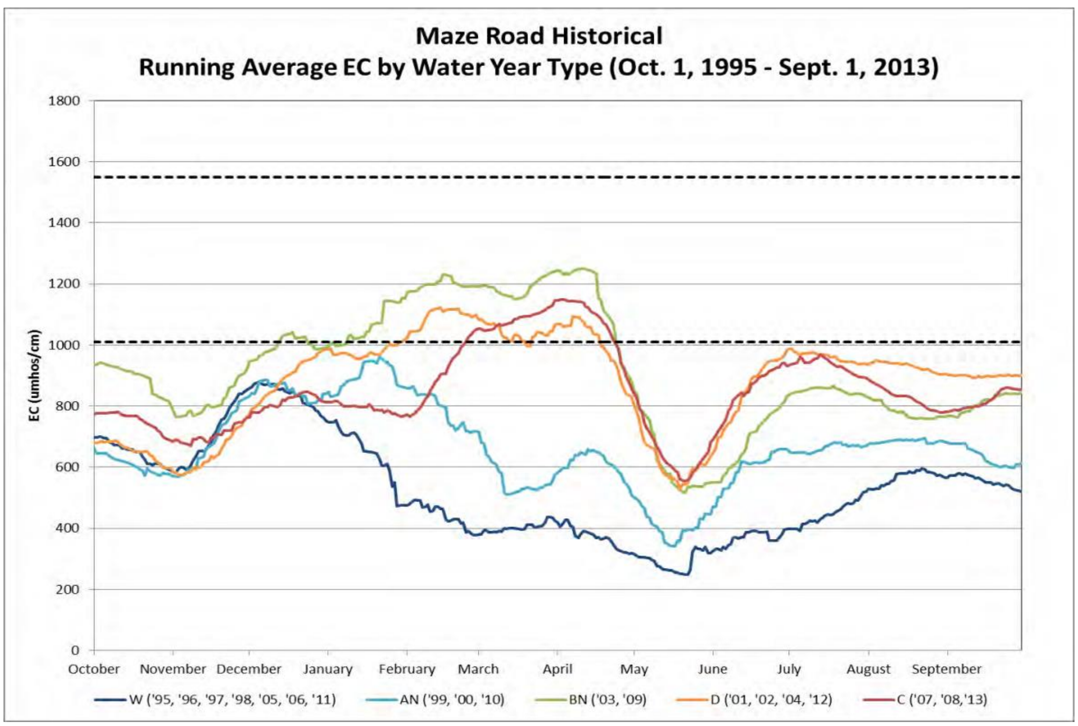


Figure 2-5 Maze Road Historical Daily Average of 30-day Running Average EC by Water YearType



2.5 **Biological Resources**

The San Joaquin Valley provides habitat for fish and wildlife with as many as 24 state or federally listed threatened and endangered species (plant and animal). Historically, the LSJR and tributaries provided a diverse fishery resource, including large populations of salmon, steelhead, sturgeon, American shad, and striped bass. Steady declines in fish and wildlife habitat have occurred since development of major water projects, with approximately 85 percent of historic seasonal and permanent wetlands having been drained and/or reclaimed for agriculture and drastic reductions of the Chinook Salmon Fishery with the completion of dams and diversion structures. Although striped bass continued to spawn in the southern Delta, it was noted that they only migrated into the LSJR during the wettest years, and that the run of striped bass was small even under ideal conditions (Radtke and Turner, 1967); (Turner, 1966); (State Water Resources Control Board, 1991).

During the 1991 review of the Bay-Delta Plan, the State Water Board re-evaluated the salinity objectives that had been adopted to protect striped bass spawing (440 EC) near Prisoners Point in the LSJR downstream of Vernalis. The review determined that the objective and location were appropriate and acknowledged that not setting similar objectives in the reach of the river upstream of Prisoners Point ". . .effectively establishes a barrier to adult migration and spawning farther upstream on the San Joaquin River." Moving the lower salinity barrier upstream of Prisoners Point was not recommended, due in part to elevated salinity concentrations upstream, lack of consistent dilution (which was provided by the movement of Sacramento River water through the Delta Cross Channel in the Prisoners Point area), and assumptions that eggs and young that were produced farther upstream would be carried to the export pumps. The review also notes the lack of a strong experimentally-derived correlation between salinity and spawning success for similar environments and documents the concerns in its Appendix 5.4.5.

As part of the 1991 revision of the Bay-Delta Plan, the State Water Board adopted salinity water quality objectives for salinity at Vernalis as follows:

- Irrigation Season (Apr1-Aug31): 700 uS/cm (30-day running average)
- Non-Irrigation Season (Sep1-Mar31): 1,000 uS/cm (30-day running average)

The objectives were adopted to provide reasonable protection of beneficial uses in the Delta downstream of Vernalis and were based on protection of agricultural irrigation supply. These objectives apply between Vernalis and Prisoners Point and while they may be limiting striped bass spawning by contributing to the creation of a "salinity barrier", the bass do still migrate into the LSJR and upstream tributaries.

The barrier was also thought to limit sturgeon spawning in the upper river, but recent studies have identified white sturgeon spawning in wet and dry Water Years (2011 and 2012, respectively) just downstream of the inflow from the Tuolumne River (Jackson and Van Eenennaam, 2013). The finding may correspond to the fact that sturgeon were noted to be broadly tolerant of temperature, salinity and flow in a 2015 peer-reviewed paper in San Francisco Estuary & Watershed Science titled *Sturgeon in the Sacramento-San Joaquin Watershed: New Insights to Support Conservation and Management* (Klimley, A. Peter, et al., 2015).

Green sturgeon have not been identified in the LSJR above Vernalis. Studies tracking migration patterns have identified the green sturgeon and, in particular, their spawning habitat as being contained within the Delta and Sacramento River Basin (Klimley, A. Peter, et al., 2015).

3 LAWS, REGULATIONS, AND POLICIES RELEVANT TO BASIN PLANNING

This staff report proposes amendments to the Basin Plan. There are a number of federal and state laws, regulations and policies that are specifically relevant to the Basin Planning process. This chapter summarizes these laws, regulations, and policies.

3.1 Legal Requirements for Establishing and Amending the Basin Plan

Water Code section 13240 authorizes the Regional Water Boards to formulate and adopt water quality control plans for all areas within their region. A Basin Plan is the basis for regulatory actions taken for water quality control. The Basin Plan is also used to satisfy parts of Section 303 of the Federal Clean Water Act (CWA), which requires states to adopt water quality standards. Basin Plans are adopted and amended by the Regional Water Boards through a structured process involving full public participation and state environmental review. Basin Plan amendments do not become effective until approved by the State Water Board and the Office of Administrative Law (OAL). U.S. Environmental Protection Agency (USEPA) approval is required for Basin Plan amendments that affect surface water quality standards. This Basin Plan amendment proposes changes to the existing water quality standards as well as the implementation of new standards.

A Basin Plan must consist of the following (Wat. Code § 13050.):

- beneficial uses to be protected,
- WQOs to protect those uses, and
- a program of implementation needed for achieving WQOs.

Regional Water Boards adopt and amend basin plans through a structured process involving peer review, public participation, and environmental review. Regional Water Boards must comply with CEQA (Pub. Res. Code., § 21000 et seq.) when amending their basin plans. The Secretary of Natural Resources has certified the basin planning process as exempt from the CEQA requirement to prepare an environmental impact report. (Pub. Res. Code, § 21080.5; Cal. Code Regs., tit. 14, § 15251, subd. (g).) Instead, State Water Board regulations on its exempt regulatory programs require the Regional Water Boards to prepare a written report and an accompanying CEQA Environmental Checklist and Determination with respect to Significant Environmental Impacts (CEQA Checklist) (Cal. Code Regs., tit. 23, § 3775 et seq.)

The next sections detail the laws, regulations and policies that apply to Basin Planning and are relevant to the proposed amendments.

3.2 Legal Requirements for Establishing, Designating and Modifying Beneficial Uses

3.2.1 Federal ~~Regulations~~ Statutes and ~~Guidance~~Regulations

The Federal Water Pollution Control Act (Clean Water Act, 33 U.S.C. § 1251 et seq.) is the primary federal law regulating the discharge of pollutants to navigable waterways. The Clean Water Act's primary purpose is to, "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." (33 U.S.C., §1251) The Clean Water Act delegates to the states the primary duty of establishing water quality standards. (33 U.S.C., § 1313) Water quality standards are state laws that describe the desired condition of state waterbodies subject to the jurisdiction of the Clean Water Act, and consist of the designated uses of such waters and water quality criteria that are protective of such uses. State beneficial use designations must take into consideration the use and value of water for public water supplies, protection and propagation of fish, shellfish and wildlife, recreation in and on the water, agricultural, industrial, and other purposes, including navigation. (40 C.F.R. § 131.10.)

Federal regulations require the protection of designated uses in all waters of the United States. Federal regulations establish special protections for the uses specified in Clean Water Act section 101(a)(2). Clean Water Act section 101(a)(2) states that it is a national goal that, wherever attainable, water quality should be sufficient "for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water." These uses are also referred to as "fishable/swimmable" uses.

Under 40 CFR section 131.10, subdivision (j), a state must conduct a "use attainability analysis" (defined in 40 CFR § 131.3, subd.(g).) whenever a state wishes to remove a designated fishable/swimmable use from a waterbody. 40 CFR section 131.10, subdivision (g) defines six circumstances where it would be appropriate for a state to remove a fishable/swimmable use.

3.2.2 State ~~Regulations~~ Statutes and ~~Guidance~~Regulations

The existing and potential beneficial uses are defined by the Central Valley Water Board in Chapter II of the Basin Plan (Central Valley Water Board, 2016a).

Chapter II, page II-1.00 of the Basin Plan states that,

> "Beneficial uses are critical to water quality management in California. State law defines beneficial uses of California's waters that may be protected against quality degradation to include (and not be limited to) '...domestic; municipal; agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves' (Water Code Section 13050(f))."

In addition, Water Code section 13241 requires that, "past, present, and probable future beneficial uses of water" be considered in establishing WQOs. The Basin Plan also emphasizes that, "[p]rotection and enhancement of existing and potential beneficial uses are primary goals of water quality planning."

Page II-1.00 of the Basin Plan describes several points that need to be considered in setting and protecting beneficial uses:

- *"All water quality problems can be stated in terms of whether there is water of sufficient quantity or quality to protect or enhance beneficial uses.*
- *Beneficial uses do not include all of the reasonable uses of water. For example, disposal of wastewaters is not included as a beneficial use. This is not to say that disposal of wastewaters is a prohibited use of waters of the State; it is merely a use which cannot be satisfied to the detriment of other beneficial uses. Similarly, the use of water for the dilution of salts is not a beneficial use although it may, in some cases, be a reasonable and desirable use of water."* [The finding and pronouncement that management of salt is an important consideration in the use of water is significant as it defines the policy of the Board to not exclude the management of salt within existing water supplies provided it is not done to the detriment of other beneficial uses.]
- *The protection and enhancement of beneficial uses require that certain quality and quantity objectives be met for surface and ground waters.*
- *Fish, plants, and other wildlife, as well as humans, use water beneficially.*

Beneficial use designation (and water quality objectives, see Chapter III of the Basin Plan) must be reviewed at least once during each three-year period for the purpose of modification as appropriate (40 CFR 131.20)."

3.2.3 **State Water Board Sources of Drinking Water Policy (Resolution 88-63)**

State Water Board Resolution 88-63, the Sources of Drinking Water Policy (*Sources of Drinking Water Policy*) establishes state policy that all waters are considered suitable or potentially suitable to support the MUN beneficial use, with certain exceptions.

The Basin Plan implements the *Sources of Drinking Water Policy* by assigning the MUN beneficial use to all water bodies that do not have their individual uses specifically listed in Table II-1. The *Sources of Drinking Water Policy* allows the Regional Water Boards to make exceptions to the MUN designation for surface and ground waters: 1) with total dissolved solids exceeding 3,000 mg/L (5,000 µS/cm EC); 2) with contamination that cannot reasonably be treated for domestic use; 3) where there is insufficient water supply for a single well to provide an average, sustained yield of 200 gallons per day; 4) in systems designed for wastewater collection or conveying or holding agricultural drainage; or 5) regulated as a geothermal energy producing source. Exceptions to the *Sources of Drinking Water Policy* may be made by amendment of water quality control plans. The *Sources of Drinking Water Policy* addresses only the designation of waters as sources of drinking water; it does not establish objectives for constituents that are protective of the designated MUN use.

3.3 **Laws that Apply to the Establishment of Water Quality Objectives**

3.3.1 **Federal ~~Regulations~~ Statutes and ~~Guidance~~Regulations**

Federal regulations define water quality criteria to be, "… elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use." (40 C.F.R. § 131.3, subd. (b).) States must adopt water quality criteria to protect a waterbody's designated uses. Such criteria must be based on sound scientific rationale. (40 C.F.R. § 131.11.)

> ~~Federal regulations require states to adopt narrative or numeric water quality criteria to protect designated beneficial uses (40 CFR §131.11(a)(1).)~~

3.3.2 **State Statutes, Regulations and Guidance**

Water Code section 13050, subdivision (h), defines water quality objectives as "…the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area."

Pursuant to Water Code section 13241, when establishing water quality objectives, the Regional Water Board is required to consider:

(a) Past, present, and probable future beneficial uses of water;
(b) Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto;
(c) Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;
(d) Economic considerations;
(e) The need for developing housing within the region;
(f) The need to develop and use recycled water

3.4 Laws that Apply to the Establishment of an Implementation Program in the Basin Plan

3.4.1 Federal Regulations and Guidance

Through Section 402, the Clean Water Act establishes a permitting system (the National Pollutant Discharge Eliminations System, or NPDES) that regulates the direct discharge of pollutants to surface waters of the United States. The USEPA has established regulations at 40 Code of Federal Regulations part 122 for the NPDES program. Individual states, including the State of California, may administer the federal NPDES Program, provided state laws meet the criteria established in 40 Code of Federal Regulations part 123.

40 Code of Federal Regulations section 122.44(d)(1)(ii) sets forth the criteria for establishing a procedure for determining whether a discharge has a reasonable potential to cause or contribute to a violation of water quality standards. It states, "When determining whether a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above a narrative or numeric criteria within a State water quality standard, the permitting authority shall use procedures which account for existing controls on point and nonpoint sources of pollution, the variability of the pollutant or pollutant parameter in the effluent, the sensitivity of the species to toxicity testing (when evaluating whole effluent toxicity), and where appropriate, the dilution of the effluent in the receiving water." While the federal regulations do not contain explicit procedures to derive effluent limitations, USEPA has provided guidance (U.S. Environmental Protection Agency, 1991) that includes explicit procedures.

3.4.2 **State Statues, Regulations, and Guidance**

*3.4.2.1 **Water Code sections 13050 and 13242***

Pursuant to Water Code section 13050, subdivision (j)(3), a basin plan amendment must include an implementation program to achieve water quality objectives. Water Code section 13242 requires that a program of implementation for achieving water quality objectives must include the following:

1) A description of the actions necessary to achieve the water quality objectives;
2) A time schedule; and
3) A description of monitoring and surveillance that must be undertaken to determine compliance with objectives.

*3.4.2.2 **Water Code section 106.3***

In compliance with Water Code section 106.3, it is the policy of the State of California that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes.

3.5 **Economic Review**

California Law requires a consideration of economics when: (i) establishing water quality objectives (Wat. Code, § 13241. Subd. (d).); (ii) before implementing an agricultural water quality control program (Wat. Code, § 13141.); and (iii) when adopting an amendment that will require the installation of pollution control equipment or is a performance standard or treatment requirement (Pub. Resources Code, § 21159.).

3.5.1 **Water Code section 13241**

See the fourth factor (d) in section 3.3.2

3.5.2 **Water Code section 13141**

Water Code section 13141 states that, "prior to implementation of any agricultural water quality control program, an estimate of the total cost of such a program, together with an identification of potential sources of financing, shall be indicated in any regional water quality control plan." Section 1.2.1 describes the costs for implementing agricultural water quality control program in the no-action alternative. Section 1.2.1.3 describes the identification of potential sources of financing and the need to develop a comprehensive and regional financial strategy.

3.5.3 Public Resources Code section 21159

Public Resources Code section 21159 requires that an agency must perform "an environmental analysis of the reasonably foreseeable methods of compliance" for "…a rule or regulation that requires the installation of pollution control equipment or a performance standard or treatment requirement…The environmental analysis shall take into account a reasonable range of environmental, economic, and technical factors, population and geographic areas, and specific sites."

3.6 Environmental Review – CEQA

The Central Valley Water Board, as a Lead Agency under the California Environmental Quality Act (CEQA), is responsible for evaluating all the potential environmental impacts that may occur due to changes made to the Basin Plan. (Pub. Res. Code, § 21000 et seq.) The Secretary of Resources has determined that the Central Valley Water Board's basin planning process qualifies as a certified regulatory program pursuant to Public Resources Code section 21080.5 and California Code of Regulations, title 14, section 15251(g). This determination means that the Central Valley Water Board is exempt from the requirement to prepare an environmental impact report. Instead, this Staff Report and the Environmental Checklist provided in Appendix F satisfy the requirements of State Water Board's Regulations for Implementation of CEQA, Exempt Regulatory Programs, which are found at California Code of Regulations, title 23, section 3775 et seq.

3.7 Antidegradation Policy

The USEPA has established a federal antidegradation policy applicable to water quality programs in 40 CFR section 131.12 (*Federal Antidegradation Policy*). The State Water Resources Control Board has established an antidegradation policy for the State of California by adopting State Water Board Resolution 68-16, the Statement of Policy with Respect to Maintaining High Quality of Waters in California (*State Antidegradation Policy*). The Central Valley Water Board must ensure that its basin planning actions are consistent with the *Federal Antidegradation Policy* and the *State Antidegradation Policy*.

3.7.1 Federal Antidegradation Policy

The Federal Antidegradation Policy (40 CFR §131.12) states:

> "(a) The State shall develop and adopt a statewide antidegradation policy and identify the methods for implementing such policy pursuant to this subpart. The antidegradation policy and implementation methods shall, at a minimum, be consistent with the following:

(1) Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

(2) Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the State shall assure water quality adequate to protect existing uses fully. Further, the State shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.

(3) Where high quality waters constitute an Outstanding National Resource Waters, such as waters with exceptional ecological, recreational or environmental assets, that water quality shall be maintained and protected.

(4) In those cases where potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy and implementing method shall be consistent with section 316 of the Act."

3.7.2 **State Antidegradation Policy**

The*State Antidegradation Policy* states, in relevant part:

(1) Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies.

(2) Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment

or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.

4 BENEFICIAL USES

One of the initial steps the LSJR Committee took while developing recommendations for salinity WQOs in the LSJR was undertaking a comprehensive evaluation of the beneficial uses in Reach 83. The goal of this evaluation was to determine whether the Basin Plan's current list of beneficial use designations in this stretch of the river was appropriate or needed additions, deletions and/or modifications (Lower San Joaquin River Committee, 2013a). Through this work, the committee, with assistance from its subcontractor, was able to identify all existing and potential beneficial uses for consideration in the development of WQOs in the LSJR, and further narrow the list to the ones that are most sensitive to salt (Larry Walker Associates (LWA), 2013).

This chapter describes the committee's review of the beneficial uses in the LSJR and summarizes its findings and recommendations.

4.1 Beneficial Uses in the Lower San Joaquin River

Chapter II of the Basin Plan defines different categories of beneficial uses that could be applied to surface waters in the Central Valley, including the San Joaquin River. A review of the Basin Plan was conducted to determine whether any of the presently designated beneficial uses for Reach 83 of the San Joaquin River needed to be de-designated, modified, or whether new designations needed to be applied. This was a required step prior to recommending appropriate salinity WQOs.

4.1.1 Current Basin Plan Designations for the Lower San Joaquin River

Existing (E) potential (P), and existing limited (L) beneficial uses which currently apply to surface waters of the Sacramento River and San Joaquin River Basins are presented in Table II-1 of the Basin Plan. The San Joaquin River on the valley floor, as defined in Table II-1 in the Basin Plan, includes four separate reaches extending from Friant Dam to Vernalis. The LSJR includes three of these four reaches and extends from the Mendota Dam to Vernalis. The project area for establishment of WQOs for salinity and boron includes only Reach 83, which is between the Mouth of the Merced River inflow and the Airport Way Bridge near Vernalis.

The beneficial uses that are designated by the Central Valley Water Board for the San Joaquin River are listed in Table II-1 of the Basin Plan. Beneficial uses designated for Reach 83 of the LSJR in the Basin Plan include:

- Potential Municipal and Domestic supply (MUN);
- Existing Agriculture Irrigation and Stock Watering (AGR);

- Existing Industrial Process Supply (PROC);
- Existing Contact Recreation (REC-1);
- Existing Non-contact Recreation (REC-2);
- Existing Warm Freshwater Habitat (WARM);
- Existing Warm and Cold Water Species Migration (MIGR);
- Existing Warm Water Spawning (SPWN - WARM); and
- Existing Wildlife Habitat (WILD).

4.1.2 **Review of Beneficial Uses**

To determine if conditions have changed since the original designations in 1975, the following review of beneficial uses of Reach 83 includes an evaluation of the existing beneficial uses listed in section 4.1.1 above and also considers the following unlisted beneficial uses:

- Industrial Service Supply (IND)
- Industrial Power Supply (POW)
- Commercial and Sport Fishing (COMM)
- Navigation (NAV)
- Cold Freshwater Habitat (COLD);
- Cold Water Spawning (SPWN - COLD)
- Preservation of Biological Habitats of Special Significance (BIOL)

*4.1.2.1 **Municipal and Domestic Supply (MUN)***

Municipal and domestic use is designated as a potential beneficial use for Reach 83. The potential designation has been in existence since the original Basin Plan was adopted in 1975. Surveys of actual use were conducted in 1950, 1975 and again in 1985 and showed that no such uses or diversions were being made of the River for either municipal or domestic use. The State Water Board, in the report from the Technical Committee for WQ Order 85-1, did a complete review of beneficial uses on the San Joaquin River from the Salt Slough inflow (upstream of the Merced River Mouth) to Vernalis. The report noted that no municipal or domestic supply uses were being made, nor did any appear to exist or be likely to exist in the future. Therefore the State Water Board stated that the Central Valley Water Board should consider removing the MUN use designation from the San Joaquin River from the Salt Slough inflow (upstream of the Merced River Mouth) to Vernalis by amending the Basin Plan. Due to financial constraints and the need to deal with the higher priority selenium issue, the removal of the MUN beneficial use designation was never made by the Central Valley Water Board.

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In 1988, the State Water Board, pursuant to *Sources of Drinking Water Policy*, reconsidered the designation of MUN for all waters of the state. The *Sources of Drinking Water Policy* (see section10.3.3) required that all waters of the state be designated as either existing or potential MUN beneficial use unless they met one of the exemption criteria. None of the exemption criteria apply to Reach 83.

This review of beneficial uses, supported by the previous State Water Board report from the Technical Committee for WQ Order 85-1, indicates that it is unlikely that the MUN beneficial use would move from the present designation of "potential beneficial use" to an existing use in the forseeable future. The potential beneficial use has been listed for almost 40 years, and no entity has developed a municipal or domestic use on Reach 83, nor are any such plans being contemplated. The development of a municipal or domestic use would be unlikely under present conditions, as this reach of the river is fully appropriated, and it is unlikely that any new use would be permitted in the future without the transfer of water rights from another entity. There are no existing, pending, or anticipated water right permits for municipal or domestic use on Reach 83, and there are no pending or anticipated applications for such a use or transfer.

The LSJR from Friant Dam to Vernalis is highly regulated and releases of stored water to Reach 83 from the Merced River inflow to the Stanislaus River inflow are primarily operational releases for irrigation use and aquatic life protection. In addition, flow in this reach is made up of groundwater accretions from poor quality groundwater and agricultural return flows of varying quality. As a result, river water flow and quality in Reach 83 are highly variable, and thus of little or no potential to be a long-term municipal or domestic supply.

There is the expectation of new or increased flow requirements in Reach 83 due to the State Water Board reevaluation of the flow requirements to protect aquatic life and salmon migration into and through the Bay-Delta. This flow, however, is being designated for aquatic life protection and, thus, would not be available for diversion for other uses, including municipal and domestic supply.

There is also an expectation that increased flows will occur in Reach 83 as a result of the San Joaquin River Restoration Program, which is a program to re-water the San Joaquin River from below Friant Dam to the Merced River inflow. These flows, however, would not be available for re-diversion for other uses as they are designated in the settlement agreement for aquatic life protection above the Merced River inflow and may be available for re-diversion downstream of the Merced River inflow for recapture of water for the Friant portion of the federal Central Valley Project (CVP). It is also unlikely that any of the water in Reach 83 of the LSJR, even if water rights were obtained, would be available for diversion for municipal or domestic uses because, in a letter to the Stanislaus County Department of Environmental Resources (California Department of Health Services, 1996), the California Department of Public Health's Drinking Water Division stated the following: *"Our Department objects to possible consideration of the San Joaquin River as a domestic water supply source for new public water systems. Any and all available alternatives must be evaluated because we will not support issuance of a domestic water supply permit for the San Joaquin River."* This department (now a division of the State Water Board) regulates all public municipal and domestic water supply systems. Stanislaus County encompasses almost 95 percent of the LSJR in Reach 83.

4.1.2.2 ***Agricultural Use (AGR)***

Agricultural use, which includes both irrigation and stock watering, is designated in Table II-1 of the Basin Plan as an existing beneficial use in Reach 83. A review of potential agricultural diversions and use was conducted along Reach 83 by the Central Valley Water Board (Central Valley Water Board, 1989). During this review, a total of 46 points of diversion for irrigation were identified in Reach 83. Based on a review of water right applications, permits and statements, these diversion points are capable of irrigating slightly over 50,000 acres. There are four major diverters in Reach 83:

1 West Stanislaus Irrigation District, which diverts irrigation water for approximately 21,666 acres;
2 Patterson Irrigation District, which diverts irrigation water for approximately 13,555 acres;
3 Twin Oaks Irrigation Company, which diverts irrigation water for approximately 2,550 acres; and
4 El Solyo Water District, which diverts irrigation water for approximately 3,780 acres.

These four diverters deliver water to over 90% of the land potentially irrigated from water diverted from Reach 83. This level of use shows that the AGR beneficial use is a major use in Reach 83 and will continue to be in the foreseeable future.

The AGR beneficial uses continues to be the dominant use made of the river and, therefore, there was no recommendation by the committee to change the present "existing" beneficial use designation.

~~*4.1.1.1*~~*4.1.2.3* ***Industrial Process Supply (PRO)***

Industrial Process Supply (PROC) is designated as an existing beneficial use of Reach 83. Surveys of Reach 83 in 1950, 1975, and again in 1985 showed that no such uses or diversions were being made of the River for industrial process supply, although none of these surveys confirmed whether incidental use is being made as part of agricultural harvest and processing.

There were originally two tallow plants along the river, but these went out of business prior to the development of the original Basin Plan in 1975. One of these former plants upstream of the mouth of the Merced River, was previously dewatered during development of the Friant Dam under the federal Central Valley Project.

Even though the beneficial use has been listed as "existing" for almost 40 years, the sites of these former tallow plants have either been removed or are abandoned with no entity or plan in the works to restore these sites for such a use. In addition, there are no known plans to develop new sites along the river and there are no water right permits or applications pending for industrial process supply use.

In addition, Reach 83 is highly regulated and made up primarily of operational releases for irrigation use, groundwater accretions from poor quality groundwater, and agricultural return flows of varying quality. Reach 83 flow and water quality are highly variable, thus not a potential constant industrial supply source. Although it was not recommended to remove the present "existing" use designation, users of the Basin Plan should be made aware that the likelihood of a consistent use of river water for Industrial Process Supply is low and that the only PROC uses in the foreseeable future are incidental uses as part of the agricultural harvest and processing associated with diversions for other agricultural uses.

~~4.1.1.2~~4.1.2.4 Water Contact (REC-1) and Non-Contact Recreation (REC-2)

Reach 83 is a major local recreational site, including both contact and non-contact-type uses. Major uses on Reach 83 include, but are not limited to, swimming, wading, diving, boating, rafting, canoeing, and fishing. Because of the high temperatures in the summer time, Reach 83 is a magnet-type recreational area because of the presence of the water and the large shady riparian growth along the river's edge.

Reach 83 is also a major area of indirect contact with the water, including many recreational activities that take place in and near the water where there is generally no body contact with water, nor any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities. These activities will continue due to presence of the San Joaquin River in an area of elevated temperatures.

Both REC-1 and REC-2 uses are present and will remain strong within Reach 83 the LSJR. Therefore, there was no recommended change to the present "existing" beneficial use designation by the committee.

~~4.1.1.3~~4.1.2.5 ***Warm and Cold Freshwater Habitat (WARM and COLD)***

Reach 83 supports a warm water ecosystem. The quality of the water supply must support, preserve and enhance aquatic habitats, vegetation, fish, or wildlife, including invertebrates. Normally a WARM water habitat implies resident species and does not include the short-term migration of anadromous species. This is supported by footnote (2) to Table II-1 of the Basin Plan. Numerous reports support the presence of resident warm water species, including those that are introduced species such as striped bass. Reach 83 is presently designated as a WARM water habitat. This designation should not be changed.

The WARM characteristic of Reach 83, however, does not support cold water ecosystems (COLD) as the substrate does not support optimum habitat and environment for egg development (pre-spawning), spawning, juvenile development and rearing and migration of smolts or young. Several of the tributaries to Reach 83 support COLD uses, which are markedly different from those that support WARM-water species. At present Reach 83 is not designated as a COLD-water habitat. It was recommended to continue to not list this reach as a COLD-water habitat.

~~4.1.1.4~~4.1.2.6 ***Migration of Aquatic Organisms (MIGR)***

In California, the migratory fish species are principally steelhead and rainbow trout (*Oncorhynchus mykiss gairdneri*), white sturgeon *Acipenser transmontanus*), American Shad (*Alosa sapidissima*), and Chinook salmon (*Oncorhynchus tshawytscha*). All of these species could potentially use Reach 83 since the tributaries to Reach 83 provide habitat for both cold and warm water anadromous species. It was recommended by the committee that both the cold and warm-water migration beneficial use be maintained for Reach 83.

Another species known to migrate ~~to spawning sites~~ is Striped Bass (*Morone saxatilis*). Striped bass~~, however,~~ generally reside in estuaries and in seawater during a portion of their adult phase and migrate in the spring to large rivers to spawn. Striped bass have been identified in the San Joaquin River, including in Reach 83, however, ~~it is unlikely that their presence was due to migration for spawning purposes. More likely,~~it is unknown if they currently spawn within the Reach (see discussion under Warm-Water Spawning). ~~they were attracted for feeding purposes on other species~~.

~~Successful spawning of striped bass is dependent on the interaction of three factors: temperature, flow and salinity. Striped bass generally prefer to spawn in large rivers that have optimum spawning flows. Sufficient flow is required to maintain eggs and larvae suspended, but not too high that eggs are washed into quiet waters. It is also possible that the higher salinity levels in Reach 83 could impede striped bass spawning, but additional research would be needed to confirm this. Because of the narrow tolerance of striped bass to these three factors, there are only two principal spawning areas and these are in the Bay-Delta. They are the Sacramento River from Isleton to Butte City and the San Joaquin River and its sloughs from Venice Island to Antioch (Moyle, 1976).~~

~~Modifying flows or lowering salinity levels to enhance striped bass spawning would need further study beyond the scope of this project and would likely meet with strong resistance.~~

Striped bass are a non-native predator that may impact salmon and other California native anadromous fish. The Warm Water Migration (MIGR-WARM) designation in Table II-1 of the Basin Plan, footnote 3 reads: Striped bass, sturgeon and shad. Although outside the scope of the current project, the LSJR Committee recommended that the Central Valley Water Board consider modifying this footnote in the future to remove the phrase “striped bass” to focus on native species over introduced species, although no change is recommended at this time.

The Cold-Water Migration (MIGR-COLD) designation in Table II-1 of the Basin Plan, footnote 4 reads: Salmon and steelhead. This footnote does apply to Reach 83 and reflects current information that shows both steelhead and salmon use Reach 83 on their migration routes to the tributaries of Reach 83. However, footnote 4 may not be correct for those reaches upstream of the Merced River inflow. Table II-1 of the Basin Plan shows the three reaches of the San Joaquin River upstream of the Merced River confluence (Reach 69 Friant Dam to Mendota Pool, Reach 70 Mendota Dam to Sack Dam and Reach 71 Sack Dam to Mouth of Merced River) as critical habitat for steelhead and this is inconsistent with finding of the National Marine Fisheries Service of the National Oceanographic and Atmospheric Administration (National Oceanographic and Atmospheric Administration, 2005). NOAA concluded in 2005 that the upstream boundary for critical habitat in the San Joaquin River is at the Merced River confluence, due in part to the diversion of natural headwaters out of the San Joaquin Basin thru the Friant-Kern Canal.

The committee felt that showing steelhead in footnote 4 of Table II-1 of the Basin Plan may assert that the species is present and that habitat in the San Joaquin River from

Friant Dam to Merced River confluence is critical habitat. With respect to Critical Habitat, there is no critical habitat designated in counties south of Merced County (National Oceanographic and Atmospheric Administration, 2005). Although not part of the present project, the committee recommended that the Central Valley Water Board might want to consider modifying this footnote in the future to more correctly describe the habitat findings of NOAA that steelhead are only found in the San Joaquin River from the Mouth of the Merced River to Vernalis.

~~4.1.1.5~~4.1.2.7 *Warm-Water Spawning, Reproduction and/or Early Development (SPWN-Warm)*

Reach 83 is an environment favorable to spawning of a variety of warm-water species. Warm water habitat, suitable water temperatures, and substrate makes this reach of the river generally suitable for spawning of many warm-water species that are present in the river reach. Therefore, warm water SPWN beneficial use is an existing use and the designation in Table II-1 in the Basin Plan should not be modified.

Warm-Water Spawning (SPWN-WARM) designation in Table II-1 of the Basin Plan, footnote 3 reads: Striped bass, sturgeon and shad. Striped bass generally reside in estuaries and in seawater during a portion of their adult phase and migrate in the spring to large rivers to spawn. Striped bass have been identified in the San Joaquin River, including in Reach 83, however, it is unlikely that their presence was due to migration for spawning purposes. Successful spawning of striped bass is dependent on the interaction of three factors: temperature, flow, and salinity. Striped bass generally prefer to spawn in large rivers that have optimum spawning flows. Sufficient flow is required to maintain eggs and larvae suspended, but not too high that eggs are washed into quiet waters. It is also possible that the higher salinity levels in Reach 83 could impede striped bass spawning, but additional research would be needed to confirm this. Because of the narrow tolerance of striped bass to these three factors, there are only two principal spawning areas and these are in the Bay-Delta. They are the Sacramento River from Isleton to Butte City and the San Joaquin River and its sloughs from Venice Island to Antioch (Moyle, 1976).

A review of the Bay-Delta Plan in 1991, confirmed the salinity objective of 0.44 mmhos/cm for the period April 1 to May 31 (0.55 mmhos/cm during dry and critical years) at Prisoners Point on Venice Island to delimit the upstream end of the San Joaquin River striped bass spawning area (State Water Resources Control Board, 1991). The objective was reviewed and retained along with a water quality objective of 1.0 mmhos/cm during the same time period upstream of the spawning area in the LSJR at Vernalis. The Bay-Delta Plan recognizes that the higher salinity level at Vernalis creates a salinity barrier to spawning except during wetter years when concentrations may remain below 0.44 mmhos/cm during April and May.

~~and more likely they were attracted for feeding purposes on other species. Their principal spawning areas are in the Bay-Delta.~~

In addition, striped bass are a non-native predator that may impact salmon and other anadromous fish. As part of the efforts to meet the goals of the San Joaquin River Restoration Program to increase natural production of anadromous fish, fisheries agencies are currently evaluating optimum management of fish species including striped bass (Gordus, 2017). The LSJR Committee recommended that the Central Valley Water Board consider modifying this footnote in the future to remove the phrase “striped bass”, however, no change is proposed at this time. Recommendations to modify flows or lower salinity levels to enhance striped bass spawning would need further study and would be dependent on the findings from the fisheries agencies.

~~4.1.1.6~~4.1.2.8 Cold-Water Spawning, Reproduction and/or Early Development (SPWN-Cold)

Cold-water spawning is not presently designated as a beneficial use for Reach 83 in Table II-1 in the Basin Plan. This is the result of the river being on the Valley floor and lacking substrate and conditions, including water temperatures, which would be suitable for cold-water spawning. It is also unlikely that these conditions would change in the foreseeable future as climate change models presently show that the San Joaquin River and the San Joaquin River Basin will be warmer in the future ((U.S. Bureau of Reclamation, 2014). No change to the present non-designation was recommended.

~~4.1.1.7~~4.1.2.9 Wildlife Habitat (WILD) and Biological Habitats for Special Significance (BIOL)

The large variation in river flow in the LSJR has resulted in a large river flood plain that is constricted between flood control levees. This area, however, has become a magnet for wildlife as the river has a continuous flow during most years. The riparian corridor has become fairly mature in vegetation and provides considerable habitat for terrestrial, avian and other terrestrial organisms, including invertebrates. The changes in flow regime being considered by the State Water Board may enhance and support this riparian corridor.

WILD is presently a designated beneficial use for Reach 83 in Table II-1 in the Basin Plan. This use is not expected to change in the foreseeable future and there was no recommendation to modify or change this beneficial use designation.

An increasing wildlife use of Reach 83 may occur with the future development of the San Joaquin River National Wildlife Refuge on what was the Faith Ranch. The U.S. Fish and Wildlife Service purchased a conservation easement on most of the Faith Ranch in 1997. At that time, the Faith Ranch was owned by Robert Gallo. The place of use designation for the RJ Gallo statement of water use (Application S014002) now shows that part of the San Joaquin River National Wildlife Refuge is included in the place of use.

Because of the expanding use of water on the San Joaquin River National Wildlife Refuge and the need to protect critical riparian habitat, it was recommended that the Central Valley Water Board consider a new beneficial use of BIOL be designated for Reach 83 in Table II-1 in a future Basin Plan amendment. The present beneficial use definition for Preservation of Biological Habitats of Special Significance (BIOL) serves and describes the uses that need to be protected. The present definition of "Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection" serves this need.

~~4.1.1.8~~4.1.2.10 ***Industrial Service Supply (IND)***

There are no known or planned industrial service supply uses foreseen for Reach 83. Therefore, it was not recommended for inclusion as a "potential" or "existing" beneficial use.

~~4.1.1.9~~4.1.2.11 ***Industrial Power Supply (POW)***

There are no known or planned power uses foreseen for Reach 83 and it is unlikely that any will be developed in the foreseeable future due to the variable flow and quality, especially sediment quality. Therefore, it was not recommended for inclusion as a "potential" or "existing" beneficial use.

~~4.1.1.10~~4.1.2.12 ***Commercial and Sport Fishing (COMM)***

The definition in the Basin Plan for this beneficial use is "Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes". Sport and recreational fishing is widespread along Reach 83. This use has been present for several decades and, as urbanization of the areas to the east and west of the river continues, this use can be expected to increase as well. The quality of this use may vary or be limited by flow variations, including low-flow conditions, but it will not preclude the attainment of this use. Based on this observation, it was recommended that the

Central Valley Water Board add the existing sport and recreational beneficial (COMM) use be added to Table II-1 in a future Basin Plan amendment for Reach 83.

~~4.1.1.11~~4.1.2.13 ***Navigation (NAV)***

The present definition in the basin plan for the NAV beneficial use states that it is intended for “Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels”. Due to the nature of the San Joaquin River, including depth, changes in flow, and shifting bottom material, the use of the river in Reach 83 for any type of shipping, travel or transportation will be severely limited. The continued use of the river for recreational boating, including fishing will continue but will always be limited in size and depth of draw of the water craft used. These latter types of use are covered under the REC-1 and REC-2 beneficial use designations in Table II-1 of the Basin Plan. It is unlikely that larger commercial or transportation-type vessels will be utilizing Reach 83 in the foreseeable future. The NAV beneficial use is not presently designated in Table II-1 of the Basin Plan and it was not recommended to modify the present non-listing.

4.1.3 **Final Recommendation for Beneficial Uses in the LSJR**

In summary, the LSJR committee found that the majority of current beneficial use designations listed in the Basin Plan were appropriate for Reach 83. While the committee did consider options to add and/or provide clarifying language to several of the beneficial uses like Commercial and Sport Fishing (COMM) and Industrial Process Supply (PROC), a final recommendation was made that no changes to the Basin Plan’s designations were needed as part of the current project to establish salinity objectives.

The reasons for this final recommendation were provided as follows:

1. The changes were not essential to the immediate interests of the committee to establish salinity objectives in the Reach 83.
2. The technical and CEQA information required to support such an effort was not available or scoped, and
3. The time required to develop such information was not consistent with the desired time schedule associated with the current effort to adopt salinity objectives for the LSJR

4.2 **Identification of the Most Salt-sensitive Beneficial Uses**

With a final recommendation to maintain the Basin Plan’s current list of designated uses in Reach 83, the LSJR committee’s next step in the development of appropriate salinity objectives was to identify the most salt sensitive beneficial uses. Aquatic life uses are typically identified as the most sensitive uses when considering beneficial uses designations for surface waters. However, a literature review commissioned by CV-SALTS in 2010 examined salinity and nutrient water quality criteria assigned to beneficial uses at the state, national and international levels and concluded that irrigation and municipal water supply beneficial uses generally have the lowest limits (Kennedy/Jenks Consultants, 2010). Nonetheless, that report recommended that the "Water quality data gaps related to beneficial uses other than agriculture and municipal need to be assessed for relevance." (Kennedy/Jenks Consultants, 2010, page 6-1, recommendation number 3).

Between May 2010 and the end of 2015, the LSJR Committee conducted reviews of beneficial uses and water quality data for the LSJR, including white papers on Aquatic Life (Buchwalter, David, Ph.D., North Carolina State University, 2014) and Stock Watering sensitivity to salinity (Kennedy/Jenks Consultants, 2013). Based on studies evaluated in the white papers, agricultural irrigation supply appears the most sensitive to salinity, followed by municipal and domestic supply.

Further review of potential salinity limitations on striped bass, sturgeon and American shad spawning (noted as an existing use in Reach 83), identified limitation to striped bass at salinity levels greater than 440 umhos/cm EC during April and May (State Water Resources Control Board, 1991). Sturgeon and American shad have broader tolerance. (Klimley, A. Peter, et al., 2015) (Stier, 1985). As discussed in more detail in the Warm-Water Spawning beneficial use review, striped bass spawning in Reach 83 have been small runs limited to the wettest Water Years. The establishment of a 1,000 uS/cm EC WQO at Vernalis by the State Water Board in 1991 that applies during April and May, effectively created a salinity barrier to stiped bass migration and spawning into Reach 83 (State Water Resources Control Board, 1991).

Irrigation has historically been considered the most sensitive beneficial use for salt and boron in Reach 83 of the LSJR. The establishment of WQOs for salinity at the Airport Way Bridge near Vernalis (an EC objective of 700 µS/cm during the irrigation season and 1000 µS/cm during the non-irrigation season) for protection of Southern Bay-Delta agriculture is an example of this. However, the salt tolerance of crops varies between different crops and requirements may change throughout the growing season, so careful consideration must be given to which salt-sensitive crops require protection for the AGR beneficial use in the LSJR Basin.

Water that is used for municipal and domestic supply can also be a driving force in establishment of salinity criteria in the Central Valley region. Water from Reach 83 of the LSJR flows into the Bay-Delta, which provides drinking water to over 22 million people in California. The Basin Plans identify the primary and secondary Maximum

Contaminant Levels (MCLs) specified in Title 22 of the California Code of Regulations, which were developed for the protection of potable water at the tap after receiving conventional treatment, as the appropriate WQOs to protect the MUN use, including its potential use. Table 64449-B in Title 22 of the California Code of Regulations contains consumer acceptance contaminant level ranges for a number of salinity constituents. For specific conductivity, the table contains a recommended value of 900 µS/cm, an upper value of 1600 µS/cm and a short-term value of 2200 µS/cm.

The next chapter provides an in-depth review of how protection of the MUN and AGR beneficial uses were considered during the development of salinity objectives in Reach 83 of the LSJR.

5 DEVELOPMENT OF WATER QUALITY OBJECTIVES

Water quality objectives (WQOs) adopted by the Central Valley Water Board must ensure the reasonable protection of designated beneficial uses and the prevention of nuisance. The Lower San Joaquin River (LSJR) Committee worked collaboratively with Board staff to identify water quality criteria for consideration as proposed WQOs. The Central Valey Water Board staff is proposing salinity WQO for the LSJR. If adopted, the objectives would be forwarded to the State Water Resources Control Board, State Office of Administrative Law, and US EPA for approval. If approved by these agencies, the objectives would be incorporated into the Basin Plan.

The previous chapter recognized AGR and MUN as the most salt-sensitive beneficial uses in the LSJR. This chapter first describes the selection process that identified electrical conductivity[5] (EC) as the appropriate salinity constituent to protect AGR and MUN. Next, the chapter describes how alternative EC criteria for consideration as WQOs were developed. The chapter concludes with an evaluation of the EC alternatives using established selection criteria and regulatory mandates to substantiate the selection of the preferred project alternative, including consideration of Water Code section 13241 factors. See Chapter 3 for more information on the federal and state laws and policies pertinent to the establishment of WQOs.

5.1 Selection of the Appropriate Salinity Constituent

5.1.1 Evaluation of Potential Salinity Constituents

The LSJR (LSJR) Committee reviewed and compiled salinity criteria, guidelines, and proposed protective values identified in several beneficial use source documents[6] commissioned by CV-SALTS. The Committee presented its findings in the following document prepared by Larry Walker Associates, dated November 12, 2014, and titled *Final Memorandum –Summary of Work Completed: Tasks 2, 3, and 8b* (Larry Walker Associates (LWA), 2014d).

Eleven salinity constituents were reviewed and criteria compiled and are presented in Table 5-1. Bicarbonate was the only salinity constituent for which only a single potential criterion value was identified. Also, no values were identified for potassium and carbonate. As shown in Table 5-1, numeric ranges for the following nine (9) salinity constituents were identified:

- Electrical conductivity (EC),

[5] An EC measurement made or corrected to 25 °C is equivalent to specific conductance. Subsequent references to EC in this document shall be assumed to be equivalent to specific conductance.
[6] CV-SALTS Beneficial Use Source documents include:

1.1 CDM Salinity Effects on MUN-Related Uses of Water, July 2012.
1.2 CDM Salinity Effects on AGR Irrigation-Related Uses of Water, August 2012.
1.3 Kennedy/Jenks Consultants Salt and Nutrients: Literature Review for Stock Watering Water, Final Report, 20 May 2013.
1.4 Aquatic Life Study Final Report January 6, 2014, prepared by Dr. David Buchwalter, Ph.D.

- Total dissolved solids (TDS),
- Sodium,
- Magnesium,
- Calcium,
- Bicarbonate,
- Chloride,
- Sulfate, and
- Boron.

These numeric ranges had been developed for the protection of the following beneficial uses: municipal drinking water, irrigation supply water, stock watering, and aquatic life. Proposed protective numeric values found in peer-reviewed journal articles that have not ever been used to regulate surface water quality were not included in Table 5-1, with the following exceptions:

1. EC and TDS for AGR (irrigation) beneficial use-related proposed protective values associated with, derived from, or informing the work of Dr. Glenn J. Hoffman (Hoffman, Glenn J., 2010); and
2. All constituents except potassium, carbonate and bicarbonate for AGR (stock watering) beneficial use-related proposed protective values suggested by (Kennedy/Jenks Consultants, 2013).

5.1.2 **Selection of Electrical Conductivity for Development of Water Quality Objectives**

The preliminary ranges of potential salinity criteria identified in Table 5-1 were reviewed against state and federal regulations including the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) (Central Valley Water Board, 2016a), the *Sources of Drinking Water Policy*, state and federal drinking water regulations, and other state and federal requirements relevant to the two most salinity-sensitive uses, drinking water and agricultural irrigation uses, as well as stock drinking water and aquatic life protection.

Table 5-1 Preliminary Range of Potential Salinity Criteria for Reach 83[1] by Beneficial Use.

Beneficial Use	EC[2]	TDS	Sodium	Magnesium	Calcium	Potassium	Carbonate	Bicarbonate	Chloride	Sulfate	Boron[3]
	dS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MUN	0.9 - 1.6 (2.2 short-term)	500 - 1000	100 - 200	---	---	---	---	---	250 - 500	250 - 500	---
AGR (Irrigation)	1.01 - 1.55	450 - 961	69 - 115	---	---	---	---	90	106 - 178	---	
AGR (Stock Water)	1.5 - 4.0	500 - 2000	50 - 2000	250 - 500	500 - 1000	---	---	---	250 - 1500	250 - 1000	5
PROC	---	---	---	---	---	---	---	---	---	---	---
IND	---	---	---	---	---	---	---	---	---	---	---
POW	---	---	---	---	---	---	---	---	---	---	---
REC-1 (Contact)	---	---	---	---	---	---	---	---	---	---	---
REC-2 (Non-contact)	---	---	---	---	---	---	---	---	---	---	---
WARM	---	---	---	---	---	---	---	---	230	124	1.13
COLD	---	---	---	---	---	---	---	---	230	124	1.13
MIGR-WARM	---	---	---	---	---	---	---	---	*	*	*
MIGR-COLD	---	---	---	---	---	---	---	---	**	**	**
SPWN-WARM	---	---	---	---	---	---	---	---	*	*	*
SPWN-COLD	---	---	---	---	---	---	---	---	**	**	**
WILD	---	---	---	---	---	---	---	---	---	---	---
NAV	---	---	---	---	---	---	---	---	---	---	---

- Reach 83 is defined as that segment of the San Joaquin River from the mouth of the Merced River to Vernalis.
- Seasonal EC WQOs for the LSJR at Vernalis (bottom of Reach 83) to protect the AGR (irrigation) beneficial use:

Apr 1 - Aug 31: 700 µS/cm as a 30-day running average.
Sep 1 - Mar 31: 1,000 µS/cm as a 30-day running average.

- Seasonal boron objectives for the protection of the AGR (irrigation) beneficial in Reach 83 are:

Irrigation season (Mar 15-Sep 15): 0.8 mg/L maximum monthly average and 2.0 mg/L maximum single sample concentration.
Non-irrigation season (Sep 16-Mar 14): 1.0 mg/L maximum monthly average and 2.6 mg/L maximum single sample concentration.
Critically Dry Water Years (both seasons): 1.3 mg/L maximum monthly average and 2.6 mg/L maximum single sample concentration. Sep 1 - Mar 31: 1.0 dS/m as a 30-day running average.

Symbols:
* = Used to denote that salinity criteria for protection of the WARM beneficial use would also be protective of the MIGR WARM and SPWN WARM beneficial uses.
** = Used to denote that a salinity criteria for protection of the COLD beneficial use would also be protective of the MIGR COLD and SPWN COLD beneficial uses.

The LSJR Committee evaluated several documents, prepared for AGR and MUN beneficial use, on behalf of the CV-SALTS Technical Advisory Committee that contained potentially applicable criteria that might be protective of the AGR and MUN Beneficial Uses. Table 5-1 summarizes the criteria that could reasonably be considered as candidate parameters for further evaluation as WQOs. The Committee's evaluations, findings, and references for the Beneficial Use documents are presented in the LWA report titled *Development of a Basin Plan Amendment for Salt and Boron in the Lower San Joaquin River (LSJR) Task #4 – Implementation Planning for Proposed Salinity Objectives* (Larry Walker Associates (LWA), 2015a).

The LSJR Committee found that the MUN criteria for sodium, chloride and sulfate are at or below the ~~irrigation and~~ stock water criteria and already incorporated as WQOs in the Basin Plans. Also, background concentrations of magnesium, calcium and bicarbonate in the LSJR are below the irrigation and stock watering criteria noted. Finally, boron WQOs already exist for the LSJR and are lower than the criteria for aquatic life.

Therefore, the LSJR Committee found that EC and TDS were constituents of salinity that still required numeric salinity WQOs. Furthermore, the Committee determined that EC could be used as a surrogate for both boron and TDS. Data from the Central Valley Water Board's water quality database collected from the LSJR at the Airport Way Bridge near Vernalis had been used to develop a linear correlation between EC and boron during development of the Control Plan amended to the Basin Plan in September 2004 (Central Valley Water Board, 2004). The regression equation obtained from that analysis was used to calculate the expected boron concentration from predicted EC of the LSJR at the Airport Way Bridge. Similarly, it was determined that TDS concentrations could be estimated using site-specific linear corrections of EC and TDS after the methodology employed by the Central Valley Water Board.

Using the relationships between EC and TDS, and EC and boron, it is possible to use EC to estimate concentrations for TDS and boron. Measured EC levels can be translated into estimated TDS and boron concentrations that can then be compared, for compliance purposes. For this reason, TDS and boron were not considered further as direct candidates for salinity parameters used to protect the AGR beneficial use in Reach 83. The LSJR Committee decided to select EC as the candidate salinity water quality criterion to be evaluated further for salinity WQOs in Reach 83 of the LSJR.

5.2 **Determination of Potential EC Criteria**

Six factors identified in Water Code section 13241 must be considered when developing WQOs. The first factor pertains to past, present, and probable future beneficial uses of the water. The Beneficial Use chapter of this staff report (Chapter 4) identified the existing AGR and potential MUN uses as the most ~~salt sensitive beneficial uses~~appropriate to evaluate to develop reasonably protective salinity WQOs in Reach 83. The previous sections of this chapter document the LSJR Committee's decision to choose EC as the best criterion for development of WQOs for Reach 83. Next, the Committee determined EC values that would be protective of these uses.

5.2.1 **Irrigated Agriculture**

As described in Chapter 1 (Section 1.2.1), the initial effort to establish WQOs protective of irrigated agriculture in the LSJR was conducted by Central Valley Water Board staff, from 2006 to 2010. In 2010, the project was turned over to the LSJR Committee for additional policy and technical work needed to inform recommendations for a Basin Plan Amendment to establish salinity objectives in the LSJR. The following sections describe these efforts in more detail.

5.2.1.1 ***Initial Crop Salt Tolerance Evaluations (2006-2010)***

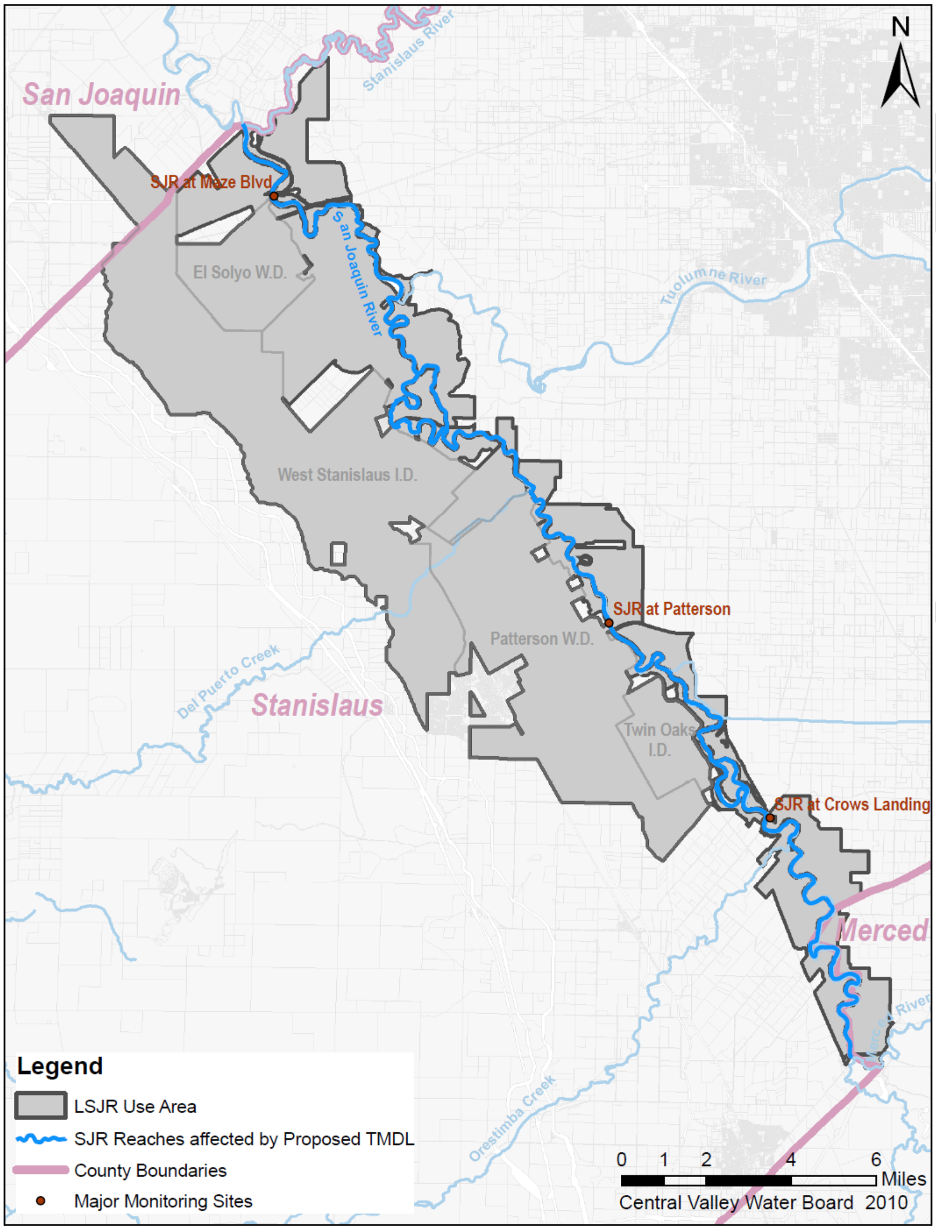
In 2010, prior to the formation of the LSJR Committee, Central Valley Water Board staff released the draft report titled *Salt Tolerance of Crops in the Lower San Joaquin River (Merced to Stanislaus River Reaches)* (Salt Tolerance Report) for public review and comment (Central Valley Water Board, 2010b). The report documented the staff's use of the Hoffman model to estimate irrigation-water salinity concentrations protective of irrigated agriculture in the LSJR Irrigation Use Area. Previously, Dr. Glenn J. Hoffman, on behalf of the State Water Board, had developed this model for estimating EC values protective of salt-sensitive crops grown in the Southern Sacramento-San Joaquin Delta (Southern Delta) (Hoffman, 2010). Tailored to information available for the LSJR Irrigation Use Area, Central Valley Water Board staff followed the technical and formatting approach used by Dr. Hoffman in the Southern Delta to calculate EC values protective of salt sensitive crops irrigated with LSJR water.

The draft Salt Tolerance Report identified the LSJR Irrigation Use Area, irrigated all or in part by water from the LSJR. The area, shown highlighted in grey on Figure 5-1, extends from the mouth of the Merced River at the southeastern end of the use area to San Joaquin County and the mouth of the Stanislaus River area at the northwestern end. The report utilized the California Department of Water Resources (DWR) land use surveys conducted in Stanislaus and San Joaquin Counties during the 1990s and 2000s. Staff accessed these surveys through the DWR website in October 2009 (California Department of Water Resources, 2009).

The draft Salt Tolerance Report presented the areal extent of each commercially important crop grown in the Irrigation Use Area that occupied more than one percent of the irrigated acreage. The three most salt sensitive crops were identified: bean, which was the most sensitive, as well as alfalfa and almonds. The report proposed protective salinity thresholds for each, developed through a series of crop tolerance modeling runs which assumed 100 percent crop-yield protection. Dry beans were estimated to occupy approximately 22 percent of the

Irrigation Use Area in the 1990s and approximately 12 percent in the 2000s; alfalfa approximately 15 and 19 percent in the 1990s and 2000s, respectively; and almonds approximately 4 and 9 percent in the 1990s and 2000s, respectively.

Figure 5-1 Map of LSJR Irrigation Use Area and monitoring stations.



The report also presented Hoffman model results under a range of conditions by varying some of the model parameters (such as leaching faction and annual rainfall). Staff ran the model multiple times for dry beans, alfalfa, and almonds over a range of EC values from 500 to 2,000 µS/cm. For the dry bean model runs, the leaching fraction ranged from 15 to 25 percent, for alfalfa runs from 7 to 25 percent, and for almond runs from 10 to 20 percent. The results were presented with the assumption that 100 percent yields would be necessary during the driest 5th

percentile of historic annual rainfall years. Full explanations of the 2010 modeling runs are presented in the draft Salt Tolerance Report (Central Valley Water Board, 2010a).
In March 2010 as part of the public comment process, the Central Valley Water Board staff presented the draft of the Salt Tolerance Report to a joint meeting of CV- SALTS Executive and Technical Advisory Committees. Following the meeting, and a public review and comment period, staff incorporated some of the minor comments received into a June 2010 revised draft Salt Tolerance Report and posted it on the Central Valley Water Board internet site for public review (Central Valley Water Board, 2010b). Subsequently, responsibility for addressing the remaining substantive comments was transferred to the LSJR Committee.

5.2.1.2 ***LSJR Committee Efforts***

After the LSJR Committee took lead of the project, it evaluated the public comments on the draft Salt Tolerance Report and provided the Central Valley Water Board staff with responses to comments (Larry Walker Associates (LWA), 2014b). Also, the Committee developed a work plan for the development of a Basin Plan Amendment for establishing salinity objectives in the LSJR (Lower San Joaquin River Committee, 2012). The recommendations included the identification of EC water quality criteria using of a soil salinity model and the incorporation of additional scientific data and new policies. The LSJR Committee agreed that a soil salinity model could estimate the EC values that growers require to prevent unacceptable salinity impact to crops, recognizing that acceptable values can vary during the growing season, and may be less important than availability of water during prolonged dry periods lasting several years. The additional scientific data that was needed to updated the model included the results of a crop acreage survey of the Irrigation Use Area conducted by the Committee in 2013 and 2014 (East and West Stanislaus Resource Conservation Districts, 2014), which is documented in Table 5-2.

The committee debated the transient and steady state models available to determine resulting soil salinity related to quality of irrigation supply water, and recognized the general state of flux of these models. Although it was argued that transient models could be more accurate, it was recognized that a peer-reviewed transient model was not available. The LSJR Committee acknowledged that Dr. Glenn J. Hoffman’s steady-state model had been peer-reviewed and successfully used for the State Water Board to inform decisions regarding salinity WQOs in the Southern Delta.

In 2013, the LSJR Committee decided that the Hoffman model was the best tool to develop potential EC water quality criteria. As described in the previous section, in order to model soil water salinity in the crop root zone, Hoffman model parameters must be selected. These parameters include: the crops most sensitive to salinity, leaching fractions representative of irrigation practices, the appropriate minimum annual precipitation, and acceptable crop yields.

5.2.1.3 **Policies to Inform Hoffman Model Parameters**

To inform the decisions needed for the different Hoffman model parameters, the LSJR Committee worked with local growers to develop policies that could be translated into specific values. The steps used to identify these parameter values are described below.

5.2.1.3.1 *Crops Most Sensitive to Salinity and in Need of Protection*

The LSJR Committee decided that salt-sensitive crops that are relatively rare should not drive analyses that will inform AGR thresholds. Instead, consideration should be given to salt-sensitive crops that make up greater than 5 percent of the commercial acreage in an irrigation use study area. This value was deemed appropriate to encompass “common crops” that are sufficiently widespread in a study area

5.2.1.3.2 *Identification of Representative Leaching Fraction*

To the extent practicable, leaching fractions should be informed by field observations of actual practices. The model should assume fractions that are representative of the most conservative (i.e. lowest leaching fraction) condition that is widely represented in the study area. The LSJR Committee decided that the best means of determining representative leaching fractions, and determining how to best represent realistic irrigation methods, was to consult directly with irrigators in the Irrigation Use Area. During several LSJR Committee meetings, irrigation stakeholders representing major water agencies agreed that 15 percent is a reasonable default assumption.

5.2.1.3.3 *Minimum Precipitation*

The LSJR Committee evaluated different minimum precipitation parameter values by reviewing historic precipitation data in the San Joaquin Basin. The 5^{th} percentile of the driest historic annual precipitation measured in the 1952 through the 2013 Water Years was calculated to be 6.1 inches. Rainfall in three (3) Water Years of the 61 years selected for modeling was below the 5^{th} percentile: 1976 had 4.3 inches, 1977 had 5.7 inches, and 2007 had 4.3 inches. The LSJR Committee determined that using the 5^{th} percentile rainfall years was sufficiently conservative for the LSJR Irrigation Use Area.

Table 5-2 Summary of Irrigated Crop Surveys in the LSJR Irrigation Use Area.

Crop	Salt Tolerance[1]	Salinity Threshold[2] (TDS mg/L)	acreage			percentage of acreage		
			1990s Surveys	2000s Surveys	2013-2014 Survey	1990s Surveys	2000s Surveys	2013-2014 Survey
Almonds	S	752	2,091	4,343	13,497	3.65%	8.58%	28.91%
Apples	S	unknown	92	53	81	0.16%	0.10%	0.17%
Apricots	S	772	4,779	2,776	1,242	8.34%	5.48%	2.66%
Cherries	S	-	372	207		0.65%	0.41%	-
Eucalyptus	MT	-	6	-		0.01%	-	-
Figs	MT	-	-	-		-	-	-
Grapefruit	S	-	-	-		-	-	-
Kiwis	S	-	-	-		-	-	-
Lemons	S	-	-	-		-	-	-
Olives	T	-	-	-		-	-	-
Oranges	S	-	-	-		-	-	-
Peaches/Nectarines	S	827	21	345	213	0.04%	0.68%	0.46%
Pears	S	-	-	-		-	-	-
Pistachios	MS	unknown	16	31	5	0.03%	0.06%	0.01%
Plums	MS	-	150	34		0.26%	0.07%	-
Prunes	MS	-	-	33		-	0.07%	-
Walnuts	S	unknown	1,902	2,338	3,390	3.32%	4.62%	7.26%
Misc. Deciduous Fruits & Nuts	S	-	-	44		-	0.09%	-
Misc. Subtropical Fruits	S	-	-	-		-	-	-
Unspecified Deciduous Fruits & Nuts	S	-	-	-		-	-	-
Castor Beans	S	-	-	3,019		-	5.96%	-
Corn	MS	1,056	5,592	318	4,416	9.76%	0.63%	9.46%
Cotton	T	-	-	16		-	0.03%	-
Dry Beans	S	539	12,623	5,893	1,400	22.03%	11.64%	3.00%
Flax	MS	-	-	-		-	-	-
Safflower	MT	-	65	-		0.11%	-	-
Sorghum	MT	-	-	-		-	-	-
Sudan	MT	-	69	613		0.12%	1.21%	-
Sugar Beets	T	-	-	-		-	-	-
Sunflowers	MT	-	-	-		-	-	-
Unspecified Field Crops	MT	-	1,305	486		2.28%	0.96%	-
Barley	T	-	-	-		-	-	-

Table 5-2 (continued). Summary of Irrigated Crop Surveys in the LSJR Irrigation Use Area.

Crop	Salt Tolerance[1]	Salinity Threshold[2] (TDS mg/L)	acreage			percentage of acreage		
			1990s Surveys	2000s Surveys	2013-2014 Survey	1990s Surveys	2000s Surveys	2013-2014 Survey
Oats	T	unknown	-	-	1,745	-	-	3.74%
Wheat	MT	2,860	-	33	2,772	-	0.07%	5.94%
Misc. & Mixed Grain/Hay	MT	-	-	110		-	0.22%	-
Unspecified Grain/Hay Crops	MT	1,691	1,923	5,609	127	3.36%	11.08%	0.27%
Alfalfa	MS	1,146	8,839	9,398	8,468	15.43%	18.56%	18.14%
Clover	MS	-	-	-		-	-	-
Induced High Water Table Native Pasture	MS	-	-	-		-	-	-
Mixed Pasture	MS	-	3,444	3,190		6.01%	6.30%	-
Native Pasture	MS	-	-	-		-	-	-
Turf Farms	MT	unknown	426	379	22	0.74%	0.75%	0.05%
Misc. Grasses	MS	-	-	-		-	-	-
Unspecified Pasture	MS	2,067	-	-	514	-	-	1.10%
Artichokes	MT	-	-	183		-	0.36%	-
Asparagus	T	-	-	17		-	0.03%	-
Broccoli	MS	-	-	122		-	0.24%	-
Bush Berries	S	-	12	422		0.02%	0.83%	-
Cabbage	MS	-	-	606		-	1.20%	-
Carrots	S	-	27	124		0.05%	0.24%	-
Cauliflower	MS	-	282	6		0.49%	0.01%	-
Celery	MS	-	-	7,455		-	14.72%	-
Cherries	S	unknown	-	277	236	-	0.55%	0.51%
Cole Crops	MS	-	51	-		0.09%	-	-
Flowers/Nursery/Christmas Tree Farms	S	-	13	-		0.02%	-	-
Green Beans	S	-	126	-		0.22%	-	-
Lettuce	MS	-	29	-		0.05%	-	-
Melons/Squash/Cucumbers	MS	681	2,426	-	724	4.23%	-	1.55%
Mixed Truck Crops (four or more)8	MS	-	95	-		0.17%	-	-
Onions/Garlic	S	-	151	-		0.26%	-	-
Pea	MS	-	-	-		-	-	-
Peppers	MS	792	452	-	20	0.79%	-	0.04%
Potatoes	MS	-	-	-		-	-	-
Spinach	MS	-	-	-		-	-	-

Table 5-2 (continued). Summary of Irrigated Crop Surveys in the LSJR Irrigation Use Area.

Crop	Salt Tolerance[1]	Salinity Threshold[2] (TDS mg/L)	acreage			percentage of acreage		
			1990s Surveys	2000s Surveys	2013-2014 Survey	1990s Surveys	2000s Surveys	2013-2014 Survey
Strawberries	S	-	-	-		-	-	-
Sweet Potatoes	MS	-	-	-		-	-	-
Tomatoes	MS	1,282	9,391	481	7,094	16.39%	0.95%	15.20%
Misc. Truck Crops	MS	-	-	-		-	-	-
Unspecified Truck Crops	MS	-	-	604		-	1.19%	-
Unspecified Rice	S	-	-	-		-	-	-
Raisin Grapes	MS	-	-	-		-	-	-
Unspecified Grapes	MS	862	59	512	716	0.10%	1.01%	1.53%
Idle Field	Other	-	459	564		0.80%	1.11%	-
		Totals	57,288	50,641	46,682	1.00	1.00	1.00

[1]Salt tolerance categories: S = Sensitive; MS = Moderately Sensitive; MT = Moderately Tolerant; T = Tolerant.

[2]Approx. AW TDS for 95% MRY, 15% LF = approximate applied water total dissolved solids (mg/L) for 95% maximum relative yield, assuming 15% leaching fraction. This quantity can be calculated from Mass-Hoffman coefficients alone, providing a more precise index of sensitivity than the four, broad classifications. It is a useful means to rank crop's levels of salt sensitivity (specifically to a 5% yield reduction), where Mass-Hoffman coefficients are available. It is not a substitute for a site-specific analysis with a more detailed set of calculations, such as a Hoffman Model run.

5.2.1.3.4 Acceptable Crop Yields

The LSJR Committee recommended 95 percent as a reasonable level of crop yield protection. However, the LSJR Committee recognized that crop yields may be less important than the availability of water during prolonged dry periods lasting several years. During such times, the LSJR Committee recommended that the EC input value selected for salinity protection result in a model output crop yield of 75 percent during "Extended Dry Periods". The definition of Extended Dry Periods is presented in Chapter 6: the *Program of Implementation* chapter of this staff report.

After vetting these policy decisions with the LSJR Irrigation Use Area stakeholders, the LSJR Committee sent a letter to the CV-SALTS Executive Committee (Lower San Joaquin River Committee, 2013b) outlining their agricultural policy recommendations as described above and the CV-SALTS Executive Committee concurred with their recommendations. In summary, the LSJR Committee's policy recommendations where applied to the Hoffman model as follows:

1. *Consideration should be given to salt-sensitive crops that make up greater than 5 percent of the acreage in an irrigation use study area.* Using the survey data presented in Table 5-2, the LSJR Committee recommended that almonds be selected as the most salt sensitive crop requiring protection in Reach 83 of the LSJR.

2. *Site-specific leaching fractions should be considered if those data are available, if not available a default leaching fraction of 15 percent should be used.* The LSJR Committee applied the 15 percent leaching fraction to the Hoffman model.
3. *Protection to sensitive crops should be provided during all but the 5^{th} percentile of driest historic annual precipitation years*. In the LSJR Irrigation Use Area, this equated to the fifth percentile historic rainfall of 6.1 inches.
4. *The crop protection threshold should be 95% of maximum relative yield during timeframes that are not considered part of an Extended Dry Period.* The LSJR Committee applied the 95% crop yield to the Hoffman model. The acceptable yield was adjusted for the LSJR Irrigation Use Area to 75 percent during Extended Dry Periods, which is discussed in more detail in the Chapter 6, Program of Implementation

5.2.1.4 ***Subsequent LSJR Committee Evaluations***

As described above, the LSJR Committee's Hoffman modeling effort utilized the new crop survey and the new policies which included a leaching fraction representing irrigation practices in the LSJR Irrigation Use Area when site-specific data are not available, crop yield values acceptable to the LSJR stakeholders under certain conditions, and revised parameters for identifying the most salt sensitive commercial crop that requires protection.

Additional modeling recommendations made by the LSJR Committee included the use of data collected only near the Crows Landing and Patterson sampling locations, and not near Maze Road. Modeling results presented in the Central Valley Water Board draft Salt Tolerance Report showed that crops were less tolerant to salt when using the Crows Landing/Patterson data, due to lower rainfall patterns, and therefore would result in more conservative WQ criteria than use of Maze Road data. The LSJR Committee decided that it is reasonable to assume that the same holds true of the subsequent modeling results. Also, the LSJR Committee decided that it was appropriate to apply the exponential water uptake patternto the model, as was recommended by various parties during the 2010 public comment period for the draft Salt Tolerance Report {Section 5.2.1.1 Initial Crop Salt Tolerance Evaluations (2006-2010)}. These and other Hoffman model parameters used by the Committee are presented in Table 5-3. The Committee presented its 2013 to 2014 survey in the following document prepared by Larry Walker Associates, dated June 19, 2014, and titled *Memorandum –Task 1: Finalize Draft Agricultural Supply (AGR) EC Objectives*.

For the final crop salt tolerance modeling, the LSJR Committee asked Central Valley Water Board staff to update the model spreadsheets used to estimate almond soil water salinity values presented in the draft Salt Tolerance Report. Table 5-3 compares the ranges of EC, leaching fraction, crop yield and other model parameters utilized during the 2010 original study and the 2016 revision. To calculate the salinity of irrigation water for crop yields of 95 and 75 percent, staff ran the model 26 times, each time varying the irrigation-water salinity EC value by 0.100 µS/cm, from an initial value of 0.500 µS/cm through a final value of 3,000 µS/cm.

The resulting soil-water salinity and crop yield values estimated by the model for each of the 26 runs are presented in Table 5-4. Figure 5-2 is a plot of irrigation-water salinity versus soil water salinity presented in Table 5-4. Figure 5-3 is a plot of irrigation-water salinity versus relative crop yield presented in Table 5-4.

Table 5-3 Parameters Comparison: 2010 and 2014 Soil Salinity Modeling

Parameter Name	2010 Modeling Parameters	2014 Modeling Parameters
Historic model period	Jan 1, 1952 - Sep 30, 2008	Jan 1, 1952 - Sep 30, 2013
Locations of historic EC data	Crows Landing/Patterson, Maze	Crows Landing/Patterson
Sensitive crops modeled	bean, alfalfa, almond	almond
Model run with and without precipitation?	yes	no (precipitation only)
Leaching Fractions (almond)	0.10, 0.15, 0.20	0.10, 0.15
Historic precipitation stations	NCDC Newman C, Modesto C	NCDC Newman C
Historic temperature stations	NCDC Newman C, Modesto C	NCDC Newman C
Fifth percentile annual rainfall	5.98 inches (1952-2008 annual)	6.07 inches (1952-2013)
Crop uptake patterns	Exponential and 40-30-20-10	Exponential
Soil-water EC threshold (almond)	3.0	3.0
Minimum acceptable crop yield	100%	95% (75% for extended dry periods)
Bare soil ET inches/month	0.7	0.7
Runoff coefficient	77	77
Crop growth stage coefficients (almond)	B: Kc1 = 0.5 C: Kc2 = 0.9 E: Kc3 = 0.5	B: Kc1 = 0.5 C: Kc2 = 0.9 E: Kc3 = 0.5
Crop growth stage dates (almond)	A: 15-Feb B: 15-Feb C: 1-Jun D: 1-Sep E: 10-Nov	A: 15-Feb B: 15-Feb C: 1-Jun D: 1-Sep E: 10-Nov
Extraterrestrial radiation latitude	37º north latitude	37º north latitude

Table 5-4 Predicted Soil-Water Salinity and Almond Crop Yield in the LSJR Irrigation Use Area

Irrigation Water EC (dS/m)	Soil-Water EC (dS/m)	Crop Yield (percentage)
0.5	1.14	100
0.6	1.37	100
0.7	1.60	100
0.8	1.82	100
0.9	2.05	100
1.0	2.28	100
1.1	2.51	100
1.2	2.74	100
1.3	2.96	100
1.4	3.19	98.2
1.5	3.42	96.0
1.6	3.65	93.8
1.7	3.88	91.6
1.8	4.10	89.6
1.9	4.33	87.4
2.0	4.56	85.2
2.1	4.8	83.0
2.2	5.0	80.9
2.3	5.2	78.7
2.4	5.5	76.5
2.5	5.7	74.4
2.6	5.9	72.2
2.7	6.2	70.0
2.8	6.4	67.9
2.9	6.6	65.7
3.0	6.8	63.5

Figure 5-3 shows that the estimated irrigation-water salinity necessary for an almond crop yield of 95 percent is slightly more than 1,500 µS/cm when the leaching fraction is set at 15 percent. Through an iteration process with additional model runs, staff determined that the estimated value is approximately 1,550 µS/cm. Table 5-5 presents the model input and output values for that run: irrigation-water salinity set at 1,550 µS/cm and the leaching fraction set at 15 percent. The bottom cell of the total annual precipitation column near the left side of both Tables 5-5 and 5-6 shows that the computed 5th percentile annual rainfall total from the 1952 through the 2013 water years was 6.07 inches. The bottom cell of the far right column in Table 5-5 shows that the model estimates a soil-water salinity of 3,530 µS/cm during a 5th percentile annual rainfall year.

Figure 5-2 Almond Soil Water Salinity (5th percentile Annual Rainfall and 15% LF)

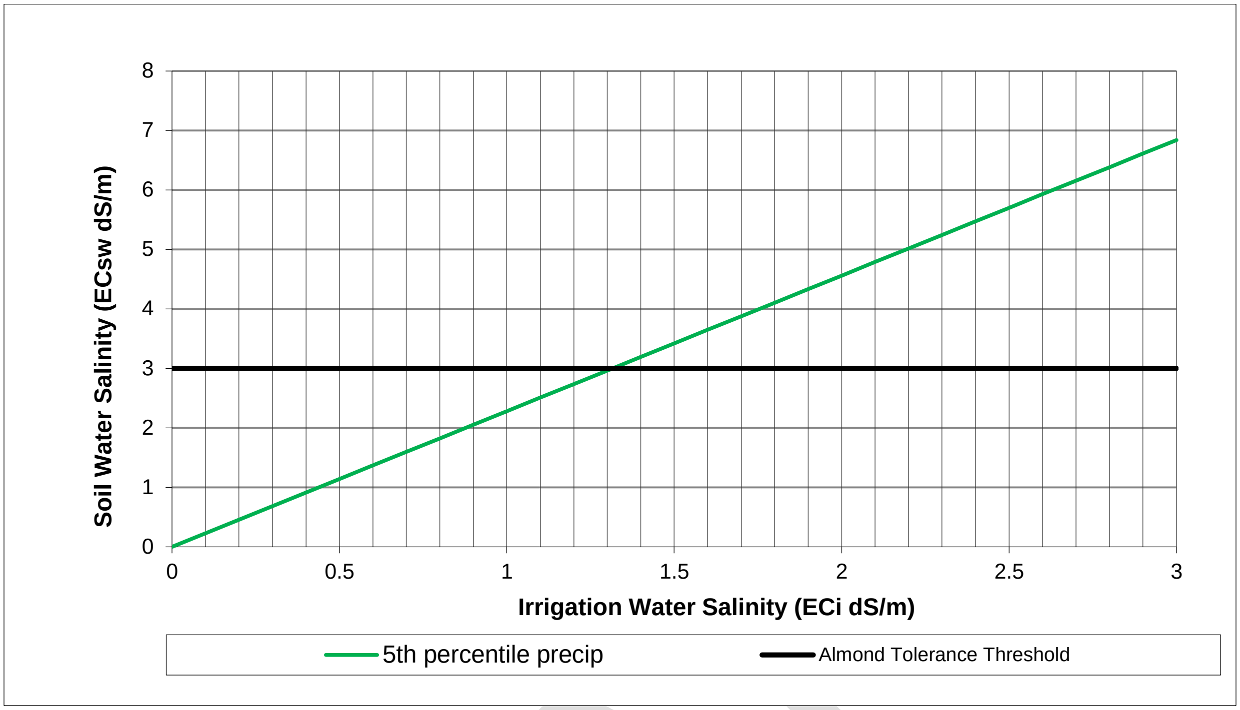


Figure 5-3 Relative Almond Crop Yield (5th percentile Annual Rainfall and 15% LF)

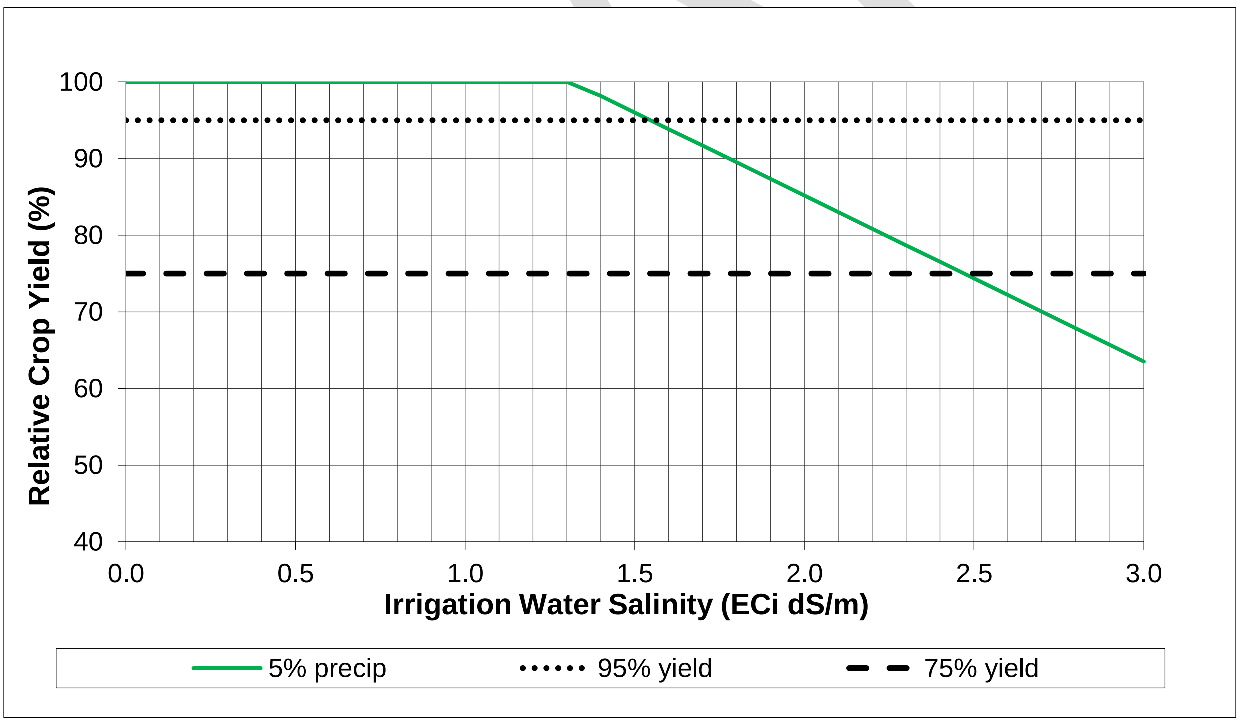


Table 5-5 Model Output: Irrigation Water EC=1.55 dS/m and LF=0.15.

Water Year	Input P_T (in.)	P_{NG} (in.)	E_S (in.)	P_{GS} (in.)	P_{EFF} (in.)	ET_C (in.)	Output EC_{SWb-2} (dS/m)
1952	16.89	8.72	2.2093	8.17	14.6807	46.9106	2.7949
1953	6.78	5.09	2.2323	1.69	4.5477	44.7044	3.4786
1954	6.51	2.69	2.2093	3.82	4.3007	44.3594	3.4940
1955	9.75	6.15	2.2093	3.6	7.5407	45.9497	3.2767
1956	10.89	8.09	2.2093	2.8	8.6807	46.2963	3.2010
1957	8.68	2.85	2.2323	5.83	6.4477	45.9620	3.3538
1958	19.69	6.92	2.2093	12.77	17.4807	45.5127	2.5647
1959	10.84	5.12	2.2093	5.72	8.6307	45.5745	3.1949
1960	6.61	5.29	2.2093	1.32	4.4007	44.9699	3.4911
1961	7.11	5.08	2.2323	2.03	4.8777	44.0289	3.4493
1962	12.00	9.58	2.2093	2.42	9.7907	44.2539	3.0918
1963	14.02	8.48	2.2093	5.54	11.8107	41.3296	2.8829
1964	6.47	2.55	2.2093	3.92	4.2607	42.5748	3.4839
1965	10.28	4.78	2.2323	5.5	8.0477	41.9786	3.1873
1966	10.57	8.86	2.2093	1.71	8.3607	44.9451	3.2058
1967	13.48	7.94	2.2093	5.54	11.2707	43.2268	2.9639
1968	6.06	3.3	2.2093	2.76	3.8507	44.3121	3.5266
1969	18.84	11.23	2.2323	7.61	16.6077	43.5097	2.5724
1970	8.64	5.19	2.2093	3.45	6.4307	44.4480	3.3396
1971	13.36	7.84	2.2093	5.52	11.1507	42.6483	2.9616
1972	6.16	5.56	2.2093	0.6	3.9507	44.5548	3.5208
1973	17.01	11.18	2.2323	5.83	14.7777	43.6354	2.7117
1974	11.53	5.46	2.2093	6.07	9.3207	44.1445	3.1245
1975	10.73	5.72	2.2093	5.01	8.5207	44.9755	3.1947
1976	4.31	0.86	2.2093	3.45	2.1007	44.7450	3.6559
1977	5.66	2.72	2.2323	2.94	3.4277	44.9956	3.5613
1978	17.25	9.61	2.2093	7.64	15.0407	45.0319	2.7268
1979	10.38	5.91	2.2093	4.47	8.1707	46.4518	3.2385
1980	13.03	6.63	2.2093	6.4	10.8207	43.4361	3.0015
1981	8.24	4.47	2.2323	3.77	6.0077	46.0953	3.3860
1982	14.81	6.54	2.2093	8.27	12.6007	43.3500	2.8670
1983	19.78	8.37	2.2093	11.41	17.5707	42.9837	2.4848
1984	8.42	6.56	2.2093	1.86	6.2107	46.8274	3.3786
1985	8.22	4.8	2.2323	3.42	5.9877	45.1595	3.3787

Table 5-5 (continued): Model Output: Irrigation Water EC=1.55 dS/m and LF=0.15.

	Input						Output
Water Year	P_T (in.)	P_{NG} (in.)	E_S (in.)	P_{GS} (in.)	P_{EFF} (in.)	ET_C (in.)	EC_{SWb-2} (dS/m)
1986	12.90	6.15	2.2093	6.75	10.6907	44.8472	3.0363
1987	6.32	3.63	2.2093	2.69	4.1107	46.4298	3.5213
1988	11.02	6.92	2.2093	4.1	8.8077	46.4231	3.1938
1989	8.15	4.74	2.2323	3.41	5.9177	45.7273	3.3890
1990	6.50	3.11	2.2093	3.39	4.2907	45.5038	3.5027
1991	8.77	2.31	2.2093	6.46	6.5607	42.6840	3.3104
1992	10.80	5.63	2.2093	5.17	8.5907	44.8405	3.1878
1993	17.84	10.9	2.2323	6.94	15.6077	42.2683	2.6127
1994	8.93	4.44	2.2093	4.49	6.7207	43.2184	3.3045
1995	18.72	9.71	2.2093	9.01	16.5107	40.9028	2.5013
1996	14.15	7.66	2.2093	6.49	11.9407	43.9054	2.9276
1997	13.61	11.97	2.2323	1.64	11.3777	44.2045	2.9748
1998	26.02	16.59	2.2093	9.43	23.8107	40.4260	1.9015
1999	8.70	3.71	2.2093	4.99	6.4907	42.4877	3.3134
2000	11.51	5.83	2.2093	5.68	9.3007	43.9027	3.1222
2001	11.14	4.46	2.2323	6.68	8.9077	45.0462	3.1678
2002	7.61	6.09	2.2093	1.52	5.4007	45.0023	3.4194
2003	10.45	4.97	2.2093	5.48	8.2407	43.3956	3.1932
2004	9.77	5.76	2.2093	4.01	7.5607	46.0418	3.2763
2005	15.29	7.11	2.2323	8.18	13.0577	43.2947	2.8317
2006	12.10	5.48	2.2093	6.62	9.8907	47.3294	3.1315
2007	4.34	3.05	2.2093	1.29	2.1307	48.1548	3.6646
2008	8.76	6.84	2.2093	1.92	6.5507	48.9043	3.3743
2009	6.54	3.78	2.2323	2.76	4.3077	42.5211	3.4799
2010	13.99	6.46	2.2093	7.53	11.7807	37.9015	2.8018
2011	12.95	5.46	2.2093	7.49	10.7407	37.4409	2.8793
2012	6.28	1.51	2.2093	4.77	4.0707	40.5814	3.4832
2013	7.74	6.31	2.2323	1.43	5.5077	40.6549	3.3694
5^{th} Percentile	**6.07**						**3.53**

Notes: ET_C = crop evapotranspiration; E_S = off-season surface evaporation

P_{GS} = precipitation during growing season; P_T = total annual (infiltrating) precipitation

Also, Figure 5-3 shows that the estimated irrigation water salinity necessary for an almond crop yield of 75 percent is approximately 2,500 µS/cm when the leaching fraction is set at 15 percent. Through an iteration process with additional model runs, staff determined that the estimated value is approximately 2,470 µS/cm. Table 5-6 presents the model input and output values for that run: irrigation water salinity set at 2,470 µS/cm and the leaching fraction set at 15 percent. The bottom cell of the far right column in Table 5-6 shows that the model estimates a soil water salinity of 5,630 µS/cm during a 5th percentile annual rainfall year.

The 2010 Central Valley Water Board draft Salt Tolerance Report was updated with the revised cropping patterns and Hoffman modelling runs, and finalized in 2016 (Central Valley Water Board, 2016b).

5.2.1.5 ***Comparison of Initial and Subsequent Modeling Results***

Some of the modeling and cropping assumptions made for both the 2010 draft Salt Tolerance Report and the 2016 final Salt Tolerance Report are presented in Sections 5.1.1 and 5.1.2 of the final Salt Tolerance Report (Central Valley Water Board, 2016b). Also, references for setting model crop coefficients and growth periods for estimating crop evapotranspiration requirements are presented in Section 5.1.3 of the final Salt Tolerance Report. Table 5-3 presents the almond crop coefficients and growth periods that were used in both draft and final reports.

Table 5-7 compares selected Hoffman modeling parameters and results from both the 2010 draft Salt Tolerance Report and the 2016 final Salt Tolerance Report's addendum. In general, the initial runs used more conservative parameter values, such as a 100 percent crop yield, and the 2010 report provided a range of salinity threshold values, such as the EC criteria of 800 µS/cm to protect dry beans and 1200 µS/cm to protect almonds. The LSJR Committee's subsequent evaluations modified the Hoffman model parameters based on the policy decisions discussed in Section 5.2.1.1. As a result, the LSJR Committee identified an EC criterion of 1,550 µS/cm during all months of the year to protect almonds, with the exception of Extended Dry Period years when an EC criterion of 2,470 µS/cm was found to protect 75% yield.

The final Salt Tolerance Report (Central Valley Water Board, 2016b) includes an addendum that details how the Central Valley Water Board staff incorporated technical and policy recommendations established by the LSJR Committee into crop salt tolerance modeling and the calculations of proposed EC water quality criteria that would be protective of irrigated agriculture in the LSJR Irrigation Use Area.

Table 5-6 Model Output: Irrigation Water EC=2.47 dS/m and LF=0.15

	Input						Output
Water Year	P_T (in.)	P_{NG} (in.)	E_S (in.)	P_{GS} (in.)	P_{EFF} (in.)	ET_C (in.)	EC_{SWb-2} (dS/m)
1952	16.89	8.72	2.2093	8.17	14.6807	46.9106	4.4630
1953	6.78	5.09	2.2323	1.69	4.5477	44.7044	5.5547
1954	6.51	2.69	2.2093	3.82	4.3007	44.3594	5.5794
1955	9.75	6.15	2.2093	3.6	7.5407	45.9497	5.2323
1956	10.89	8.09	2.2093	2.8	8.6807	46.2963	5.1114
1957	8.68	2.85	2.2323	5.83	6.4477	45.9620	5.3554
1958	19.69	6.92	2.2093	12.77	17.4807	45.5127	4.0954
1959	10.84	5.12	2.2093	5.72	8.6307	45.5745	5.1017
1960	6.61	5.29	2.2093	1.32	4.4007	44.9699	5.5747
1961	7.11	5.08	2.2323	2.03	4.8777	44.0289	5.5079
1962	12.00	9.58	2.2093	2.42	9.7907	44.2539	4.9370
1963	14.02	8.48	2.2093	5.54	11.8107	41.3296	4.6035
1964	6.47	2.55	2.2093	3.92	4.2607	42.5748	5.5633
1965	10.28	4.78	2.2323	5.5	8.0477	41.9786	5.0897
1966	10.57	8.86	2.2093	1.71	8.3607	44.9451	5.1191
1967	13.48	7.94	2.2093	5.54	11.2707	43.2268	4.7329
1968	6.06	3.3	2.2093	2.76	3.8507	44.3121	5.6314
1969	18.84	11.23	2.2323	7.61	16.6077	43.5097	4.1077
1970	8.64	5.19	2.2093	3.45	6.4307	44.4480	5.3327
1971	13.36	7.84	2.2093	5.52	11.1507	42.6483	4.7292
1972	6.16	5.56	2.2093	0.6	3.9507	44.5548	5.6222
1973	17.01	11.18	2.2323	5.83	14.7777	43.6354	4.3301
1974	11.53	5.46	2.2093	6.07	9.3207	44.1445	4.9892
1975	10.73	5.72	2.2093	5.01	8.5207	44.9755	5.1013
1976	4.31	0.86	2.2093	3.45	2.1007	44.7450	5.8378
1977	5.66	2.72	2.2323	2.94	3.4277	44.9956	5.6868
1978	17.25	9.61	2.2093	7.64	15.0407	45.0319	4.3542
1979	10.38	5.91	2.2093	4.47	8.1707	46.4518	5.1714
1980	13.03	6.63	2.2093	6.4	10.8207	43.4361	4.7929
1981	8.24	4.47	2.2323	3.77	6.0077	46.0953	5.4069
1982	14.81	6.54	2.2093	8.27	12.6007	43.3500	4.5782
1983	19.78	8.37	2.2093	11.41	17.5707	42.9837	3.9678
1984	8.42	6.56	2.2093	1.86	6.2107	46.8274	5.3950
1985	8.22	4.8	2.2323	3.42	5.9877	45.1595	5.3952
1986	12.90	6.15	2.2093	6.75	10.6907	44.8472	4.8484

Table 5-6 Model Output: Irrigation Water EC=2.47 dS/m and LF=0.15

	Input						Output
Water Year	P_T (in.)	P_{NG} (in.)	E_S (in.)	P_{GS} (in.)	P_{EFF} (in.)	ET_C (in.)	EC_{SWb-2} (dS/m)
1987	6.32	3.63	2.2093	2.69	4.1107	46.4298	5.6229
1988	11.02	6.92	2.2093	4.1	8.8077	46.4231	5.0999
1989	8.15	4.74	2.2323	3.41	5.9177	45.7273	5.4116
1990	6.50	3.11	2.2093	3.39	4.2907	45.5038	5.5931
1991	8.77	2.31	2.2093	6.46	6.5607	42.6840	5.2861
1992	10.80	5.63	2.2093	5.17	8.5907	44.8405	5.0903
1993	17.84	10.9	2.2323	6.94	15.6077	42.2683	4.1720
1994	8.93	4.44	2.2093	4.49	6.7207	43.2184	5.2768
1995	18.72	9.71	2.2093	9.01	16.5107	40.9028	3.9942
1996	14.15	7.66	2.2093	6.49	11.9407	43.9054	4.6749
1997	13.61	11.97	2.2323	1.64	11.3777	44.2045	4.7502
1998	26.02	16.59	2.2093	9.43	23.8107	40.4260	3.0363
1999	8.70	3.71	2.2093	4.99	6.4907	42.4877	5.2909
2000	11.51	5.83	2.2093	5.68	9.3007	43.9027	4.9856
2001	11.14	4.46	2.2323	6.68	8.9077	45.0462	5.0585
2002	7.61	6.09	2.2093	1.52	5.4007	45.0023	5.4602
2003	10.45	4.97	2.2093	5.48	8.2407	43.3956	5.0990
2004	9.77	5.76	2.2093	4.01	7.5607	46.0418	5.2318
2005	15.29	7.11	2.2323	8.18	13.0577	43.2947	4.5217
2006	12.10	5.48	2.2093	6.62	9.8907	47.3294	5.0004
2007	4.34	3.05	2.2093	1.29	2.1307	48.1548	5.8518
2008	8.76	6.84	2.2093	1.92	6.5507	48.9043	5.3882
2009	6.54	3.78	2.2323	2.76	4.3077	42.5211	5.5569
2010	13.99	6.46	2.2093	7.53	11.7807	37.9015	4.4740
2011	12.95	5.46	2.2093	7.49	10.7407	37.4409	4.5978
2012	6.28	1.51	2.2093	4.77	4.0707	40.5814	5.5620
2013	7.74	6.31	2.2323	1.43	5.5077	40.6549	5.3803
5th Percentile	**6.07**						**5.63**

Notes: ET_C = crop evapotranspiration; E_S = off-season surface evaporation

P_{GS} = precipitation during growing season; P_T = total annual (infiltrating) precipitation

Table 5-7 LSJR Irrigation Use Area Hoffman Modeling Results

Crop	Leaching Fraction	Crop Yield	Crop Salinity Threshold	Report Date	Data Range
Dry beans	15%	100%	800	2010	1951-2008
Dry beans	20%	100%	1,200	2010	1951-2008
Almonds	15%	100%	1,200	2010	1951-2008
Alfalfa	10%	100%	1,000	2010	1951-2008
Alfalfa	15%	100%	1,600	2010	1951-2008
Almonds	15%	95%	1,550	2016	1951-2013
Almonds	15%	75%	2,470	2016	1951-2013

Notes: Crows Landing/Patterson monitoring stations
Effective precipitation
5th percentile annual rainfall
Exponential water uptake pattern

5.2.2 **Municipal Supply**

In addition to identifying potential criteria for the protection of the AGR beneficial use, the LSJR Committee also evaluated possible criteria to protect the Municipal and Domestic Supply (MUN) beneficial use. The Basin Plan identifies the primary and secondary Maximum Contaminant Levels (MCLs) specified in Title 22 of the California Code of Regulations, developed for the protection of potable water at the tap after receiving conventional treatment, as the appropriate WQOs to protect the MUN use. Table 64449-B in Title 22 of the California Code of Regulations contains consumer acceptance secondary MCL ranges for a number of salinity constituents. Secondary MCLs are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the levels specified in the secondary MCL table. For specific conductivity, Table 64449-B contains a specific conductivity Secondary MCL recommended value of 900 µS/cm, an upper value of 1,600 µS/cm and a short-term value of 2,200 uS/cm.

5.2.3 **EC Criteria Range**

Upon completion of their salinity criteria evaluations, the LSJR Committee was able to identify an upper range of EC values for consideration as potential salinity WQOs to protect the AGR and MUN beneficial uses.

For the lower end of the range, the Committee considered the existing EC WQOs of 700 µS/cm and 1,000 µS/cm in the LSJR at the Airport Way Bridge near Vernalis, established by the State Water Board to protect Southern Delta agriculture (State Water Board, 2000). As a comparison, Central Valley Water Board staff conducted a follow-up Hoffman model run using all of the same parameter values discussed in section 5.2.1.1, with the exception of a more conservative leaching fraction of 10 percent (Central Valley Water Board, 2014b). The Central Valley Water Board Memorandum is presented in Appendix B. The resulting salinity threshold value of EC to protect almond crops was 1,010 µS/cm, essentially equivalent to the Vernalis EC objective of 1,000 µS/cm. The lower Vernalis objective of 700 µS/cm was equivalent to Ayers and Westcot's recommended salinity guideline for "Unrestricted Use" (Ayers, R.S. and Westcot, D.W., 1985). To protect the AGR beneficial use, this salinity guideline has been historically used by the Central Valley Water Board to interpret a narrative objective in the Basin Plan (*"Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses")*. However, concerns have long been raised by Central Valley irrigators over the application of the 700 µS/cm as an EC regulatory threshold to protect agriculture, since this value assumes that highly salt sensitive crops occur in all areas of the Central Valley and must be protected during all water-year types. In addition, the value does not take in to account the mitigation of some salinity impacts by modern irrigation strategies (U.S. Bureau of Reclamation, 2010). With these considerations in mind, the LSJR Committee's primary focus was an EC criteria range of 1,010 to 1,550 µS/cm to protect AGR which falls below the upper Secondary MCL value of 1,600 uS/cm, which is considered protective of the MUN use.

In terms of averaging periods for the criteria identified, the LSJR Committee decided to remain consistent with the WQOs and sampling regimes established in the San Joaquin River at the Airport Way Bridge nearVernalis for the protection of agricultural beneficial uses of water entering the Delta, and recommended using the same water quality compliance period of a 30-day running average of mean daily EC for Reach 83 of the LSJR (State Water Board, 2000). For values specific to the protection of the MUN use, the LSJR Committee recommended the Title 22 method of using an annual average using at a minimum the previous four consecutive quarterly samples.

5.3 Development of Project Alternatives

With a potential range of EC criteria identified, the LSJR Committee turned their attention to issues relating to feasibility. Two factors in Water Code section 13241 that must be considered in establishing WQOs for the Basin Plan pertain to the environmental characteristics of the hydrographic unit and reasonably achievable water quality conditions (Wat. Code, § 13241, subds. (b) and (c).) In order to identify project alternatives that could be reasonably achieved within the identified range of criteria, the LSJR Committee chose to evaluate existing conditions and potential management or implementation actions that reduce salinity in the LSJR, and apply a watershed model that could forecast salinity conditions that result from implementation of these actions.

The Watershed Analysis Risk Management Framework (WARMF) model was selected by the LSJR Committee as the best available tool to predict the potential impacts of different management or implementation actions on salinity levels in the river. WARMF is a physically-based watershed model capable of simulating watershed hydrology and water quality on a daily or shorter time step. WARMF has been used in the San Joaquin River Basin in the past (Herr and Chen, 2008; Herr, Chen, and Van Werkhoven, 2008; Kratzer, et al, 2008; LWA, et al, 2010; and Systech, 2011). Brief summaries of these publications are presented in the 4 March 2014 Larry Walker Associates Memorandum, commissioned by the LSJR Committee, and titled: *Task 2a: Compile and Update Water Quality and Salt Loading Data* (LWA, 2014a). The WARMF tool was used first to establish baseline conditions in the LSJR based on historic data and then applied as a forecasting tool to predict potential impacts of different management or implementation actions on salinity levels in the river.

5.3.1 **Process to Identify and Evaluate the Effectiveness of Potential Management Actions**

The LSJR Committee initially identified a large number of potential management actions available to control salinity (Larry Walker Associates (LWA), 2015a), and decided to combine existing and potential implementation actions into bundles of potential activities. The bundles of implementation actions were then modeled. The LSJR Committee modeled the LSJR baseline conditions and three bundles of management actions. From the modeling results, the LSJR Committee could better assess the overall feasibility of potential management actions to meet salinity criteria in the river and then develop specific project alternatives. The following steps were taken by the LSJR Committee to identify a set of management actions:

a) Identify management actions that can be used to manage salt in the Irrigation Use Area,
b) Develop selection criteria for screening the management actions,
c) Screen management actions for inclusion in each WARMF modeling bundle,
d) Evaluate historic flow and water quality data, and run the WARMF model to establish baseline conditions,
e) Run the WARMF model on the bundles of management actions, and
f) Evaluate results on bundled management actions and compare them to modeled baseline conditions.

For a more detailed explanation of these steps, refer to the LWA report titled: *Task 4 - Implementation Planning for Proposed Salinity Objectives* (Larry Walker Associates (LWA), 2015a).

5.3.1.1 ***Available Management Actions***

The LSJR Committee realized that there are numerous salinity control measures that could potentially be implemented in the Irrigation Use Area. The Committee directed LWA to identify management actions ranging from large regional controls to more localized actions. Fifteen (15) management actions were identified and grouped into 2 categories: 1) Actions that reduce salt load into the LSJR and; 2) Actions that export salt from the LSJR watershed. The identified management actions and the methods under which they were categorized are summarized in Table 5-8 which was originally presented in a 2015 LWA report (Larry Walker Associates (LWA), 2015a). While Table 5-8 focuses on salinity, the implementation actions described will be similar for boron and other ions. The implementation actions represent a range of potential actions for consideration during the development of three alternative management scenarios. Each alternative management scenario contains a combination of several implementation actions, and it should be noted that some of the actions listed (i.e. Salinity Real Time Management Program, Active Alternative Land Management, etc.) by definition already involve a combination of actions.

Table 5-8 Range of Potential Implementation Actions

METHODS	IMPLEMENTATION ACTIONS	EXAMPLES	DESCRIPTION OF IMPLEMENTATION ACTIONS
MANAGE SALT DISCHARGES TO LSJR TO MATCH ASSIMILATIVE CAPACITY	1. Controlled Timing of Salinity Discharges (RealTime Management Program)**		Would take advantage of assimilative capacity in the river to export salt to the Delta and ocean. Requires a coordinated program to manage discharges, diversions, and river and tributary releases to enable timed releases of drainage. Also requires real-time monitoring of flow and EC at selected sites, real-time data QA and a means of information sharing and dissemination
REDUCE SALT AND BORON LOADING TO THE LSJR (LOAD REDUCTION)	2. Reduce Point Sources of Salts	a. Self Regenerating Water Softener Ban or Restrictions**	Would reduce salt loads from POTWs that have self regenerating water softeners in their service areas
		b. New or Improved (less saline) Surface Water Supply**	Would reduce salt loads from POTWs that can substitute new surface water supplies for existing groundwater supplies
		c. Ind/Food Processing Source Control (and/or Pretreatment)**	Would reduce salt loads from POTWs by requiring industrial control of salts in discharges to sewer system. For specific industries discharging to land, source reductions may potentially benefit the LSJR through reduced salt loadings via groundwater accretion. Includes, but is not limited to, product substitution, process modification, and solids removal.
		d. Desalination of POTW Effluent	Would reduce salt loads to the river from POTWs through installation of desalination facilities. Requires brine handling/disposal.
	3. Reduce Nonpoint Sources of Salts	a. Reduce application of salts contained in fertilizers and soil amendments	Would reduce salt loads through high efficiency irrigation, improved fertilizer management, or other measures aimed at reduced application of chemicals containing salt.
	4. Evaporation Ponds (lined)	a. Evaporation Ponds	Would reduce loads by capturing all or portion of drainage flows and diverting to evaporation ponds. Requires brine or salt handling/disposal.
		b. Solar Evaporators	Alternative means to further evaporate drainage water (from evaporation or recirculation practices) for harvesting or disposal of salt.
		c. Salt Energy Ponds	Alternative means to further evaporate drainage water (from evaporation or recirculation practices) and generate energy during the course of the natural evaporation of water.
	5. Water Treatment (drainage)**	a. Satellite or regional treatment facilities	Would reduce salt loads through installation of desalination facilities. Requires brine handling/disposal.
	6. Land Retirement**	a. Retired lands as Reuse Facilities	Would reduce salt loads associated with drainage and also functions to retain salt by accepting recycled water, along with its salt load. Regional reuse could include active alternative land management or use of lands for drainage, treatment and disposal, etc.
		b. Retire lands to non-irrigated uses	Would reduce salt loads by reduction in applied water and associated drainage. Lands could be converted to commercial, industrial purposes, flood control, habitat purposes, etc.
		c. Temporary Land Retirement (Fallowing)	Would reduce salt loads by reduction in applied water and associated drainage. The decision to fallow land would be made at the beginning of a season. Fallowing could be seasonal or could continue for longer durations.
	7. Water Supply Improvement	a. Delta Corridors Plan	Would reduce salt loads into the LSJR by eliminating the recirculation of SJR water back into the Delta Mendota Canal. Irrigation with lower saline DMC water would result in lower concentrations of salinity in the drainage water discharged from the west side of the basin.

Table 5-8 Range of Potential Implementation Actions

METHODS	IMPLEMENTATION ACTIONS	EXAMPLES	DESCRIPTION OF IMPLEMENTATION ACTIONS
		b. Bay Delta Conservation Plan	Would reduce salt loads by importing less saline water into the Delta Mendota Canal for irrigation of land on the west side of the basin, ultimately resulting in lower concentrations of salinity in the drainage water.
REDUCE SALT AND BORON LOADING TO THE LSJR (LOAD REDUCTION) continued	8. Water Conservation	a. Replace Infrastructure (pipelines to replace canals)**	Would conserve water by reducing seepage to reduce diversion of tributary flows. Reduction in salt loading would depend on whether water conserved would be applied to other land in the basin. If not re-applied, conservation would result in reduction in salt loading. If re-applied, net reduction in loading would be minimal. Incidental benefits of seepage (groundwater recharge and canal-dependent vegetation) will be lost.
		b. Optimize existing irrigation efficiency	Similar to 8(a). Note that irrigation systems are being updated at a rapid pace, primarily because the production benefits of drip and microspray systems on certain crops have proven to be very significant, and the cost of the systems has come down. While the total salt load is the same, salts are precipitated and retained near the root zone, so the total salt load to the aquifer is episodic, occurring during periods of infrequent seasonal flushing.
	9. New high-efficiency irrigation systems, per se	a. Increase retention of soluble salts	Would reduce loading through reduction in drainage volume. Conventional notions of leaching excess salt through the soil to maintain production change somewhat with drip and microspray irrigation, in which salts may accumulate harmlessly beyond the soil zone accessed by plants to uptake water.
	10. Sequential Reuse & volume Reduction (Salt sensitive crops & solar evap)**	a. Integrated Farm Drainage Management (IFDM)	Would reduce the volume discharged; results in an increase in concentration. Relies on eventual salt export to an alternative sink. Reuse occurs on dedicated facilities with attendant costs. Feasibility would be enhanced by a reliable market for the recovered salt products.
		b. Salt accumulation area (SJRIP)	Would reduce the volume discharged from the Grasslands Drainage Area (GDA). Grow salt tolernat crops, install tile drains and collection systems, solar evap or treatment of drainage water and disposal at Kettleman Hills landfill or a possible in-basin salt sink.
	11. Active Alternative Land Mgmt (sequential reuse/crop selection etc.)		Would reduce the volume discharged. A blend of 10 and 12b, mainly distinguished by the intentional nature of land management through crop selection and irrigation practices, without creating a dedicated facility.
	12. Drainage Water Recirculation	a. Tailwater Recovery	Would reduce loadings through reuse and volume reduction. Where reuse replaces irrigation with imported water, would reduce salt load associated with that supply. This practice relies on ultimate salt disposal for long term sustainability.
		b. Tilewater Recovery - Re-route drainage water (Grasslands Bypass)	Similar to 12a., but entails recirculation of greater salt concentration from the outset. (Grasslands Bypass)

Table 5-8 Range of Potential Implementation Actions

METHODS	IMPLEMENTATION ACTIONS	EXAMPLES	DESCRIPTION OF IMPLEMENTATION ACTIONS
	13. Reduce Impact of Groundwater as a Source of Salinity to LSJR		General category which may include: (a) reduction in shallow groundwater levels to reduce subsurface drainage (and salt) loading into subsurface drain systems (areas where this is hydrogeologically feasible may be fairly limited) and (b) reduction in groundwater as water supply or reduction in salt loadings in groundwater though well-head treatment.
MANAGE SALT LOADS VIA SEQUESTRATION/ TRANSPORT/ DISPOSAL	14. Salt Disposal/Out of Basin Transport (Supports Actions #2-6, 12 that create a brine)**	a. Brine Line to Ocean	Alternative means of salt transport and out-of-basin disposal
		b. Truck to WWTP with ocean or bay outfall	Similar to 14a.
		c. Landfill disposal	Alternative means of in-basin or out-of-basin disposal of crystallized salt
		d. Out of Basin Salt Sink	Similar to 14c.
		e. Commercial market for reclaimed salt	Alternative means of out-of-basin disposal of salt.
		f. Direct Well Injection	Alternative means of In-basin disposal of concentrated salts or brines
		g. Brine line to WWTP with ocean or bay outfall	Similar to 14.a
ADAPTIVE WATER SUPPLY MGMT	15. SJR water diversions during periods of excess SJR flows		Would take advantage of excess flows in SJR during wet years or wet seasons to provide irrigators with low salinity water to better manage salts (i.e., following periods of high salinity due to drought or other factors, to better control the leaching process, to alternate with irrigation using higher salinity water, etc.)

**Action considered as a part of SSALTS.

5.3.1.2 ***Development of Management Action Screening Criteria***

Screening criteria were developed to help guide the selection of the management actions presented in Table 5-8 to be included in the three bundles of actions for modeling. The screening criteria, presented in Table 5-9, were developed to allow for a qualitative evaluation of potential management actions and were based upon a review of the approaches and considerations used in the *LSJR Salt and Boron TMDL* (Central Valley Water Board, 2004), the *Draft Final Phase 2 Report – Development of Potential Salt Management Strategies* (CDM Smith, 2014), and *The Rainbow Report* (California Department of Water Resources, 1990). The screening criteria include three main categories and several sub-categories as shown in Table 5-9, developed by the LSJR Committee (Larry Walker Associates (LWA), 2015a). The categories are technical feasibility, economic viability, and ability to implement.

Each of the sub-categories was used to further characterize the relative merits of a particular management action. The sub-categories were useful in evaluating the presumed effectiveness and shortcomings of a given action with respect to the quantity and timing of salt loads that the action could reasonably address and the potential costs/impacts that could occur with implementation of the management action.

5.3.1.3 ***Management Action Screening***

Using the screening criteria, the LSJR Committee evaluated the 15 identified management actions, and earmarked each for inclusion or exclusion within a bundle to be modeled. Management actions considered to have numerous poor performing qualitative assessments (e.g. unproven technology, low flexibility, high costs, difficult to model, etc.) were eliminated altogether from inclusion in the bundles of management actions.

Out of the 15 management actions listed in Table 5-8, six were screened out and nine were carried forward for potential inclusion in one or more of the bundles to be modeled using the WARMF model. The following lists the nine actions, each with its Table 5-8 alpha-numeric designation and description:

1. Action 1 – Controlled Timing of Salinity Discharges
2. Action 2c – Reduce Point Sources – existing industrial/food processing sources control and/or pretreatment
3. Action 3a – Reduce Nonpoint Sources – Reduce application of salts in fertilizers and soil amendments
4. Action 5a – Water Treatment – Regional Facility
5. Action 8b – Water Conservation – Optimize Existing Irrigation Efficiency
6. Action 9a – Installation of New High Efficiency Irrigation and Delivery Systems
7. Action 10b – Sequential Reuse and Volume Reduction – Salt Accumulation Area similar to the San Joaquin River Water Quality Improvement Project (SJRIP)

8. Action 12a – Drainage Water Recirculation – Tailwater Recovery
9. Action 12b – Drainage Water Recirculation – Tilewater Recovery

Table 5-9 Screening Criteria Used in the Evaluation of Management Alternatives

Goal	Criteria	Sub-Criteria	Assessment Range			Suggested Metrics
Address a Significant Source of Salt Loading to the LSJR	1. Technical Feasibility	a. Technologies are readily available/adaptable	Unproven	Proven, not available and/or not adaptable	Proven, readily available and adaptable	Qualitative
		b. Ability to meet WQOs and load allocations or WQO achieved in river	Low rate of compliance	Med rate of compliance	High rate of compliance	Predicted rate of LSJR compliance with WQO
		c. Provides for flexibility to growers and wetland operators	Low flexibility	Medium flexibility	High flexibility	Qualitative
		d. Flexible/adaptable to climate changes/water year types	Low flexibility	Medium flexibility	High flexibility	Qualitative
	2. Economic Viability	a. Relative Capital and O&M costs	Highest costs	Medium costs	Lowest costs	Estimated costs. Metric to be determined (i.e., millions/year, dollars/ton of salt removed or dollars/ac-ft, etc.)
	3. Ability to Implement	a. Potential environmental issues	High issues/delays	Med issues/delays	Low issues/delays	Qualitative
		b. Time period for planning/design/construction	Most time to implement	Medium time to implement	Least time to implement	Qualitative
		c. Legal/regulatory/institutional hurdles	High potential for hurdles	Medium hurdles	Little to no hurdles	Qualitative
		d. Time to implement	Most time to implement	Medium time to implement	Least time to implement	Years
		e. Action within authority of implementing agency	No authority exists	Some authority	Full authority exists	Qualitative

The Committee evaluated the nine management actions carried forward using the screening criteria above to develop three salinity management bundles for detailed evaluation. The bundles were designed to serve as “book-ends” to achieve the lower and upper ends of the criteria range. The planned plus extreme management bundle and the Planned plus extreme treatment bundle were designed to demonstrate the level of agricultural drainage water quality achievable with management actions that involve significant effort, with the intent to meet or remain below an EC value of 1,010 µS/cm. The planned bundle was run to determine if the upper end of 1,550 µS/cm or better could be achieved with existing and planned management actions already developed and in the process of being implemented in the LSJR Basin. The following are brief descriptions of the three bundles:

1. The planned management bundle was designed to encompass existing salinity control activities and those planned for implementation within the next 5 – 10 years.
2. The planned plus extreme management bundle was designed to demonstrate the level of agricultural drainage water quality achievable with management actions that involve significant management effort such as expanded areas of salt containment areas.
3. The planned plus extreme engineered treatment bundle was also designed to demonstrate the level of agricultural drainage water quality achievable with management actions that involve significant engineering effort such as collection for treatment at a desalting facility with the clean water returned to the river.

The three salinity management bundles are described in detail in the LWA report prepared for the LSJR Committee, (LWA, 2015a). Tables 3, 4, and 5 of that memorandum summarize the management actions included in each bundle.

5.3.1.4 ***Identification of Historic Conditions and Baseline Modeling***

The LSJR Committee directed LWA to use historic EC concentrations at locations on the river and its tributaries to characterize historic conditions and model baseline EC and flow conditions in the river.

5.3.1.4.1 Historic Conditions

The Committee realized that an understanding of historic conditions would assist in identification of the level of management or implementation actions that could result in attainment of EC concentrations within the range of EC criteria concentrations. Available surface water quality and salt loading data relevant to the LSJR, both within and upstream of Reach 83, were identified and compiled. Appendix A presents the process undertaken to identify and compile the data. The data and data sources were housed within the WARMF model. The WARMF database served as the overall project database. Understanding of historic conditions identified the salt loads that exist upstream of Reach 83. These upstream loads constitute a significant portion of the salinity measured in the reach.

Historical ambient water quality data within Reach 83 of the LSJR were characterized and plotted against the proposed range of EC criteria (1,010 – 1,550 µS/cm). Two important historical monitoring locations on the LSJR were selected for further evaluation: (1) Maze Road, used to characterize water quality between the Tuolumne and Stanislaus Rivers, and (2) Crows Landing, used to characterize water quality between the Merced and Tuolumne Rivers. Data collected at an additional location, Patterson Bridge, were used to supplement data gaps at Crows Landing after determining that water quality at the two locations was similar based on a strong linear relationship for EC (R^2 = 0.92466). The linear relationship analysis is presented an LWA report prepared for the LSJR Committee (Larry Walker Associates (LWA), 2014d).

Water quality conditions at Maze Road and Crows Landing were characterized on the basis of month, season, and water-year type for the water years 1977 through 2013. These water quality conditions were then utilized in determining the rates of compliance with the proposed range of WQOs. Compliance comparisons of historical 30-day running average EC levels measured at the Maze Road and Crows Landing-Patterson locations were made for the criteria range of 1,010 to 1,550 µS/cm, in 100 µS/cm increments. These characterizations of historical water quality and their comparisons to the range of EC criteria showed improved water quality and increasing compliance starting in 1995 with the implementation of the Grassland Bypass Project (GBP). The GBP systematically reduces loads of selenium and salt from 90,000 acres of commercial farmland from entering the LSJR upstream of the Merced River. Considering that the operational conditions and water quality of the LSJR differ from pre-GBP and post-GBP, the LSJR Committee focused on evaluation and modeling of the 1995 through 2013 time period. This decision established the baseline salinity conditions in Reach 83 which could be used to compare with model results of potential future management actions.

5.3.1.4.2 <u>Baseline Modeling</u>

The LSJR Committee directed LWA to perform WARMF baseline modeling of historic flow and EC for the LSJR. LWA's modeling results are presented in its memorandum, titled *Summary of Work Completed: Tasks 2, 3, and 8b*, dated 12 November 2014 (Larry Walker Associates (LWA), 2014d). The WARMF model was run using historic data collected from the LSJR monitoring stations at Maze Road and Crows Landing to establish "Baseline" model simulations of flow and EC upon which later model simulations could be developed and compared. These model results were plotted against the historical ambient water quality to evaluate model performance. The Baseline modeling results for flow compared well to historical flow data from both monitoring locations. Model EC results compared well to historical data at Maze Road. However, comparisons to historical EC at Crows Landing were not as strong. The effects of discrepancies between historical and WARMF- simulated baseline EC conditions at Crows Landing are further discussed in the LWA report titled: *Task 4 - Implementation Planning for Proposed Salinity Objectives* (LWA, 2015a). In addition, the WARMF simulated output and historical ambient water quality were plotted to evaluate the model fit on the one-to-one linear regression line, which shows where model simulated results match historical ambient data. The results are shown in Figures 5-5 through 5-10, originally presented in the LWA report (Larry Walker Associates (LWA), 2015a).

The baseline WARMF simulations provided a representative characterization of the significant salt sources in the LSJR Basin, quantification of salt loadings from the various sub-watersheds, and descriptions of the timing of salt loading to the LSJR. The results provide information on the regions, sources, and timing of salt loading within the watershed where management measures could be employed to provide the greatest reductions in salt loads to the river. Model results showed that the highest salt loads occur from February through May with relatively higher loads present through late August. East side riverine inputs provide dilution flows with low TDS loads relative to upstream sources. Although west side and upstream salt sources have decreased over time, west side salt sources upstream of the Merced River confluence (i.e., upstream of Reach 83) are significant, and are the best targets for implementation of salinity management actions. Reduction of sources upstream of the Merced River has the greatest influence on modeling baseline ambient salinity concentrations observed in Reach 83. This information allowed for selection of the most appropriate salinity control measures for modeling.

Qualitative review of the results shows that the model performs well in simulating flow at the various monitoring locations along the LSJR. Simulated data closely follow the observed hydrograph and results plot closely along the one-to-one regression line except during periods of high observed flow (Figures 5-4 through 5-6). During these periods, the river's observed measurements may not be accurate due to flood flows, and the model may be a more accurate representation of actual flow in the river. Although the simulated results for EC trend along the one-to-one regression line, the model shows more variability in simulated EC at the various monitoring locations (Figures 5-7 through 5-9).

5.3.1.5 ***Modeling of Three Management Action Bundles***

Three management bundles were modeled using WARMF to determine compliance with the range of potential salinity WQOs (1,010 – 1,550 µS/cm) (Larry Walker Associates (LWA), 2015a). The WARMF model produces daily output for flow, EC, and TDS. Statistics for the three modeled alternatives for individual water years were calculated using 30-day running average EC values. Individual water year results were generated to compare the three management alternatives with the historical data and the WARMF model baseline output based on water-year type. Water years are classified as either critical, dry, below normal, above normal, or wet, and are based on the San Joaquin Valley Water Year Index, as defined in State Water Board Revised Water Right Decision 1641 (D-1641) (State Water Resources Control Board, 2000). For each water-year type, a 12-month time series of average values was generated. Average values were determined on a daily basis by first classifying each year of model output by water-year type and then averaging the 30-day running average values for each day from each modeling run.

Figure 5-4 WARMF Simulated (black) and Historical Observed (blue) Flow at Maze Road

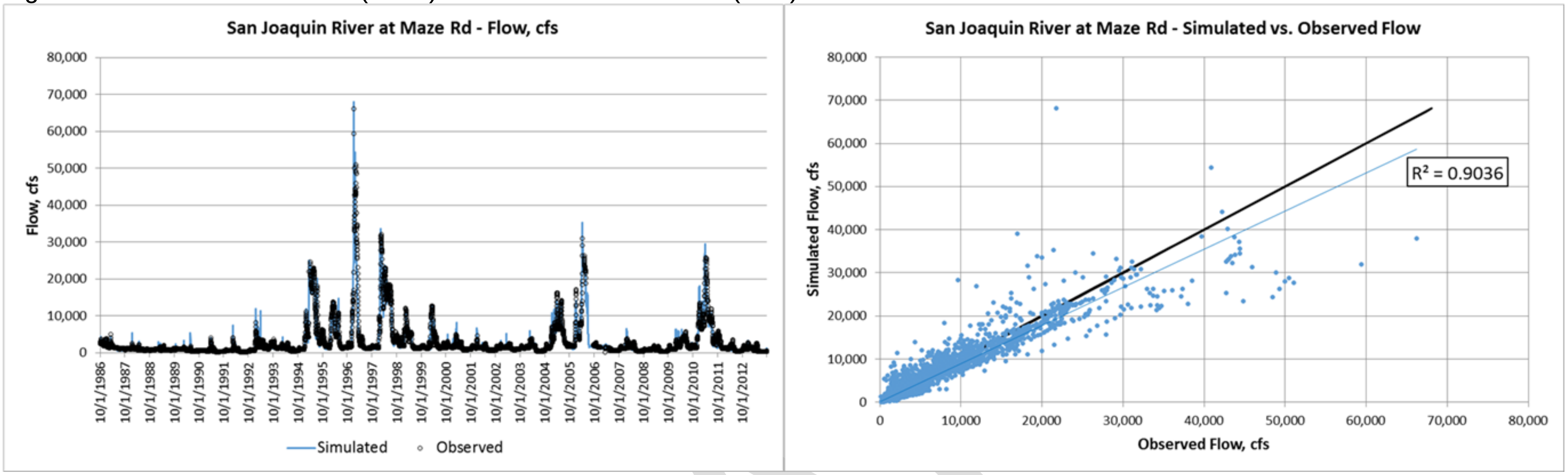


Figure 5-5 WARMF Simulated (black) and Historical Observed (blue) Flow at Patterson Bridge

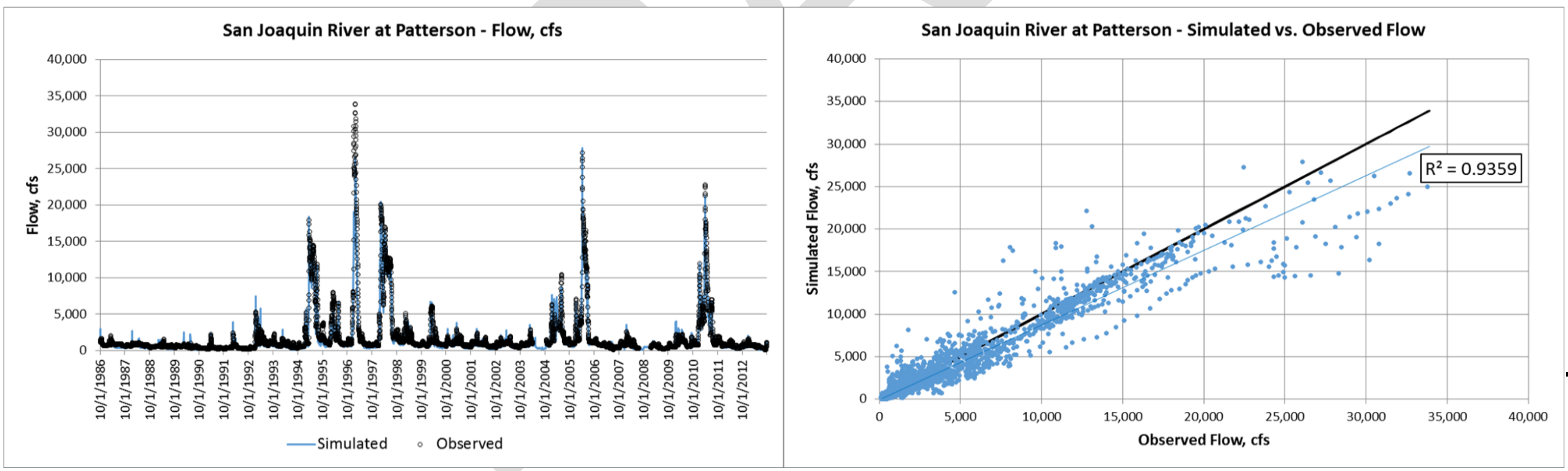


Figure 5-6 WARMF Simulated (black) and Historical Observed (blue) Flow at Crows Landing

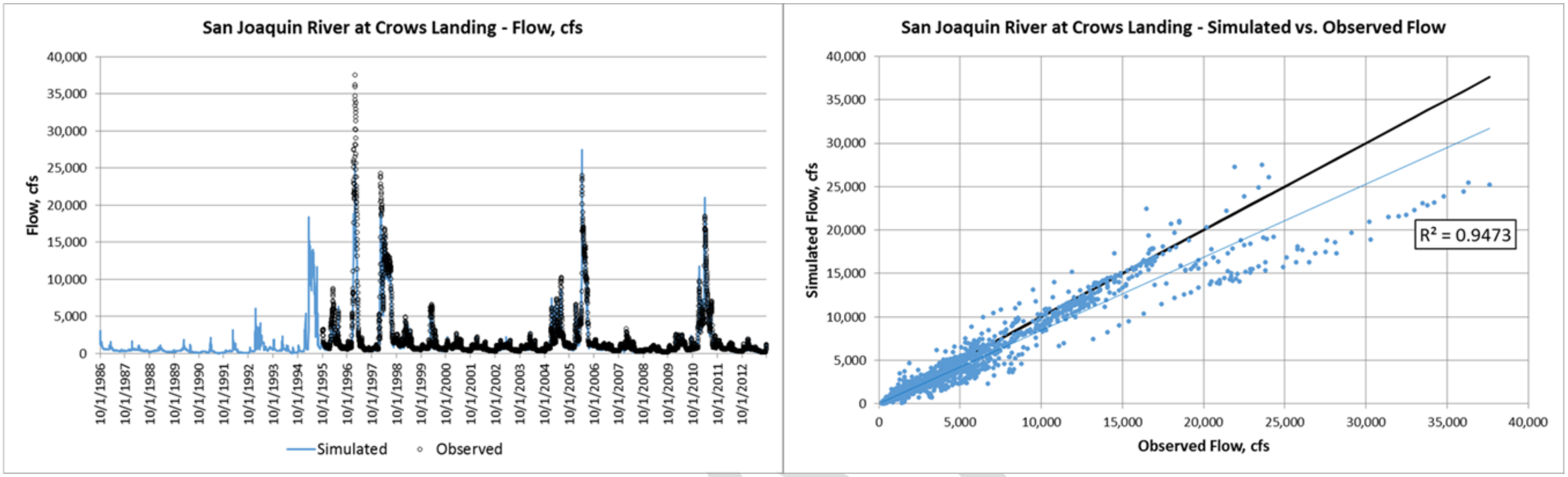


Figure 5-7 WARMF Simulated (black) and Historical Observed (blue) EC at Maze Road.

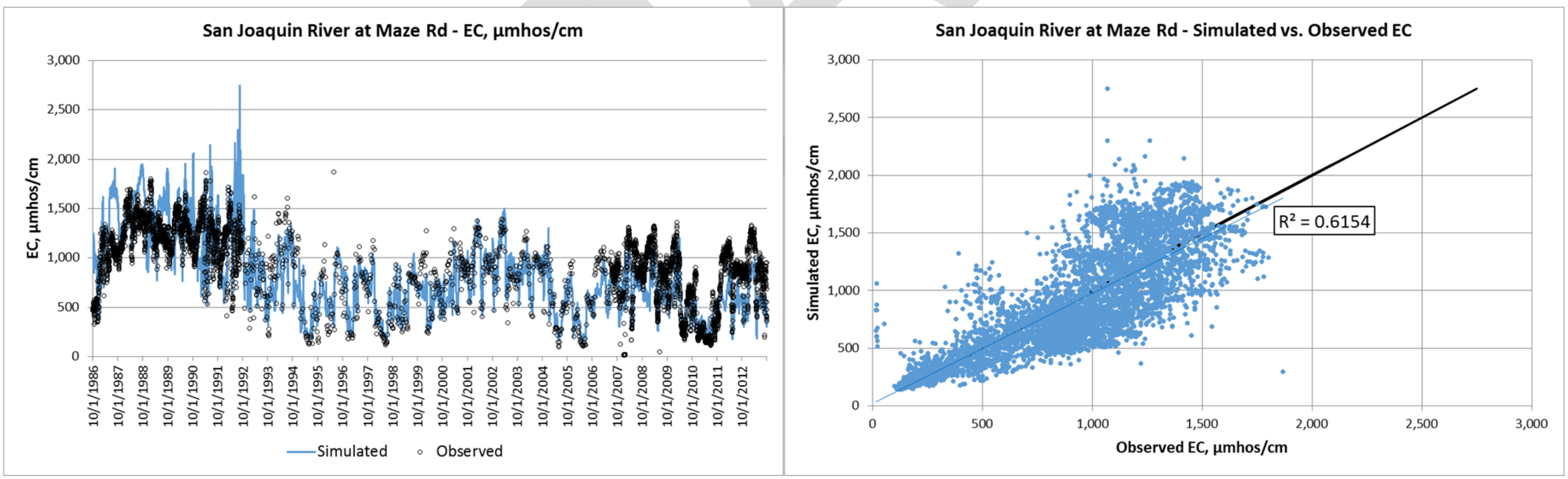


Figure 5-8 WARMF Simulated (black) and Historical Observed (blue) EC at Patterson B

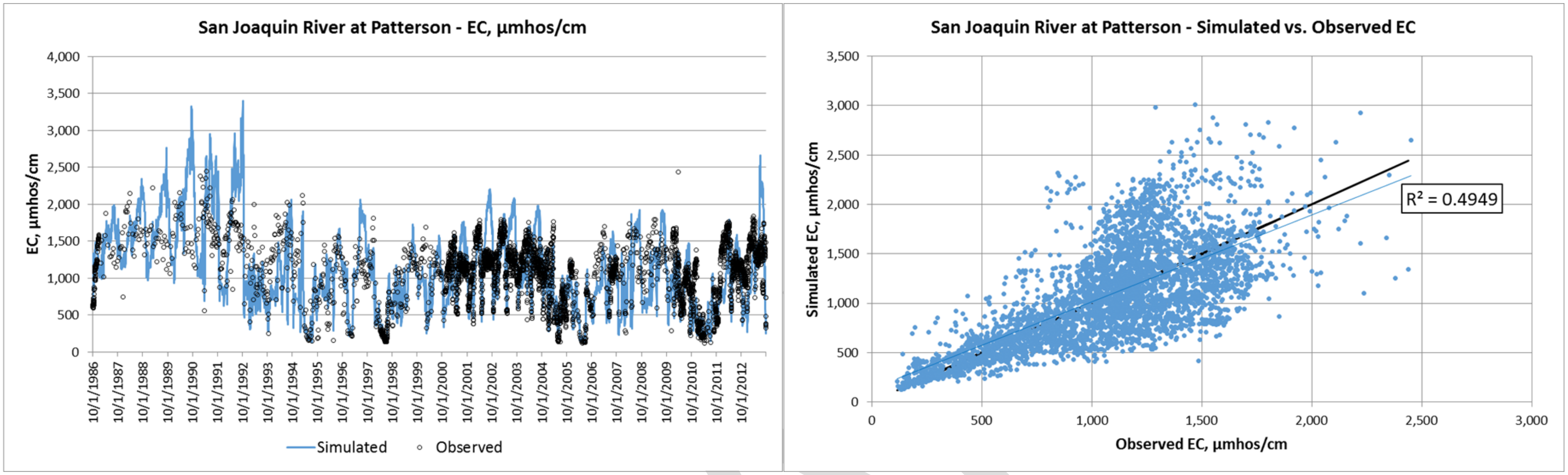
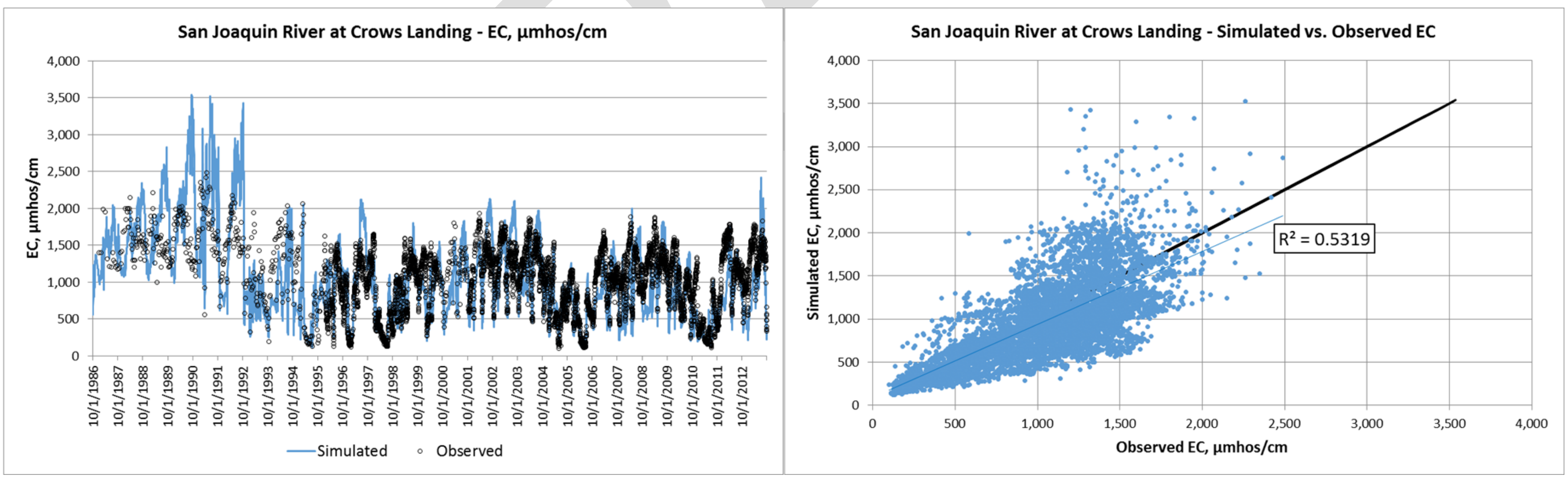


Figure 5-9 WARMF Simulated (black) and Historical Observed (blue) EC at Crows Landing Bridge



5.3.1.5.1 Planned Bundle of Management Actions

The Planned Bundle of Management Actions is defined in Table 3 of the LWA Task 4 report (Larry Walker Associates (LWA), 2015a). The most substantial in terms of salt load reduction is the completion of the Grasslands Bypass Project, which will result in a cessation of agricultural discharges to Mud Slough by the end of 2019 (except for flooding events). The WARMF modeling simulated flow and EC conditions expected to occur as a result of implementation of salinity control actions that are currently in effect or planned for implementation, with two exceptions. The first exception is regarding treated effluent discharges from the Cities of Modesto and Turlock wastewater treatment plant discharges. The model assumed a 3 percent reduction in salt loads. The second exception is regarding salts in fertilizers and soil amendments. A 10 percent reduction in the application of nitrogen-based fertilizers in select subareas was modeled. As relatively minor inputs to the WARMF model in terms of overall salt load reduction, these values served as conservative predictions for these actions.

The highest pre-processed WARMF model results for the Planned Bundle at Crows Landing were all less than 1,550 µS/cm for all water year types (Figure 5-19). Pre-processed WARMF model results for below normal, dry, and critical water years show peaks in EC levels between August and September at around 1,500 µS/cm. When the Planned Bundle pre-processed WARMF model results at Crows Landing are adjusted to match the timing and magnitude of historical EC levels, modeled results for all water-year types again fall below 1,550 µS/cm (Figure 5-20). Adjusted Planned Bundle WARMF model results are actually reduced for below normal, dry, and critical water years, with peak values in EC levels between February and May at around 1,350 µS/cm. All adjusted WARMF EC results at Crows Landing for wet and above normal water years fall under 1,010 µS/cm.

5.3.1.5.2 Planned plus Maximum Treatment Bundle of Management Actions

The Planned plus Maximum Treatment Bundle of Management Actions is defined in Table 4 of the LWA Task 4 report (Larry Walker Associates (LWA), 2015a). The modeling simulated the same conditions as those in the Planned Bundle with the addition of a reverse osmosis (RO) treatment facility. The RO facility would treat drainage diverted from Mud and Salt Sloughs and return the high quality treated water back to these water bodies just upstream of their confluence with the San Joaquin River. The treatment facility was designed to support the achievement of a 1,010 µS/cm EC target at Crows Landing. The RO facility would have a maximum treatment capacity of 160 million gallons per day (mgd) and would return 80 percent of diverted flows back to the two diversion points as a low salinity mixture of treated water.

The highest pre-processed WARMF model results for the Maximum Treatment Bundle at Crows Landing for all but critical water years were under 1,010 µS/cm (Figure 5-21). Additionally, pre-processed WARMF model results for the critical water year peak at around

1,200 µS/cm between August and September. When the Maximum Treatment Alternative pre-processed WARMF model results at Crows Landing are adjusted to match the timing and magnitude of historical EC levels, modeled results for all water-year types are observed to fall below 1,010 µS/cm (Figure 5-22). Critical water year adjusted average EC levels peak at around 1,010 µS/cm in August.

5.3.1.5.3 Planned plus Maximum Management Bundle of Management Actions

The Planned plus Maximum Management Bundle of Management Actions is defined in Table 5 of the LWA Task 4 report (Larry Walker Associates (LWA), 2015a). The modeling simulated the conditions modeled in the Planned Bundle with the addition of a SJRIP-like project that diverts flows from Mud and Salt Sloughs to progressively irrigate salt tolerant crops. Under the Maximum Management Bundle, all flows (and their corresponding salt loads) would be discharged to land and would not directly reach the San Joaquin River. The pre-processed WARMF model results for the Maximum Management Bundle at Crows Landing indicated that in dry, wet, and above normal water years the EC would be less than 1,010 µS/cm (Figure 5-23). For critical and below normal water years, pre-processed WARMF model results indicated EC levels could be as high as 1,800 µS/cm between August and September at Crows Landing.

When the Maximum Management Bundle WARMF results at Crows Landing are adjusted to match the timing and magnitude of historical EC levels, modeled results for all water-year types are observed to fall below 1,350 µS/cm (Figure 5-24). Results indicate that the permanent diversion of water from the system, as opposed to modeled the Maximum Treatment Bundle that returns treated water to the river, provides little to no additional EC improvement compared to the Planned Bundle. The highest adjusted EC values are estimated to occur during critical and below normal water years when EC levels peak at around 1,350 µS/cm from July through September.

*5.3.1.6 **Evaluation of WARMF Bundle Results and Comparison with Baseline Modeling***

Ambient historical results and Baseline model results at Maze Road show a relatively good match when comparing EC levels (Figure 5-10 and Figure 5-11). However, Baseline model results at Crows Landing show discrepancies in both the magnitude and timing of peak EC levels when comparing them to historical EC levels in below normal, dry, and critical water years (Figure 5-12 and Figure 5-13). Ambient historical results and Baseline model results at Crows Landing show a relatively good match when comparing flow (Figure 5-14 and Figure 5-15), indicating that the discrepancy between historical and modeled results is due to differences in the TDS mass loads.

The results of each of the modeled alternatives were plotted for critical water years to compare each alternative at Crows Landing. Figure 5-16 shows pre-processed WARMF model output and Figure 5-17 presents modeled results adjusted to historical output. Critical water year results were chosen because this water year type proved to be the most challenging in terms of modeling to meet the EC targets. For both the pre-processed WARMF model output and the adjusted WARMF model output at Crows Landing, the Maximum Treatment Alternative was observed to provide the lowest EC levels. Details of the results of each of the three modeled management alternatives are described below

Figure 5-10 Maze Road Historical Daily Average of 30-day Running Average EC by Water Year Type

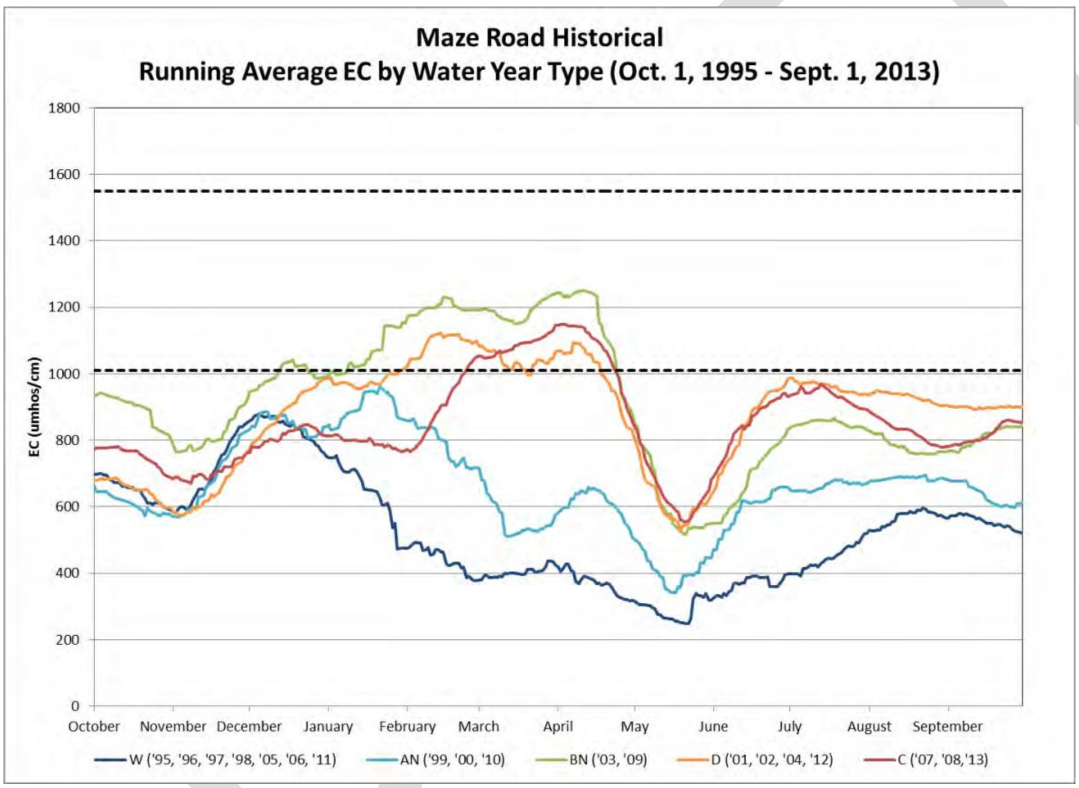


Figure 5-11 Maze Road Baseline Daily Average of 30-day Running Average EC by Water Year Type

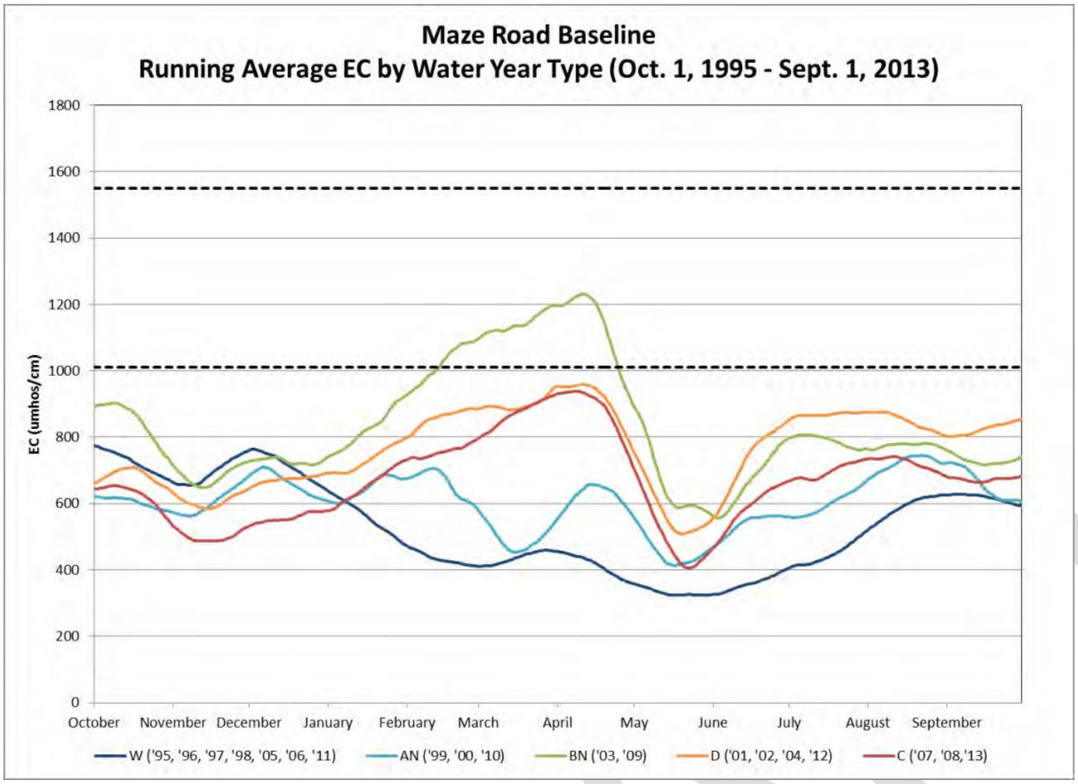


Figure 5-12 Crows-Patterson Historical Daily Average of 30-day Running Average EC by Water Year Type

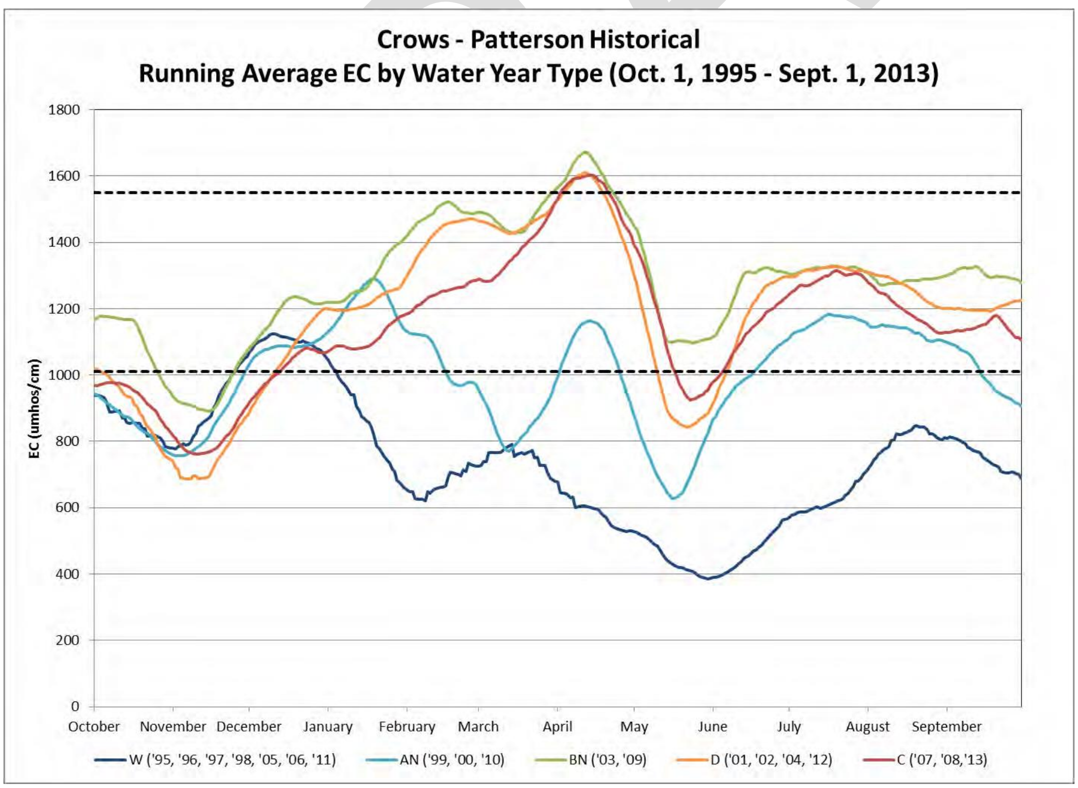


Figure 5-13 Crows Landing Baseline Daily Average of 30-day Running Average EC by Water Year Type

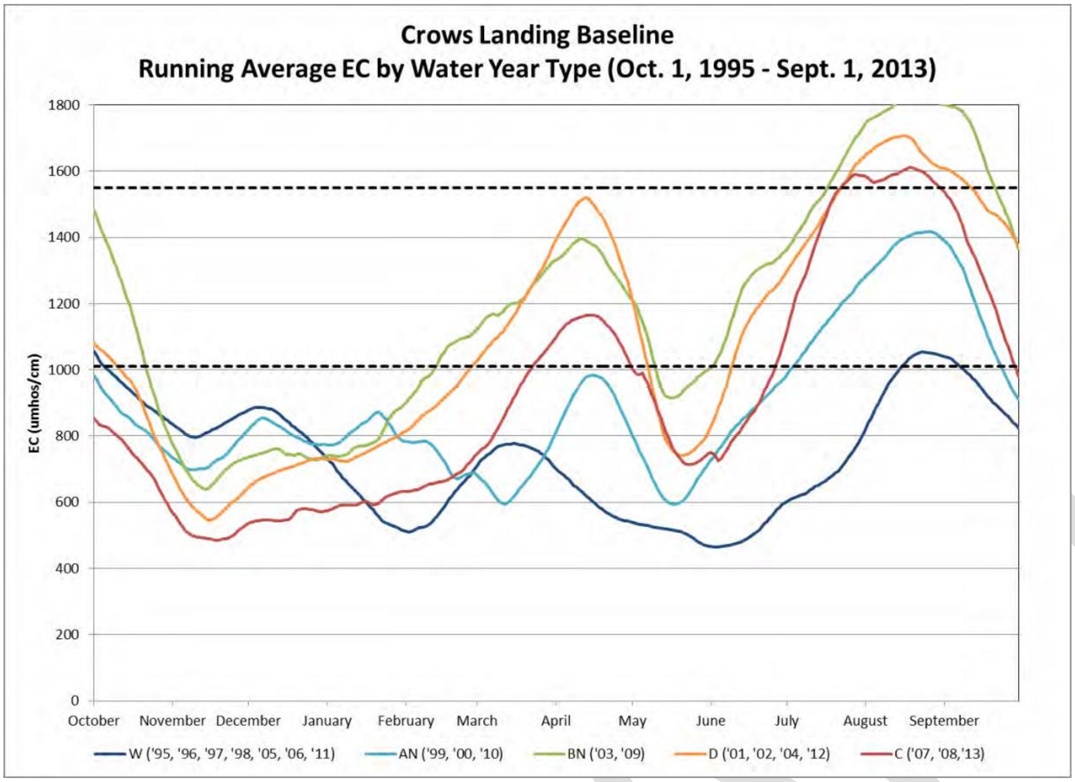


Figure 5-14 Crows-Patterson Historical Daily Average of 30-day Running Avg Flow by Water Year Type

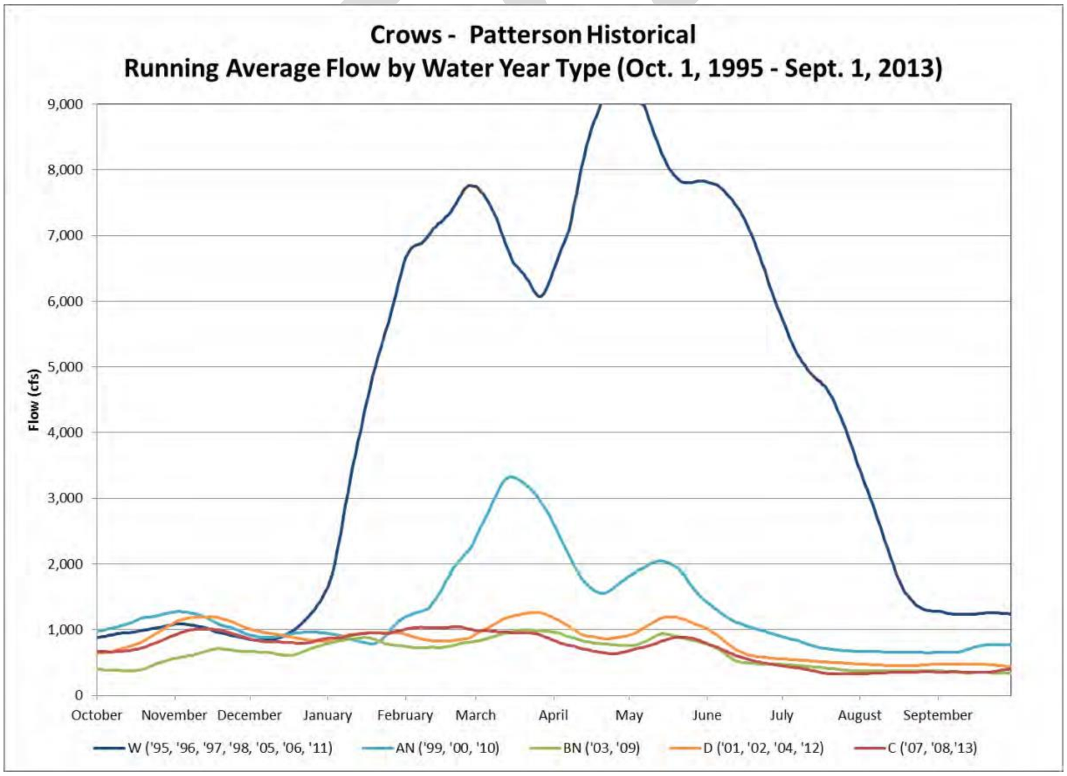


Figure 5-15 Crows Landing Baseline Daily Average of 30-day Running Average Flow by Water Year Type

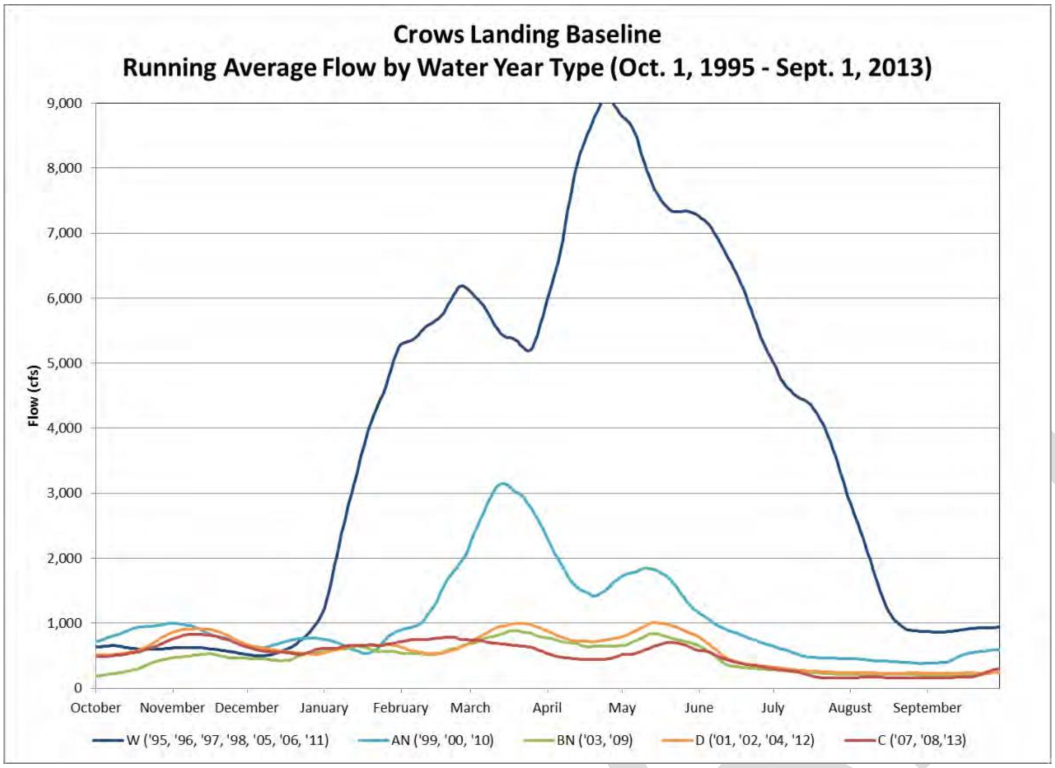


Figure 5-16 Crows Landing Critical Water Year Daily Average of 30-day Running Average EC for Management Alternatives - Pre-processed WARMF

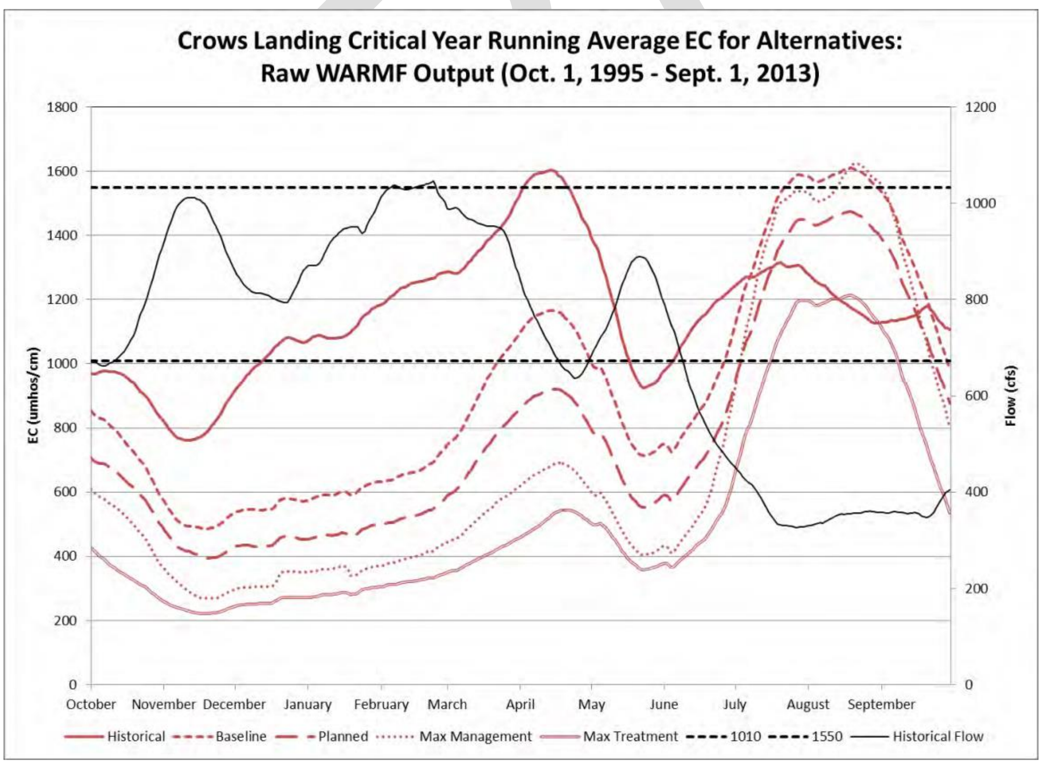
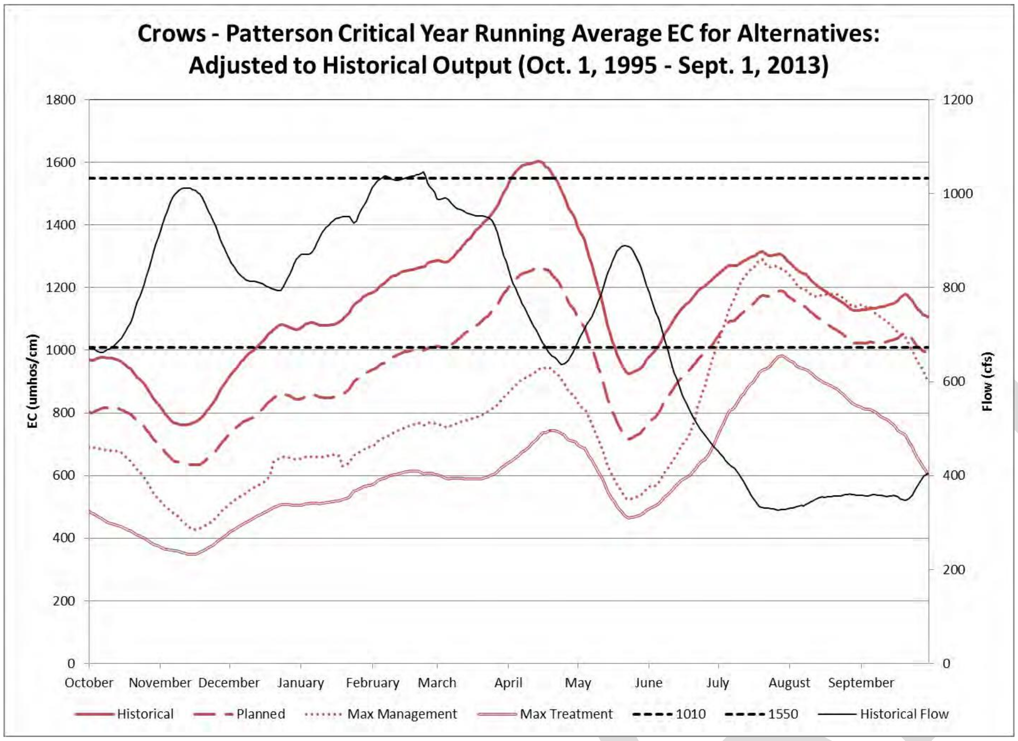


Figure 5-17 Crows-Patterson Critical Water Year Daily Average of 30-day Running Average EC for Management Alternatives - Adjusted to Historical Output



As mentioned earlier, differences in the timing and magnitude of simulated EC levels at Crows Landing were observed when comparing historical results (Figure 5-12) to Baseline simulation results (Figure 5-13). Because the modeled management alternatives depict incremental changes from the modeled baseline simulation, the difference in simulated EC between the modeled management alternatives and the baseline was adjusted using a correction factor applied to historical data The methodology for development and application of the correction factor to results at Crows Landing is described in more detail in the LWA Task 4 report (LWA, 2015b). Figure 5-16 depicting the pre-processed WARMF output at Crows Landing is provided for scenario simulation reference. The adjusted simulation pre-processed results, adjusted from historical data, are presented in Figure 5-17. The adjusted results should be the basis for discussion of the achievability of objectives with implementation of a management alternative as they are more accurate estimates of EC under the conditions represented by each scenario. No adjustments were made to WARMF modeling results for Maze Road due to the good match between historical EC observations and Baseline model results at this location.

5.3.2 **Potential Operational Changes at New Melones Reservoir**

One of the concerns of the LSJR Committee was the potential that the Project Alternatives could increase the frequency of water releases from the New Melones Reservoir by the U.S.

Bureau of Reclamation necessary to meet the Vernalis WQOs. To address this issue, the LSJR Committee coordinated with Dan Steiner, a modeling expert retained by the San Joaquin Tributaries Authority. In order to evaluate this potential, Mr. Steiner used the New Melones Operational Model (Steiner, 2015) to estimate changes in New Melones Reservoir releases related to compliance with Vernalis WQOs that would have been required during the 1995-2013 time period had the bundles of management alternatives been in place.

To address the effect of management measures in and above Reach 83 on EC conditions at Vernalis, Results of WARMF modeling at Maze Road were provided to Mr. Steiner, who then used his calibrated New Melones Operational Model worksheet to predict resultant flow and water quality conditions at Vernalis and to assess changes in required releases from New Melones Reservoir to meet Vernalis EC objectives. The model accounts for the complexities of operation of New Melones Reservoir and Goodwin Dam. The results of the analyses performed by Mr. Steiner are summarized below (Steiner, 2015).

The New Melones Operational Model results for the Planned Bundle showed either no change in some years to a maximum reduction in water quality releases of 56,000 acre-feet in the amount of water released from the reservoir to meet current Vernalis EC Objectives compared to releases estimated by the Baseline model simulation.

The New Melones Operational Model results for the Maximum Treatment Bundle showed either no change in some years to a maximum reduction in water quality releases of 68,000 acre-feet in the amount of water released to meet the current Vernalis EC objective compared to the Baseline WARMF model simulation. This estimate represents an additional 12,000 acre-feet reduction in release requirements as compared to the reductions estimated for the Planned Alternative. Results for the Maximum Treatment Alternative simulation indicate that the construction and operation of a 160 mgd RO facility that returns 80 percent of the treated effluent back to the LSJR upstream of Reach 83 may reduce EC levels in Reach 83 to levels that support a potential EC objective of 1,010 µS/cm in all water years.

The New Melones Operational Model results for the Maximum Management bundle showed either no change in some years to a maximum reduction in water quality releases of 65,000 acre-feet in the amount of water released to meet the current Vernalis EC objective compared to releases estimated by the Baseline WARMF model simulation. This estimate represents an additional 9,000 acre-feet savings as compared to the Planned Bundle.

In summary, none of the bundled management implementation actions, as modeled by New Melones Operational Model, demonstrated that an increase of water releases from the New Melones Reservoir would be required to meet the salinity objectives at Vernalis. On the contrary, all of the options showed that there would either be no change or a reduction in releases from New Melones Reservoir, depending on type of water year (Steiner, 2015).

5.4 Identification and Selection of Project Alternatives

The WARMF modeling of the implementation of the three bundles of management actions described above provided an indication of the range of ambient salinity levels estimated to be achievable in Reach 83. This information was used to assist in the development of five distinct project alternatives for EC WQOs in Reach 83 between the range of 1,010 and 1,550 µS/cm. Also, a No Action Alternative (i.e. establish no EC objective in Reach 83), as required by CEQA, and a year-round 700 µS/cm WQO (based on Ayers and Westcot, 1985) were added for a total of seven potential project alternatives for further evaluation. The alternatives, listed in Table 5-10, are as follows:

1) No EC Objective

2) 1,550 µS/cm Objective

3) Tiered Objective – 1,350 µS/cm, except during Critically Dry Water Years (WY) 1,500 µS/cm

4) 1,500 µS/cm Objective and a 1,350 µS/cm Performance Goal for certain seasons and WY types

5) 1,350 µS/cm Objective

6) 1,010 µS/cm Objective

7) 700 µS/cm Objective

The LSJR Committee also included the option of setting different WQOs for Extended Dry Periods.

These potential project alternatives were examined using a set of evaluation criteria that were developed by the LSJR committee specifically for this purpose. The following evaluation criteria presented in Table 5-10 were built upon the Table 5-8 screening criteria:

1) Consistent with federal/state laws, plans and policies,

2) Consistent with other relevant WQOs (e.g., existing Reach 83 boron WQOs; Vernalis WQOs),

3) Reduces dependency on New Melones Reservoir water quality releases,

4) Supports salt transport out of basin,

5) Scientifically Defensible (protects beneficial uses),

6) Meets CV-SALTS Goals, and

7) Feasible to Implement.

An evaluation of the selection criteria was determined to be necessary for any project alternative to be advanced. The LSJR Committee applied a “yes” or “no” approach to indicate whether a given project alternative would be expected to reasonably meet a given criterion (Table 5-10). For additional detail on the development of selection criteria, see the LWA Task 4 report (Larry Walker Associates (LWA), 2015a)

Table 5-10 LSJRC Basin Plan Amendment Project Alternative Matrix

Project Alternatives	Technical Basis for Alternatives Electrical Conductivity (EC) Water Quality Objectives (WQOs)	Evaluation Criteria: Ratings: Y=Criteria are fully met, N=Criteria are partially or not met						
		A. Consistent with federal/state laws, plans and policies	B. Consistent with other relevant WQOs (e.g., Boron, Vernalis EC)	C. Reduced dependency on New Melones Water Quality Releases	D. Supports salt transport out of basin	E. Scientifically Defensible (protects Beneficial Uses)	F. Meets CV-SALTS Goals	G. Feasible to Implement
1 No EC Water Quality Objectives	Basin Plan: Continue to regulate dischargers pursuant to the Control Program for Salt and Boron Discharges into the Lower San Joaquin River.	N	N	N	Y	N	N	Y
2 1,550 µS/cm EC Water Quality Objective	Hoffman Model: Run output for almond crop yield of 95% when applied irrigation results in 15% leaching fraction and annual precipitation equals the dryest 5% historical precipitation in the LSJR Basin.	Y	Y	Y	Y	Y	Y	Y
3 Tiered Water Quality Objectives for Water Year Considerations: 1,350 µS/cm and during critically dry water years 1,550 µS/cm	1,350 µS/cm: WARMF Model: Run output for the Planned Bundle of Management Actions. 1,550 µS/cm: Same technical basis as WQO option #2.	Y	Y	Y	N	Y	N	N
4 1,550 µS/cm EC Water Quality Objective and 1,350 µS/cm EC Performance Goal for Seasonal and Water Year Considerations (see Table 10)	1,550 µS/cm: Same technical basis as WQO option #2. 1,350 µS/cm: WARMF Model: Run output for the Planned Bundle of Management Actions.	Y	Y	Y	Y	Y	Y	Y
5 1,350 µS/cm Water Quality Objective	WARMF Model: Run output for the Planned Bundle of Management Actions.	Y	Y	Y	N	Y	Y	N
6 1,010 µS/cm Water Quality Objective	Hoffman Model: To consider drought conditions, run output for almond crop yield of 95% when applied irrigation results in 10% leaching fraction and annual precipitation equals the dryest 5% historical precipitation in the LSJR Basin. (Also, approximately equal to nongrowing season Vernalis EC WQO of 1,000 µS/cm.)	N	Y	Y	N	Y	N	N
7 700 µS/cm Water Quality Objective	Ayers and Westcot. (Also, equal to growing season Vernalis EC WQO.)	N	Y	Y	N	Y	N	N

5.4.1 **Final Selection of Project Alternatives**

During two meetings held on March 17 and March 26, 2015, the LSJR Committee considered the seven project alternatives, the evaluation criteria, the WARMF modeled baseline, and the modeled management alternative bundles. Some of the key questions that tied into the selection criteria listed above included:

- Does the alternative provide reasonable protection of the ~~most sensitive~~ AGR and MUN uses in Reach 83?
- Will the alternative reduce releases from New Melones Reservoir to meet the Vernalis EC Objective?
- Can the alternative accommodate current and future Real-Time Salinity Management Program activities to meet Vernalis salinity objectives and support the objective to move salts out of the basin?
- Did the uncertainty analyses on the WARMF modeling output indicate a reasonable likelihood that the WQO was achievable?

As a result, the LSJR Committee identified a Preferred Alternative (#4) and three other alternatives (#1, #2, and #6) for a more detailed examination and consideration in the Basin Planning process.

Likewise, the initial screening also resulted in three potential project alternatives being rejected for further consideration in the Basin Planning process for the following reasons:

- Project alternative #3 (Tiered Objective – 1,350 µS/cm, except during Critically Dry Water Years) 1,500 µS/cm
  This alternative was eliminated because there was too much uncertainty with the WARMF model output of the planned actions to set an objective of 1,350 µS/cm in all but the critical water years. This alternative would also constrain the ability to export salts out of the basin when available assimilative capacity exists.

- Project alternative # 5 (1,350 µS/cm)
  This alternative was rejected for the same reasons as noted for #3.

- Project alternative # 7 (700 µS/cm)
  This alternative was rejected from further consideration because it was believed to be overly protective of the AGR (irrigation water supply) beneficial use in Reach 83 and would effectively eliminate the ability to export salts out of the basin. In addition, WARMF modeling demonstrated that it was not feasible to achieve for all water-year types even with the implementation of extensive treatment actions.

It should be noted that while similar arguments for eliminating alternatives #3, #5, and #7 also exist for alternative #6 (1,010 µS/cm), the committee felt that it was important to include at least one value on the lower end of the criteria range for further evaluation and feasibility analysis.

Extended Dry Periods

The Preferred Alternative proposes adjusting WQOs during time periods when environmental conditions result in agricultural producers placing a higher value on water quantity then water quality in order to maintain a viable operation (i.e. an Extended Dry Period). The San Joaquin River Basin streams are subject to large fluctuations in flow, especially during drought periods. During these periods, the Committee was faced with two basic questions: 1) what level of agricultural beneficial use protection is needed and 2) how should Extended Dry Periods be identified to protect the agricultural use.

To answer the first question, the Committee worked with the agricultural water users to discuss levels of salinity protection needed. The Committee identified the following overriding concerns expressed by the users:

1. During drought periods quantity of water overrides quality; excess salt accumulated in soil can be addressed after these periods,
2. Any water is better than no water; salinity control can be managed by blending other water supplies,
3. Crop survival may become more important than crop yield, and
4. The periods of relaxed salinity standards should be minimized and not permanent.

After discussions with the agricultural water users, it was determined that a 75% crop yield level of protection could be tolerated during extended dry periods. The LSJR Committee used the Hoffman model to determine that an EC of 2,470 µS/cm in the irrigation water would provide this protection level. The Committee recognized that such a relaxation for crop survival would begin to store salt in the basin and would need to be dealt with at a later time. Therefore, a continued period of higher salinity objectives was recommended for the first year following an extended dry period in order to allow salt to be flushed from the soil profile and out of the river basin.

To define an Extended Dry Period, the LSJR Committee utilized the State Water Resources Control Board’s San Joaquin Valley “60-20-20” Water Year Hydrologic Classification as a foundation. Details on the methodology to determine Extended Dry Periods are provided in the Implementation Chapter in Section 6.2.3.

Comparison of the EC concentration protective of AGR during Extended Dry Periods (2,470 uS/cm) with existing WQOs to protect MUN (ranging from a recommended EC of 900 uS/cm to a short-term EC of 2,200 uS/cm), clarified that during these time periods, MUN use may be more sensitive to salinity than AGR use. While crop growth and production occur primarily during the irrigation season and is best protected utilizing a 30-day running average concentration objective, the objectives to protect MUN are based on continued use over a lifetime. Title 22 recommends evaluating attainment of secondary maximum contaminant levels including salinity, as an annual average using at a minimum the previous four consecutive quarterly samples. Therefore, the recommended salinity objective for Extended Dry Periods is 2,470 uS/cm as a 30-day running average and 2,200 uS/cm as an annual average using at a minimum the previous four consecutive quarterly samples.

5.4.2 Evaluation of Water Code Section 13241 Factors for the Final Alternatives

Water Code section 13241 requires the Central Valley Water Board to consider the following factors in establishing WQOs: (a) past, present, and probable future beneficial uses of water, (b) environmental characteristics of hydrographic unit, including quality of water available to it, (c) water quality conditions reasonably achievable through coordinated control of all factors that affect water quality in the area, (d) economic considerations, (e) the need for developing housing within the region, and (f) the need to develop and use recycled water. After considering these, and possibly other factors, the Central Valley Water Board may establish appropriate water quality criteria as WQOs. The following sections discuss the factors as they relate to the final alternatives.

*5.4.2.1 **Beneficial Uses***

The beneficial uses of Reach 83 are described in detail in Chapter 4, Beneficial Uses. The beneficial uses that are most sensitive to salinity are AGR and MUN. The final alternatives represent a reasonable range of possible WQOs protective of both of those uses.

*5.4.2.2 **Environmental Characteristics of the Hydrographic Unit***

Review of historic data showed clear variability in salinity both seasonally and between different water-year types (from critically dry to wet). Freshwater dilution flows from the eastside tributaries are critical to providing assimilative capacity for salt. Flows from upstream of the Merced River provide the majority of salt loading to Reach 83. The distinct characteristics of the hydrograph support consideration of seasonal and water-year type dependent WQOs.

*5.4.2.3 **Water Quality Conditions That Could Reasonably Be Achieved***

WARMF modeling of the planned actions in the San Joaquin River watershed, primarily the completion of the Grassland Bypass Project at the end of 2019, show an overall decrease in

EC for Reach 83 compared to historical EC levels and achievement of a 1,550 µS/cm WQO in all water year types. An EC value of 1,350 µS/cm may also be achievable in the river with planned actions, especially during wetter years. However, model uncertainty must be taken into consideration, supporting the use of 1,350 µS/cm as a performance goal rather than a WQO. Meeting the WQO for Alternative #6 (1,010 µS/cm) may be achieved through the substantial management action of installing a reverse-osmosis treatment facility, but as described below, that would not be an economicaly reasonable option to consider. Similarly, a WQO of 1,550 µS/cm will provide more assimilative capacity in the water body to move salts out of the basin as compared to a WQO of 1,010 µS/cm.

5.4.2.4 ***Economic Considerations***

Chapter 9 provides a detailed Economic Analysis for the final project alternatives. In summary, project Alternative #6 (1,010 µS/cm year-round) would require the most costly management actions with the installation of a reverse-osmosis treatment facility as compared to the other alternatives that rely primarily on planned actions within the watershed.

5.4.2.5 ***Need for Housing***

Adopting an EC objective below 1,350 µS/cm may restrict the development of housing in the Cities of Turlock and Modesto as their current effluent concentrations approach 1,200 uS/cm and may not be able to adjust to lower limits.

5.4.2.6 ***Need to Develop and Use Recycled Water***

An objective of 1,010 µS/cm may decrease the ability of agricultural users to recycle and conserve water within their irrigation districts in order to meet the lower objective in their discharge as compared to an objective of 1,550 µS/cm. The 1,010 uS/cm may also affect the Cities of Turlock and Modesto’s ability to expand current conservation efforts as their discharge is approaching 1,200 uS/cm. The proposed objective of 1,550 uS/cm with an Extended Dry Period adjustment to 2,270 uS/cm as a 30-day running average and 2,200 uS/cm as an annual average (using at a minimum the previous four consecutive quarterly samples) provides the most flexibility to allow for reuse and conservation in both agricultural and urban environments while reasonably protecting beneficial uses.

5.5 **Selection of Preferred Alternative**

Among the four potential project alternatives selected by the LSJR Committee for consideration in the Basin Planning process, project alternative #4 was selected as the Preferred Alternative because it was determined to best meet the seven evaluation criteria and provide the greatest operational flexibility to export salts out of the basin while promoting the best possible water quality for the protection of both the AGR and the MUN beneficial uses in Reach 83.

The three other potential project alternatives did not rank as high as alternative #4 on an aggregate basis for the following reasons:

- Project alternative # 1 (No Action Alternative)
  ~~This alternative was not selected as the Preferred Alternative because it would be contrary to the directive of the Control Program for Salt and Boron Discharges to the LSJR that requires establishment of a WQO for salinity upstream of the Airport Way Bridge near Vernalis.~~ Under this alternative~~-~~, the Board would continue to evaluate, on a case-by-case basis, whether permit requirements regulating salinity discharges to the LSJR required by waste discharge requirements issued under Water Code section 13260 or NPDES permits issued under Water Code section 13370 et seq. would be sufficiently protective of beneficial uses and would be consistent with the Control Program for Salt and Boron Discharges to the LSJR. This case-by-case evaluation would necessarily require a re-evaluation of applicable numeric and narrative water quality criteria/objectives whenever a permit was issued or revised. This alternative was not selected as the Preferred Alternative because it would be contrary to the directive of the Control Program for Salt and Boron Discharges to the LSJR, which requires establishment of a WQO for salinity upstream of the Airport Way Bridge near Vernalis; continuing to perform such an evaluation on a case-by-case basis would not result in the coordinated and consistent approach to regulating salinity required by the Control Program for Salt and Boron Discharges to the LSJR.

- Project alternative #2 (1,550 µS/cm)
  This alternative was not selected as the Preferred Alternative since it does not recognize the potential to achieve better water quality during some water-year types.

- Project alternative #6 (1,010 µS/cm)
  This alternative was not selected as the Preferred Alternative because it would require the implementation of a significantly more costly management action (reverse-osmosis treatment included in the Maximum Treatment Bundle), as compared to the Preferred Alternative, and its water quality benefits in terms of protection of the AGR irrigation water supply beneficial use were not considered to be commensurate with its costs.

The Preferred Alternative (#4) includes an EC WQO of 1,550 µS/cm (at 25 degrees Celsius) and an EC Performance Goal[7] of 1,350 µS/cm for the irrigation season during certain water-year types (more information on the implementation of the Performance Goal is presented in Chapter 6). The LSJR Committee agreed that an EC WQO of 1,550 µS/cm provided reasonable protection of AGR in the LSJR Irrigation Use Area, based on the results of the

[7] The Performance Goal would be used to measure progress towards achievement of EC levels during certain water-year types and times of the year that are of higher quality than the proposed EC WQO for Reach 83 of the LSJR. See the Implementation Chapter for more information on the application of the Performance Goal.

Hoffman model for the protection of almond crops. The 1,550 µS/cm EC WQO also provides protection of the potential MUN use because it is less than the upper Secondary MCL value specified for specific conductivity in Title 22 of the California Code of Regulations. By also including an implementation EC Performance Goal, Alternative #4 will promote achievement of the best possible water quality under variable conditions. The LSJR Committee recommended utilizing a maximum 30-day running average of mean daily EC as the averaging period for both the WQO and Performance Goal

The LSJR Committee also recommended that the Preferred Alternative include the option of utilizing Extended Dry Period WQOs. Based on Hoffman model results for the protection of almond crops with a lower crop yield parameter (75%), the committee recommended an EC WQO that does not exceed 2,470 µS/cm as a 30-day running average. In conjunction with this WQO that is reasonably protective of AGR, the LSJR Committee recommended the use of the short term secondary MCL for specific conductivity of 2,200 µS/cm to provide a reasonable level of protection for the potential MUN use. This short-term value is calculated by using an annual average (with a minimum of the previous four consecutive quarterly samples). The definition and implementation requirements of the Extended Dry Period is detailed in Chapter 6.

6 PROGRAM OF IMPLEMENTATION

This section describes the proposed program of implementation for the Preferred Alternative for EC water quality objectives (WQOs) in the LSJR identified in Chapter 5. Chapter 3 (Section 3.4) describes the laws and policies that apply to implementation and these include actions necessary to achieve the WQOs, a time schedule and a monitoring and surveillance program (described in more detail in Chapter 7).

6.1 Preferred Alternative

Based on the information developed in previous sections of this staff report, the proposed action (Preferred Alternative) is to adopt an EC WQO and an EC Performance Goal that contains seasonal and water-year considerations in Reach 83 of the LSJR, as shown in Table 6-1.

The proposed Basin Plan amendments would establish a EC WQO that would require EC at 25 degrees Celsius not exceed 1,550 µS/cm as a 30-day running average in Reach 83, except during Extended Dry Periods, when the WQO would require that EC not exceed 2,470 µS/cm as a 30-day running average and 2,200 µS/cm as an annual average using at a minimum the previous four consecutive quarterly samples. The Preferred Alternative also includes the implementation of an EC Performance Goal of 1,350 µS/cm for certain seasonal and water-year types.

6.2 Proposed Program of Implementation for Preferred Alternative

6.2.1 Management Actions to Achieve Water Quality Objectives

While the LSJR Committee considered a number of potential implementation management actions during the WARMF modeling and feasibility analysis phase of the project (see Section 5.3), the selection of the Preferred Alternative means implementation of the management actions that have been planned during the next 5 to 10 years should achieve the proposed WQOs in the river. The planned salinity management actions modeled by the LSJR Committee should dramatically improve salinity levels to below those previously measured and modeling results indicated that 1,550 µS/cm EC at Crows Landing is attainable through implementation of those planned actions. Modeling also indicated that if a WQO was met at Crows Landing, planned management should alsoreduce the amount of water released from New Melones Reservoir to achieve the Venalis EC WQO. The most prominent impact to salinity upstream of Crows Landing will be the completion of the final phase of the Grassland Bypass Project, scheduled for the end of 2019.

It should be emphasized that the continued implementation of components of the Real Time Management Program (RMTP) will also benefit salinity management in the river and assist with overall compliance. The RTMP facilitates the control and timing of wetland and/or agricultural drainage to the LSJR to coincide with periods when dilution flows are sufficient to meet salinity objectives.

Routine EC and boron monitoring should be conducted in the LSJR at Crows Landing and EC monitoring at Maze Road in order to assess compliance with the proposed EC and the existing boron WQOs for Reach 83, and to determine the effectiveness of the management actions. More information regarding the monitoring program is in Chapter 7.

6.2.2 **Special Consideration for Point-Source NPDES discharges**

Upon adoption and implementation of the proposed EC WQOs, changes to NPDES permits may be necessary. The Central Valley Water Board will consider the requirements of the EC WQOs when the NPDES permits are renewed or reopened. Water quality-based effluent limitations will be required in NPDES permits for dischargers that have reasonable potential to cause or contribute to an instream excursion above the EC WQOs in the LSJR based on the monthly average receiving water EC at the first diversion point downstream of their outfall providing AGR irrigation supply or MUN beneficial use. When conducting a Reasonable Potential Analysis, the Central Valley Water Board shall consider available dilution of the effluent in the receiving water, as determined at the first downstream diversion that provides AGR irrigation supply or MUN beneficial use.

If an NPDES point source discharge is deemed to have reasonable potential to cause or contribute to an instream excursion of the EC WQOs at the first diversion that occurs downstream that provides AGR irrigation supply or MUN beneficial use, water quality-based effluent limits shall be required. For publicly-owned treatment works (POTWs) the water quality-based effluent limitations may be established in terms of EC concentration or total dissolved solids (TDS) loading to account for site-specific consideration of dry weather versus wet weather conditions. However, concentration and loading limits shall not be applied at the same time. When establishing water quality-based effluent limitations for POTWs in terms of TDS loading, an EC to TDS ratio of 0.64 shall be used to convert EC concentrations to TDS concentrations, unless a discharger-specific ratio can be demonstrated. The design average dry weather flow of the POTW shall be used to calculate the TDS loading limits.

6.2.3 **Extended Dry Period Definition**

The Preferred Alternative requires the use of an Extended Dry Period definition for the implementation of proposed alternative WQOs during time periods when environmental conditions result in agricultural producers placing a higher value on water quantity than water quality in order to maintain a viable operation. The San Joaquin River Basin is subject to large fluctuations in flow, especially during drought periods. During these periods, the Committee was faced with two basic questions: 1) what level of agricultural beneficial use protection is needed and 2) how should Extended Dry Periods be identified to protect the agricultural use.

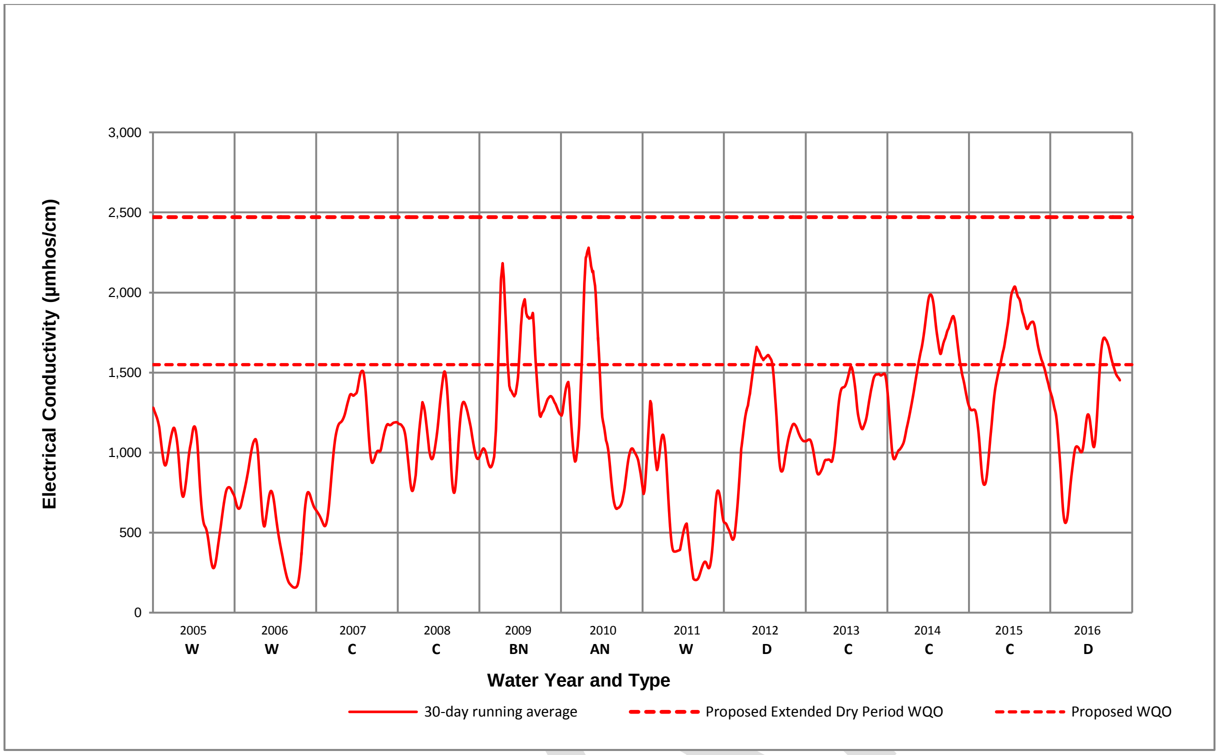
To answer the first question, the Committee sat down with the agricultural water users to discuss levels of salinity protection needed. The Committee identified the following overriding concerns expressed by the users:

1. During drought periods quantity of water overrides quality; salt buildup can be addressed after these periods,
2. Any water is better than no water; salinity control can be managed by blending other water supplies,
3. Crop survival is more important that crop yield, and
4. Relaxation of salinity standards need to be short-term, not permanent.

After discussions with the agricultural water users, it was determined that a 75% crop-yield level of protection could be tolerated during these short-term periods. The LSJR Committee used the Hoffman model to determine that EC of 2,470 µS/cm in the river would provide this protection level. The Committee recognized that such a relaxation for crop survival would begin to store salt in the basin and would need to be dealt with at a later time.

In order to answer the second question (how to identify an Extended Dry Period), the Committee determined when Extended Dry Periods would have occurred in the past had the WQO been in place, and compared those periods to the actual historical water quality at the Crows Landing monitoring station. Figure 6-1 plots the 30-day running average EC at Crows Landing and the WQOs of 1,550 µS/cm and 2,470 µS/cm during the 2005 through 2016 Water Years. Next, the Committee used this evaluation to help establish a definition for Extended Dry Periods.

Figure 6-1 Electrical Conductivity 30-day running average at Crows Landing: WY2005 – 2016 and the Hoffman Model established Protection for AGR Beneficial Use.



Through the LSJR Committee efforts, an Extended Dry Period definition was established using the State Water Board's San Joaquin Valley "60-20-20" Water Year Hydrologic Classification[8] included in revised Water Right Decision 1641 to assign a numeric indicator to a water-year type as follows (State Water Resources Control Board, 2000):

- Wet – 5
- Above Normal – 4
- Below Normal – 3
- Dry – 2
- Critically Dry – 1

[8] The method for determining the San Joaquin Valley Water Year Hydrologic Classifications (e.g., critical, dry, below normal, above normal, wet) is defined in the SWRCB Revised Decision 1641, March 2000, Figure 2, page189. This method uses the best available estimate of the 60-20-20 San Joaquin Valley water year hydrologic classification at the 75% exceedance level using the best available data published in the California Department of Water Resources' ongoing Bulletin 120 series.

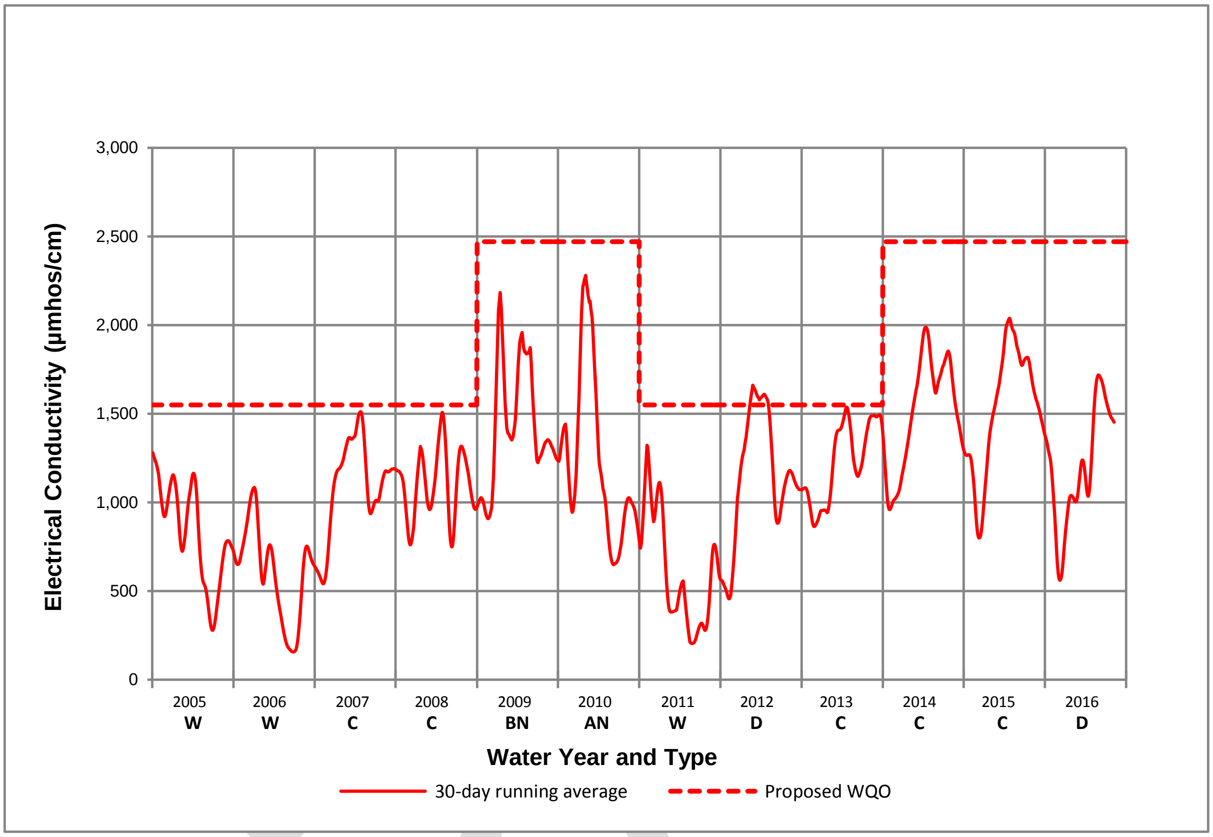
The indicator values would be used to determine when an Extended Dry Period is in effect:

- An Extended Dry Period shall begin when the sum of the current year's 60-20-20 indicator value and the previous two year's 60-20-20 indicator values total six (6) or less.
- An Extended Dry Period shall be deemed to exist for one water year (12 months) following a period with an indicator value total of six (6) or less.

Figure 6-2 plots the 30-day running average EC at Crows Landing and the proposed WQOs of 1,550 µS/cm and 2,470 µS/cm that would have been in place during the 2005 through 2016 water years had the proposed WQOs been required. The figure shows that the proposed WQOs would have protected the agricultural beneficial use during these water years.

Figure 6-2 shows for water years 2007, 2008 and 2009 there would have been two critical and one below normal water years. Beginning in water year 2009, the sum would have been 5 and thus an extended dry period would have existed. The figure also shows that water year 2010 was above normal. The sum for defining an extended dry period would have been 8 during that water year, but it would still have been an extended dry period according to the definition above. During this year, the high salt load that was in the river could still be removed without exceeding the WQO.

Figure 6-2 Electrical Conductivity 30-day running average at Crows Landing: WY2005 – 2016.



6.2.4 **Implementation of Performance Goal**

The Preferred Alternative also includes the implementation of an EC Performance Goal of 1,350 µS/cm for specific seasonal and water-year types (See Table 6-1). A Performance Goal used in implementation differs from a WQO in that its exceedance can trigger a management action, but not liability for regulatory non-compliance. The 1,350 µS/cm EC value is being proposed as a Performance Goal because:

- The WARMF model of planned actions in the watershed showed EC levels remaining at or below 1,350 µS/cm in Reach 83, particularly in years with more rainfall. While these results suggest that the river may achieve an EC level in the future that is lower than the proposed EC WQO of 1,550 µS/cm, the level of uncertainty inherent in the WARMF model at Crows Landing is too large to support pursuing a WQO lower than 1,550 µS/cm.

- Agricultural supply water at 1,350 µS/cm or lower would provide a higher level of protection during the irrigation season while allowing salt load to be moved out of the basin during the non-irrigation season.
- Water quality at 1,350 µS/cm or better would also help to maintain the soil salinity balance by flushing salt accumulated below the root zone during Extended Dry Periods.

Table 6-1 LSJR Reach 83 WQOs and Performance Goal (PG) for Seasonal and Water Year Considerations (µS/cm) during Non-Extended Dry Periods.

Water-Year Type	Irrigation Season		Non-irrigation Season
	March – June	July - September	October - February
Wet	**1,350 (PG)** & 1,550 (WQO)		1,550 (WQO)
Above Normal	**1,350 (PG)** & 1,550 (WQO)		1,550 (WQO)
Below Normal	**1,350 (PG)** & 1,550 (WQO)	1,550 (WQO)	
Dry	**1,350 (PG**) & 1,550 (WQO)	1,550 (WQO)	
Critical	1,550 (WQO)		

As part of the evaluation, the EC data should be analyzed to determine if the planned actions assumed for the Planned Bundle modeling have resulted in ambient river EC water quality less than 1,550 µS/cm. To ensure that planned improvements are not offset by significant new sources of salinity, the Central Valley Water Board should consider limiting and, if needed, prohibiting new sources of salt that would significantly increase salinity concentrations in Reach 83 of the San Joaquin River.

If the planned salinity management actions do not result in the attainment of the EC Performance Goal as expected, Regional Water Board staff will evaluate why the EC Performance Goal was not achieved. Such evaluation may include requesting reports from dischargers in Reach 83, soliciting input from interested parties, or other appropriate actions such as, requesting information from the Real-Time Management Group formed under the 2006 Salt and Boron TMDL for the San Joaquin River.

6.2.5 **Time Schedule**

It is projected, based on the modeling results for the Planned Alternative (Section 4.1.1), that the Preferred Alternative EC WQO can be consistently achieved after implementation of the Grassland Bypass project. The Grassland Bypass project is currently scheduled to be completed by the end of 2019. As such, the effective date of the Preferred Alternative EC WQO should be established to occur starting in 2020.

6.2.6 **Basin Plan Re-opener**

A re-opener should be established in the Basin Plan ten (10) years after adoption of the amendment to evaluate if an EC value of less than 1,550 µS/cm as the numeric WQO in Reach 83 can consistently be achieved. Based on findings from the evaluation, the Central Valley Water Board may consider the following actions:

- Initiating a Basin Plan amendment effort to establish a new EC WQO.
- Maintaining the current EC WQO with no further planned evaluation.
- Scheduling a future evaluation to allow for additional data collection and analysis.
- Reconvene the LSJR Committee to assist in developing appropriate actions

7 MONITORING AND SURVEILLANCE PROGRAM

The Water Code requires Basin Plan amendments to describe the surveillance and monitoring that will be necessary to evaluate attainment of applicable water quality objectives (WQOs). Specific monitoring and reporting requirements can be required through monitoring and reporting programs established for NPDES permits, WDRs, and conditional waivers of WDRs to ensure that the necessary information is collected and available to the Central Valley Water Board to determine progress in implementing the Basin Plan requirements and in attaining water quality standards.

Water Code section 13242 requires that implementation programs designed to achieve WQOs include a description of the surveillance to be carried out in order to determine compliance with the objectives. The Lower San Joaquin River Committee (LSJR Committee) used information presented in previous chapters of this staff report to identify monitoring components needed to evaluate attainment of the proposed salinity WQOs. The necessary components (hereafter referred to as the LSJR Monitoring Program) will be incorporated into Chapter V of the Basin Plan, which is the Basin Plan's Surveillance and Monitoring section. The process utilized to determine needed monitoring as well as the recommended components is outlined in this chapter.

7.1 Monitoring Program Goals

The purpose of the LSJR Monitoring Program is to evaluate compliance with the salinity and boron WQOs, compare water quality to Performance Goals in Reach 83 of the LSJR, and to assess the effectiveness of the implementation program. The goals of the LSJR Monitoring Program are as follows:

- Assess compliance with the proposed EC and existing boron WQOs (Table 7-1) in Reach 83 of the LSJR;
- Characterize long-term changes/trends in the ambient EC and boron concentrations within Reach 83 of the LSJR;
- Compare trends and changes in water quality to proposed Performance Goals;
- Assess whether the program supports compliance with salinity objectives at Vernalis;
- Assess the effectiveness of implemented management actions in controlling salt and boron in Reach 83; and,
- Use the resulting water quality information to identify potential revisions to the WQOs, Performance Goal, and/or implementation program.

Table 7-1 Lower San Joaquin River Boron Water Quality Objectives.

Period of Applicability	Maximum (mg/L)	Monthly Mean (mg/L)	Critical[1] WY Monthly Mean (mg/L)
March 15th through September 15th	2.0	0.8	1.3
September 16th through March 14th	2.6	1.0	1.3

[1] Table IV-3, Basin Plan

These assessment goals may be modified in the future based on additional information and/or the adaptive management of the implementation program.

7.2 Water Quality Information Needed to Meet Goals

The ability to answer the assessment goals described above comprised the criteria considered by the LSJR Committee for identifying necessary water quality information.

7.2.1 Assess Compliance with the EC and Boron Water Quality Objectives

Compliance with a 30-day running average salinity objective is best measured through either the use of continuous sensors or daily sample collection. WARMF model results were calibrated with water quality information in the river at Crows Landing and Maze Road, which represent river segments between major eastside tributary inputs. To measure compliance with the Southern Delta salinity objectives, continuous or daily EC sample collection is recommended in the River at Vernalis.

Sample collection on a weekly basis is recommended for boron. The weekly collection would both determine if existing water quality frequently nears or exceeds the monthly average and monthly maximum WQOs as well as provide information to verify if a correlation still exists between EC and boron concentrations. A confirmed correlation may be used to estimate boron concentrations during other periods as outlined in Appendix C. Highest boron concentrations have consistently been found in the river at Crows Landing; therefore, weekly boron at that site should provide worse case compliance information. Exceedances of boron at Crows Landing would require additional boron analyses in the river at the Maze Road Bridge and the Airport Way Bridge near Vernalis to ensure compliance is being achieved.

7.2.2 Characterize Long-term Changes/Trends in the Ambient EC and Boron Concentrations within Reach 83 of the LSJR

Trends are best assessed with higher frequency data collection, especially if the system experiences changing flow conditions and has a large number of factors that could contribute to the concentration and loading of salinity and boron. For the LSJR, these factors include the seasonal changes in discharge from agricultural and wetland inflows in addition to variable water-year types impacting available assimilative capacity. Continuous or daily sample collection for EC and weekly for boron at key locations in the river system would adequately characterize the effects of management actions, dam releases, or climate change over time relative to the rate of change and overall variability of flow, weather conditions, and water resource management. The frequency improves statistical power to identify changes in complex systems, the assessment duration, data variability, and the magnitude of the change in conditions. Trends in the data collected can be assessed through statistical comparisons that determine if differences over time are random in nature or systematic. Recommended locations and frequency identified to meet Goal 1 should provide adequate information to evaluate long-term changes and trends in ambient EC and boron concentrations.

7.2.3 Compare trends and changes in water quality to proposed Performance Goals

Since the Salinity Performance Goal is also a 30-day running average, the daily EC sampling design noted in the previous goals will provide a defensible data set for comparisons.

7.2.4 Assess Whether the Program Supports Compliance with Salinity Objectives at Vernalis

Since the salinity objectives at Vernalis are 30-day running averages, continuous or daily EC would be needed at the site to adequately determine compliance. Weekly boron analyses would also be needed during periods when the boron concentrations are exceeded at Crows Landing.

7.2.5 Assess the Effectiveness of Implemented Management Actions in Controlling Salt and Boron

WARMF modeling estimated that if currently planned management activities such as completion of the GBP were implemented, the proposed Performance Goals for salinity may be met. The monitoring design discussed in previous goals would be adequate to evaluate ability to meet Performance Goals. Should the Performance Goals not be met, management practices implemented since the adoption of the Basin Plan Amendment should be compared to those identified during modeling, to determine whether controllable factors are impacting water quality or whether results are consistent with variability inherent in the initial modeling results. Load information will be needed to determine whether anticipated salt load reductions are occurring as anticipated or whether changes in concentration are more closely related to changing assimilative capacity. Continuous flow measures at three critical sites within the LSJR (at Crows Landing, Maze Road, and Vernalis) would be needed in combination with the specific constituent information outlined in previous goals to allow for an adequate assessment.

7.2.6 Use the Resulting Water Quality information to Identify Potential Revisions to the WQOs and/or implementation Program

Daily salinity data at Crows Landing, Maze and Vernalis will adequately characterize WQO and Performance Goal attainment, including the duration and magnitude of WQO and Performance Goal exceedances. Weekly boron data at Crows with an expansion to Maze Road and Vernalis should the boron objectives be exceeded at Crows will also provide a solid data set for evaluating compliance. In addition, data collected at monitoring stations located on the San Joaquin River and its tributaries upstream of Crows Landing should be evaluated if objectives are exceeded. Upstream monitoring stations are identified in the Central Valley Comprehensive Water Quality Monitoring Guides (Central Valley Water Board, 2017). Continuous flow information at Crows, Maze and Vernalis can be combined with water quality data to determine changing loading patterns and available assimilative capacity. This data collection will support existing and expected modeling efforts under the Real Time Management Program for salinity that are used to characterize water flow and quality conditions and evaluate implemented, planned, and proposed management actions.

7.3 Proposed Monitoring Requirements

Based on the monitoring needs identified to meet the project goals, the following parameters, locations, frequencies and special considerations are proposed.

7.3.1 Electrical Conductivity

Table 7-2 Recommended Electrical Conductivity Monitoring.

SJR Location	Sampling Agency	Sampling Frequency and Method	Data Processing Method
Maze Road	DWR	daily average of 15-minute sensor data	30-day running average
Crows Landing Bridge	USGS	daily average of 15-minute sensor data	30-day running average

7.3.1.1 ***Location Rationale***

The LSJR at Crows Landing and at Maze Road sufficiently characterizes Reach 83 upstream of the Airport Way Bridge near Vernalis with respect to the location of major tributaries and point sources (Figure 7-1). The Maze Road station will be utilized to characterize water quality between the Tuolumne and Stanislaus Rivers; the Crows Landing Bridge station will be utilized to characterize water quality between the Merced and Tuolumne Rivers.

7.3.1.2 ***Frequency***

The proposed EC WQO and Performance Goal will, at a minimum, require daily EC sample collection on the LSJR. While daily sample collection would be sufficient to calculate a 30-day running average, daily average values would also capture time-of-day bias and changes that may occur during a 24-hour period.

7.3.2 **Boron**

Table 7-3 Recommended Boron Monitoring.

SJR Location	Program	Sampling Frequency and Method	Data Processing Method
Crows Landing Bridge	Grassland Drainage	weekly grab sampling	Monthly maximum and mean

7.3.2.1 ***Location Rationale***

Sample collection at the Crows Landing Bridge can be used to assess boron compliance, as the site has historically had the highest boron concentration within Reach 83 of the LSJR. Attainment of the boron objective at this location suggests downstream attainment, where the influence of the Tuolumne and Stanislaus Rivers would improve water quality. Upstream management actions include those upstream of Reach 83, and resultant changes would be adequately characterized by Crows Landing Bridge monitoring. Should the boron objectives be exceeded at Crows Landing, boron analyses should be expanded to weekly sampling at Maze Road and Vernalis.

7.3.2.2 ***Frequency***

Reliable boron continuous sensors are not currently available therefore, weekly sample collection is recommended to both calculate a monthly average and to determine if previous or revised EC to boron correlations exist. Should the correlation exist, EC measurements may be used as a surrogate for boron. Appendix C discusses the potential correlation in more detail. Surrogate relationships between parameters such as

EC and boron may be further evaluated to better understand trends and the effect of implementation programs.

7.3.3 **Flow**

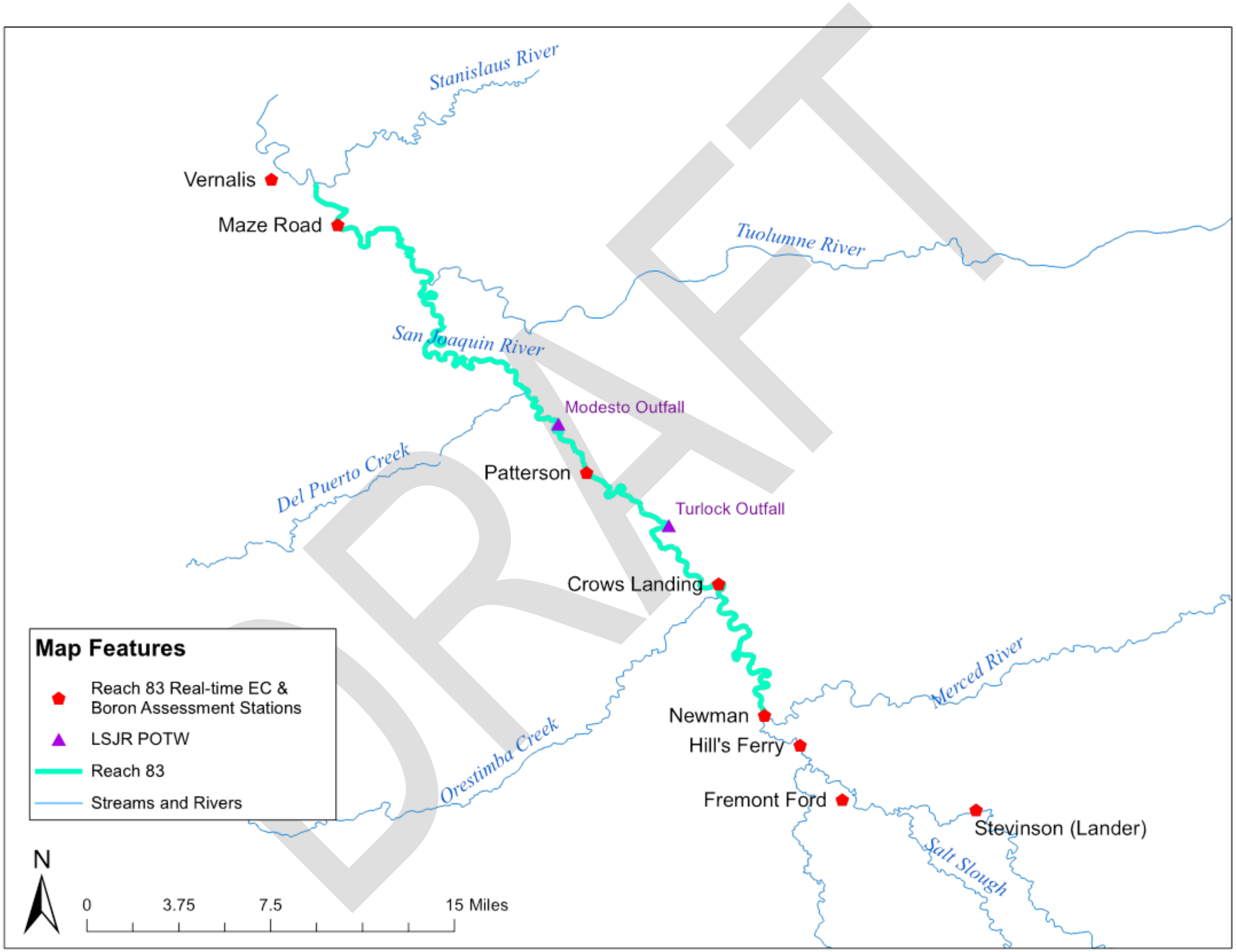
Concentrations are known to fluctuate in relation to flow. To evaluate changing loads into the system that may result from changing management activities and/or changes in hydrology, continuous flow monitoring is recommended in the river at Crows Landing, Maze Road and Vernalis.

7.3.4 **Adaption**

Changes to the LSJR Monitoring Program could be made as part of the WQO assessment process and could be targeted to address specific trend changes, characterize specific segments, or better evaluate specific sources or management actions. Design of this additional monitoring would be based on existing data, modeling information, and best professional judgment to meet the monitoring objectives. For example, if an episodic exceedance of boron occurred for unknown reasons at Crows Landing Bridge during the same month in multiple years, additional sample collection of upstream tributaries could be scheduled for that month in the following year(s). Also, additional sample collection in that month at Maze Road and Vernalis would further characterize Reach 83 WQO objective compliance. In many cases data collected by others would be sufficient and additional sample collection might not be necessary. Data collected at monitoring stations located on the San Joaquin River and its tributaries upstream of Crows Landing should be evaluated if objectives are exceeded. Upstream monitoring stations are identified in the Central Valley Comprehensive Water Quality Monitoring Guides (Central Valley Water Board, 2017).

Finally, the proposed monitoring activities described above will provide a robust data set that can be used to measure the cumulative effect of all salinity management actions.

Figure 7-1 Project Location, and Sampling Locations.



7.4 Existing Monitoring Programs on the Lower San Joaquin River

7.4.1 Availability of Existing Monitoring Data

Existing monitoring efforts in the LSJR are significant and include continuous (typically 15-minute interval) sensors and sample collection for flow, EC, temperature, pH and dissolved oxygen at numerous locations within Reach 83 and immediately upstream in the San Joaquin River, Stanislaus River, Tuolumne River, Merced River, Orestimba Creek, Mud Slough, and Salt Slough. The Central Valley Water Board, the United States Geological Survey (USGS), the California Department of Water Resources (DWR), and the United States Bureau of Reclamation (USBR) all conduct routine flow and EC monitoring that can be used to meet and augment the recommended monitoring identified above. In addition, the USBR and San Luis & Delta-Mendota Water Authority collect weekly boron data at Crows Landing for the Grassland Drainage Project.

The following monitoring programs are or have collected samples that may be used to address the LSJR Monitoring Program assessment questions:

- The Central Valley Water Board previously collected weekly as well as daily average boron and EC samples through the Selenium Control Program and Surface Water Ambient Monitoring Program (SWAMP). Although this monitoring work was completed in 2011, information collected provides a historic database.
- The San Joaquin River Real-time Water Quality Management Program (RTMP) uses telemetered stream stage and salinity data and computer models to simulate and forecast water quality conditions along the LSJR. Its goal is to maximize export of salt from the San Joaquin River Basin while minimizing high quality releases made specifically for meeting San Joaquin River salinity objectives at Vernalis (the boundary of the Sacramento-San Joaquin Delta). DWR and USBR are cooperating agencies in this program, which has accessed an extensive network of flow and salinity (EC) continuous (15-minute interval) sensors in the San Joaquin River and major tributaries. These continuously measured data are reported through the California Data Exchange Center (CDEC), maintained by DWR.
- Monitoring by the United States Bureau of Reclamation and the San Luis & Delta-Mendota Water Authority for the Grassland Drainage discharge to the San Luis Drain is part of the 2010 use agreement (Agreement No. 10-WC-20-2975) that refers to the 2001 Waste Discharge Requirements (Grassland WDR, Order No. 5-01-234) monitoring program. The 2001 WDR was rescinded and replaced by Order R5-2015-0094, which requires weekly EC and boron sampling on the San Joaquin River and other upstream tributaries. This WDR monitoring characterizes the effects of the

Grassland Bypass Project to reduce selenium and boron loading to surrounding wetlands and refuges, as well as the LSJR.

- The Central Valley Water Board's Irrigated Lands Regulatory Program (ILRP) requires monitoring through WDRs for agricultural non-point source discharges. The Westside San Joaquin River Coalition 2014 WDR includes boron and EC monitoring on the San Joaquin River upstream of Reach 83. Other ILRP WDRs includes upstream tributary monitoring.
- The City of Turlock and City of Modesto publically owned treatment works (POTWs) monitor EC at locations above and below their points of discharge to the LSJR. Both POTWs points of discharge are located in the segment of river between Crows Landing and Maze Road. The data are reported annually to the Central Valley Water Board.

Table 7-4 and Table 7-5 summarize the best available information on monitoring conducted in the main stem of Reach 83 and the immediate proximity. The data are of high quality and are readily available through the CDEC or the California Environmental Data Exchange Network (CEDEN). Figure 7-1 identifies the locations of each of these San Joaquin River main stem sites.

Based on review of the existing programs, continuous flow and EC data are available at Crows Landing, Maze Road, and Vernalis. The RTMP stakeholders are using the 30-day running average data from these stations for prediction of salinity at Vernalis. The sensor values are field calibrated by the operators and supplemented with calibration measurements done as part of the RTMP. Thus, no additional sample collection stations will be necessary for LSJR EC WQO compliance monitoring.

Boron is currently being collected weekly at Crows Landing. The remaining monitoring needs of boron at Maze and Vernalis would only occur if the boron WQOs are exceeded at Crows Landing. Evaluation of implemented management practices would only be triggered if salinity performance goals are exceeded.

Table 7-4 Electrical Conductivity and Boron Monitoring in the Lower San Joaquin River.

	Source	CEDEN	CEDEN	CDEC	CDEC	CDEC	CEDEN
	Program	SWAMP	Grasslands	Real-Time Program			ILRP
	Agency	CVRWQCB	USBR	DWR	USBR	USGS	WSJRC
	Frequency	Weekly	Weekly	Continuous	Continuous	Continuous	Monthly
	EC	Yes	Yes	Yes	Yes	Yes	Yes
Location	**Boron**	Yes	Yes	No	No	No	Yes
	Site ID	541SJC501		SJR	VER	VNS	
Vernalis	Begin Date	1995		2005	1999	1999	
	End Date	2011		Present	Present	Present	
	Site ID	541STC510		MRB			
Maze Road	Begin Date	1995		2007			
	End Date	2011		Present			
	Site ID	541STC507		SJP			
Patterson	Begin Date	1995		2000			
	End Date	2011		Present			
	Site ID	535STC504	535STC504			SCL	
Crows Landing Bridge	Begin Date	1995	2011			2004	
	End Date	2011	Present			Present	
	Site ID					NEW [flow]	
Newman [Flow Only]	Begin Date					1995	
	End Date					Present	

Note: POTW river monitoring are weekly EC grab samples upstream and downstream of the effluent outfalls. Both effluent outfalls are between the Merced and Tuolumne Rivers

Table 7-5. Electrical Conductivity and Boron Monitoring in the San Joaquin River Upstream of Reach 83.

	Source	CEDEN	CEDEN	CDEC	CDEC	CDEC	CEDEN
	Program	SWAMP	Grasslands	Real-Time Program			ILRP
	Agency	CVRWQCB	USBR	DWR	USBR	USGS	WSJRC
	Frequency	Weekly	Weekly	Continuous	Continuous	Continuous	Monthly
	EC	Yes	Yes	Yes	Yes	Yes	Yes
Location	**Boron**	Yes	Yes	No	No	No	Yes
Hills Ferry	Site ID	541STC512					
	Begin Date	1985					
	End Date	2007					
	Site ID	541MER538	541MER538			FFB	
Fremont Ford	Begin Date	1995	2011			2004	
	End Date	2011	Present			Present	
Stevenson/Lander Ave.	Site ID	541MER522		SJS			541MER522
	Begin Date	1995		2000			2011
	End Date	2011		Present			Present

Note: POTW river monitoring are weekly EC grab samples upstream and downstream of the effluent outfalls. Both effluent outfalls are between the Merced and Tuolumne Rivers.

7.5 Remaining Monitoring Needs

7.5.1 Reporting

Data for the RTMP sensors (USBR, USGS and DWR) are reported and archived through CDEC. There is currently no specific SWAMP guidance for continuous sensors; however, the continuous sensor programs used by these agencies follow the intent of the SWAMP Quality Assurance Project Plan (QAPP) approach. Without implementation of continuous data QA computer software, continuous sensor data should be reviewed to identify out-of-range results in the 15-minute interval dataset and the performance of calibration samples should be considered. Boron and EC grab samples reported through CEDEN by the Grassland Bypass Project are collected according to their QAPP requirements and are consistent with SWAMP guidance as approved by the Central Valley Water Board in support of the Grassland Project Revised Monitoring Program document.

Adaptive management of the monitoring and assessment program may be necessary based on the Central Valley Water Board's review of WQO attainment. Recommended monitoring or assessment actions from this review may be performed by other stakeholders or regulated parties. Actions initiated by other regulatory programs (e.g., Grassland Bypass Project, NPDES permits, etc.) should be evaluated in light of the goals and proposed components of this program.

7.6 Final Proposal

Based on the extensive monitoring network currently in place on the LSJR, no additional monitoring requirements are proposed at this time. However, because the monitoring program relies on other external programs, it is important that those efforts are supported and tracked, especially where improvements or changes are proposed.

Should boron WQOs be exceeded at Crows Landing, weekly boron analyses should commence at Maze Road and Vernalis. Should salinity Performance Goals be exceeded at Crows Landing or Maze Blvd., Central Valley Water Board staff should work with dischargers and other agencies and stakeholders to determine if planned management practices have been implemented and/or there is reason to adjust the program during a reopener period (10-years after amendment adoption). Also, the Central Valley Water Board will evaluate data collected at monitoring stations located on the San Joaquin River and its tributaries upstream of Crows Landing when determining if a reopener period is necessary. Upstream monitoring stations are identified in the Central Valley Comprehensive Water Quality Monitoring Guides (Central Valley Water Board, 2017).

8 ECONOMIC ANALYSIS

Existing law (Wat. Code, sections 13141 and 13241, Pub. Resources Code, § 21159, Cal. Code Regs., tit. 23, § 3777, subd. (b).) detailed in Section 3.5 requires that the Central Valley Water Board consider economics when conducting basin planning activities. The Board is required to evaluate economics when establishing water quality objectives (WQOs), implementing an agricultural water quality control program, or requiring the installation of new pollution control equipment as part of a basin planning action. This chapter summarizes the economic analysis presented in a report prepared for the Lower San Joaquin River (LSJR) Committee titled *Development of a Basin Plan Amendment for Salt and Boron in the Lower San Joaquin River (LSJR): Task 5 – Economic Analysis* (Larry Walker Associates (LWA), 2015c), intended to show estimated costs to various discharge sectors associated with implementation of major salinity management actions, including those in the selected Project Alternative (Alternative 4) as described in the WQOs and Implementation chapters of this staff report. In addition, the analysis includes the costs of alternative salinity WQOs that may provide a higher level of protection (Alternatives 2 and 6).

8.1 Economic Considerations for Alternative 1 (No Action)

Since this alternative is contrary to the directive of the Control Program for Salt and Boron Discharges to the LSJR that requires establishment of WQOs for salinity in Reach 83, as established in the Basin Plan, the economic considerations were not evaluated.

8.2 Economic Considerations for Alternative 2

Based on WARMF modeling results, the 1,550 µS/cm EC WQO associated with Project Alternative (Preferred Alternative #4) is expected to reliably be met at Crows Landing with implementation of currently planned implementation actions that were modeled for the Planned Bundle of Management Actions. The management actions included in the Preferred Alternative are discussed in Chapter 5 (Section 5.3).

In the interest of documenting the costs associated with implementation of the various salinity control actions included as part of the Preferred Alternative (Planned Bundle of management actions) and planned to occur in the project area during the next 5 – 10 years, project stakeholders were contacted and asked to provide planning level cost estimates for those implementation actions amenable to cost estimate development. The management action expected to provide the most significant salinity load reductions to Reach 83 of the LSJR based on WARMF modeling is the completion of the Grassland Bypass Project (GBP). The GBP was initiated in 1995 and is scheduled to be completed at the end of 2019. The cost of Implementation Action 8b (Water Conservation – Optimize Existing Irrigation Efficiency) was not estimated because these costs have already been incorporated into the overall costs of the Irrigated Regulatory Lands Program (ICF International, 2010). The cost of Implementation Action 12b (Drainage Water Recirculation – Tilewater Recovery) was not estimated because no tilewater recovery projects were identified in the project area for consideration in the WARMF modeling effort. The estimated planning level costs of the implementation actions included in the Planned Bundle are provided in Table 8-1 and described in detail in Appendix D (originally presented as Attachment A in the LWA 2015 Task 5 Report).

At this time, the evaluation of compliance with a potential 1,550 µS/cm EC objective in Reach 83 is proposed to be accomplished by using water quality data collected at Crows Landing and Maze Road Bridge under existing monitoring programs (See Chapter 7). Evaluation of boron compliance is proposed to be accomplished using data collected by the GBP at Crows Landing. Thus, no additional costs are currently anticipated for an additional monitoring and surveillance program needed to track compliance with EC or boron WQO in Reach 83. However, because the long-term funding of existing LSJR water quality monitoring programs is unknown, a need could arise in the future to fund water quality monitoring at Crows Landing and Maze Road Bridge specifically to evaluate compliance with Reach 83 WQOs. Furthermore, future monitoring efforts could reveal that additional monitoring, either in location or frequency, is needed to adequately evaluate compliance with Reach 83 WQOs. These future, potential monitoring activities are estimated to require an annual budget of approximately $111,000 to accomplish all data collection, instrument maintenance, quality assurance and quality control (QA/QC), data analysis, and report preparation collectively performed by the existing monitoring programs operating in the LSJR. Monitoring and reporting costs were developed in consideration of EC and boron monitoring at Crows Landing Bridge and EC monitoring at Maze Road.

While the Preferred Alternative included controlled timing of salinity discharges as one of its implementation actions, apart from the consideration of tailwater recovery projects in the project area, controlled timing of salinity discharges was not modeled in WARMF. To this end, the $111,000 cost estimate for a monitoring and surveillance program noted above does not consider the ongoing costs of implementing the San Joaquin Real Time Management Program (RTMP) to manage salt loads and resulting concentrations at Vernalis, including costs of a cyberinfrastructure, coordination among participating stakeholders, or the forecasting of water quality conditions that will dictate when timed salinity discharges can or cannot occur under the RTMP.

Table 8-1: Cost Estimates of Specific Implementation Actions included in the Preferred Alternative.

Implementation Action	Cost Basis	Cost Estimate	
		Annual Cost	**Capital Cost**
1. Controlled Timing of Salinity Discharges	Addressed under Implementation Action 12a as cost of tailwater recovery projects	See 12a	
2c. Reduce Point Sources	City of Modesto – Pretreatment Program costs	$964,989[1]	-----
	City of Modesto – Surface Water Expansion Projects: Phase 1 (top est.) and Phase 2 (bottom est.)		$105,000,000[2] $113,000,000[2]
	City of Turlock – Pretreatment Program costs	$20,000[3]	-----
	City of Turlock – Surface Water Supply Diversification Project	$1,350,000[3]	$89,000,000[3]
3a. Reduce Nonpoint Sources	As a sensitivity analysis, 10% reduction in the application of nitrogen-based fertilizers in the Northwest, East Valley Floor, and Grassland Drainage Area subareas. (Implementation action would result in a cost savings)	-$14,200,000[4]	-----
9a. Installation of New High Efficiency Irrigation and Delivery Systems	Retrofitting of existing irrigation systems with high efficiency systems (drip or microspray) in the Northwest, East Valley Floor, and Grassland Drainage Area subareas (includes cotton^)	$9,600,000[4] $21,500,000^[4]	$26,800,000[4] $59,700,000^[4]
8b. Water Conservation – Optimize Existing Irrigation Efficiency	The costs for water conservation measures to optimize existing irrigation efficiency were included in the overall costs of the Irrigated Lands Regulatory Program and not calculated specifically for the Lower San Joaquin River Irrigation Area (ICF International, 2010)	-----	-----
10b. Sequential Reuse and Volume Reduction – Salt Accumulation Area	Total cost of Grassland Bypass Project (completion by December 2019; see Attachment A for cost itemization)	-----	$136,388,129[5]
12a. Drainage Water Recirculation – Tailwater Recovery	Patterson Irrigation District – Two Drains Project (cost range provided)	-----	$4,200,000 – $4,300,000[6]
	Grassland Water District – North Grasslands Water Conservation and Water Quality Control Project	-----	$12,000,000[7]
Monitoring and Surveillance Program	Compliance Monitoring and Surveillance Program costs	$111,000[8]	-----
	Total	**$19.3 Million**	**$541 Million**

Notes – Cost estimate provided by:

1. City of Modesto Annual Compliance Report for Conductivity, August 5, 2015.

2. Thomas Sinclair, Environmental Regulatory Compliance Manager, City of Modesto, Utilities Department Wastewater Division, August 26, 2015.

3. Dan Madden, City of Turlock, Municipal Services Water Quality Control Division, August 18, 2015.

4. Mark J. Roberson, PhD, CPSS, Senior Soil & Water Scientist, Formation Environmental, August 26, 2015 (Appendix D for additional information).

5. David Cory, San Joaquin Valley Drainage Authority, July 24, 2015 (see Appendix D for additional information).

6. Peter Rietkerk, P.E., General Manager, Patterson Irrigation District, August 18, 2015.

7. Ken Swanson, P.E., District Engineer, Grassland Water District, August 4, 2015 (see Appendix D for additional information).

8. Brian Laurenson, P.E., Vice President, Larry Walker Associates, July 13, 2015. (See Appendix D for additional information).

8.3 Economic Considerations for Alternative 4 (Preferred)

The only difference between Project Alternatives #2 and #4 is the inclusion of a 1,350 µS/cm EC Performance Goal in the latter alternative. As such, the economic considerations for the implementation of Alternative #4 are the same as those described below for the Preferred Alternative (#2). Since the Performance Goals are based on expected water quality once currently scheduled activities are implemented, no additional costs are anticipated. Should the performance goals be exceeded, documents already developed under the Board approved RTMP will be evaluated to determine whether implementation activities have occurred on schedule and the relative sources of salt loading, in order to determine whether adjustments to the Control Program is needed in the future.

8.4 Economic Considerations for Alternative 6

Among the four potential project alternatives selected by the LSJRC for consideration in the Basin Planning process, Project Alternative #6 (1,000 µS/cm) was the only alternative considered that would require new salinity control measures to attain the WQO.

Project Alternative #6 would require the construction and operation of a desalination facility in the Grassland Drainage Area in order to meet a 1,010 µS/cm EC objective at Crows Landing. This would result in significant, additional costs to the discharge sectors. The planning level cost analysis of Alternative #6 estimates the conceptual desalination facility total project cost at $900 million, the annual operation and maintenance cost at $16.1 million, and the 30-year life-cycle cost at $1.15 billion (see Appendix E, originally presented as Attachment B in the LWA 2015 Task 5 Report). The economic analysis provided for Alternative #6 acts as an evaluation of the costs of an alternative salinity WQO. While the LSJRC has not discussed how such a desalination project would be funded if it were ever to be built, some level of cost-sharing between those entities that discharge to the LSJR, including POTWs, would likely be necessary.

Reverse osmosis (RO) at individual POTW facilities was not considered as part of the Planned Plus Maximum Treatment Focus Alternative as a means for POTWs to meet the 1,000 µS/cm EC objective as end-of-pipe effluent limits. Under Alternative #6, POTWs would either require a means to establish attainable effluent limits in implementing a 1,000 µS/cm EC objective, similar to the POTW permitting considerations discussed above in the Preferred Alternative section or would be required to implement other compliance strategies including RO treatment, improvements to remove discharges from the LSJR on a year-round basis, or development of a specific pollutant trading program.

Similar to the discussion provided for the Preferred Alternative, evaluation of compliance with a potential 1,010 µS/cm EC objective in Reach 83 is proposed to be accomplished by using water quality data collected at Crows Landing and Maze Road Bridge by existing monitoring programs. The cost of any future monitoring that may be required to augment those water quality data collected by existing programs is unknown and thus, not included as part of this analysis. However, it is estimated that a single monitoring and surveillance program would require an annual budget of approximately $111,000 to accomplish all data collection, instrument maintenance, QA/QC, data analysis, and report preparation collectively performed by the existing monitoring programs operating in the LSJR.

Appendix E, prepared by Carollo Engineers (LWA subcontractor), provides information regarding the overall cost of implementing an alternative EC objective of 1,010 µS/cm in Reach 83. A portion of these significant overall costs would be the responsibility of the agricultural community, if the alternative objective is adopted.

8.5 **Extended Dry Period**

A WQO adjustment for an Extended Dry Period was considered for all the alternatives evaluated. Based on modeled values, the adjust WQO of 2,200 uS/cm, would be achieved with implementation of scheduled activities. Therefore, no additional costs above those documented in Alternative 4 are anticipated.

8.6 **Summary**

This staff report predicts that there are no additional implementation costs currently associated with the Preferred Alternative. Potential future costs are relatively minor and are primarily related to monitoring and reporting requirements. A portion of the overall monitoring and reporting costs may be the responsibility of the discharger community in the future if existing monitoring ceases to fulfill the requirements set for the in the Monitoring and Surveillance Program. Appendix D provides supplemental information related to costs for specific implementation actions included in the Preferred Alternative. This staff report predicts that a new agricultural program will not be required to achieve the preferred EC WQOs alternative, nor will any additional pollution control equipment such as RO systems or desalting facilities.

9 ENVIRONMENTAL ANALYSIS

9.1 Environmental Review

As detailed in Chapter 3 (Section 3.6), the Central Valley Water Board as a Lead Agency under the California Environmental Quality Act (CEQA), is responsible for evaluating the potential environmental impacts that may occur because of changes made to the Basin Plan as a result of the proposed Basin Plan Amendment. The full staff report and the Environmental Checklist presented in Appendix F satisfy the requirements of State Water Board's Regulations for Implementation of CEQA for Exempt Regulatory Programs.

This chapter specifically evaluates the potential environmental impacts, including cumulative impacts, of the proposed amendments to the Basin Plan as compared to baseline conditions.

9.1.1 Setting/Baseline

The baseline against which the proposed Basin Plan amendment is assessed includes the following characteristics:

- Existing water body characteristics, hydrology and operation (see Chapters 2 & 5)
- Existing discharges to the LSJR (including discharges from irrigated agriculture, Publically Owned Treatment Works (POTW) wastewater effluent and storm water) and receiving water quality
- Existing regulatory programs and policies

Existing regulatory programs and policies include, but are not limited to, the following.

- Irrigated Lands Regulatory Program (ILRP) to ensure that agricultural discharges do not negatively impact beneficial uses.
- The NPDES program to regulate point source discharges to surface water, including municipal wastewater treatment plants and medium to large municipal separate storm sewer systems (MS4s) serving populations greater than 10,000.
- Storm Water General Permit programs for construction and industrial activities.
- Water Quality Certification program for dredge and fill activities.
- The *Sources of Drinking Water Policy* which assumes that all surface and ground water has the potential to provide municipal and domestic supply unless specific exceptions are met.

- The State Water Board Statement of Policy with Respect to Maintaining High Quality of Waters in California (Resolution 68-16 or Antidegradation Policy).
- South Delta Salinity Objectives (State Water Resources Control Board, 2006)
- Control Program for Salt and Boron Discharges to the LSJR (Central Valley Water Board, 2004)
- Selenium Control Program (Central Valley Water Board, 2010c)
    - Grassland Bypass Project (Order Number R5-2015-0094)

The most recent major hydrologic change to the LSJR was the adoption of the Selenium Control Program, which includes implementation of the GBP. The GBP systematically reduces selenium, salt and boron loading to the LSJR from a 90,000-acre area of irrigated agriculture. The GBP began operation in 1995 and is scheduled to go to zero discharge by 2019. In addition, a Control Program for Salt and Boron Dischargers to the LSJR was adopted by the Central Valley Water Board in 2004 to meet salinity WQOs at Vernalis. As part of the program, a Real-Time Salinity Management Program was approved by the Central Valley Water Board in 2014.

For baseline conditions, 30-day running average EC concentrations were evaluated at Crows Landing (location with the poorest water quality in Reach 83) from the beginning of the GBP (1996) through 2014. The information was evaluated against irrigation season and water-year type as defined by San Joaquin Valley Water Year Index (from wet to critically dry). A summary is depicted in Figure 6-1.

9.1.2 **Analysis of the Preferred Alternative**

If adopted, the proposed Basin Plan amendment will establish salinity WQOs for the LSJR, between the mouth of the Merced River and the Airport Way Bridge near Vernalis. The new electrical conductivity (EC) WQOs were developed in consideration of state and federal laws, regulations, and policies, including the state's *Sources of Drinking Water Policy*, the Basin Plan, state and federal regulations, and other state and federal requirements relevant to drinking water, stock drinking water, agricultural irrigation uses, and aquatic-life protection.

Based on WARMF modeling results, the proposed 1,550 μmhos/cm EC WQO associated with the Preferred Alternative is expected to reliably be met in the San Joaquin River at Crows Landing with the implementation of currently planned actions to manage/reduce salts that were modeled for the Preferred Alternative. The planned actions included in the Preferred Alternative are listed in Table F-2 of Appendix F. The planned action expected to provide the most significant salinity load reductions to Reach 83 of the LSJR based on WARMF modeling is the completion of the Grassland Bypass Project (GBP). The GBP was initiated in 1995 and is scheduled to be completed at the end of 2019. The EC WQOs will be achieved primarily through the completion of the Grassland Bypass Project. The proposed objectives are lower than EC concentrations observed during 1996 through 2014 (baseline conditions).

When the planned actions were modeled through 2019, water quality was noted to remain below 1,350 µS/cm during all but extended dry periods. Therefore, the proposed action also includes the establishment of an implementation EC Performance Goal and alternative Extended Dry Period WQOs in Reach 83. The Performance Goal will be used to measure progress toward achievement of EC levels during the irrigation season of non-Extended Dry Periods when EC levels lower than the EC WQO would be beneficial to agriculture and are considered potentially achievable. The Extended Dry Period exception exists to allow discharges to the LSJR to occur under hydrologic conditions (e.g., low flows and elevated EC levels) when it is anticipated that agriculture will value water availability over water quality (water with EC concentrations greater than the proposed WQO of 1,550 µS/cm). The process for determining extended dry periods is outlined in Chapter 6 (Section 6.2.3) and is summarized in Appendix F.

The proposed WQO, Performance Goals and adjusted WQO for extended dry periods were overlain onto the historic baseline water quality conditions in the LSJR at Crows Landing (Figure 6-2). The resulting overlay indicates that meeting the proposed WQOs caps salinity concentrations in all cases and improves water quality during some periods. Meeting the proposed Performance Goals consistently means improved water quality over historic conditions.

The proposed amendment requires routine EC and boron monitoring in the LSJR at Crows Landing and Maze Road Bridge to track compliance with the EC and boron WQOs and the achievement of the Performance Goal. The needed monitoring is currently incorporated as part of the RTMP to manage salt loads and resulting concentrations at Vernalis, therefore, water quality monitoring of EC and boron will not result in adverse physical effects to baseline conditions.

The proposed action will not result in any direct or indirect environmental effects that have not already been evaluated. The proposed Basin Plan amendment will not cause any potentially significant environmental impacts over baseline conditions and, therefore, there are no mitigation measures or alternatives necessary to reduce or avoid significant impacts. This conclusion is reflected in the Environmental Checklist provided in Appendix F.

9.1.3 **Cumulative Impact Analysis**

Cumulative impacts refer to one or more individual effects which, when taken together, are considerable or which compound or increase other environmental impacts. Cumulative impacts are the result of the incremental impact of a project when added to other closely related past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time. Reasonably foreseeable future projects include the Board's revision of permit requirements for regulated entities that discharge into the LSJR. Board staff anticipate that the regulated entities whose permits may be revised by the Board subsequent to the adoption of the proposed Amendment may include agricultural operations that utilize the LSJR for agricultural water supply and discharge return flows into the LSJR, and the two POTWs that discharge wastes into the LSJR.

The Board has issued ILRP General Orders to third-party coalitions (representatives of agricultural growers), including the Eastern San Joaquin Watershed, the Western San Joaquin River and the Grassland Drainage Area, that require the coalitions to develop regional water quality management plans for areas where irrigated agriculture may be contributing to water quality problems. The ILRP General Orders require growers to conduct evaluations of their management practices to ensure they are protecting groundwater and surface water, and require coordinated monitoring at specified monitoring points that have been determined to be representative of water quality within the watershed. The ILRP, which is a relatively new regulatory program, is requiring coalitions throughout the state to engage in a process of evaluating and addressing water quality impairments, and this program is generally resulting in increased water quality. Unless water quality conditions are expected to degrade due to either significant changes in agricultural diversion and return-flow discharge operations, which dominate the flow conditions in the LSJR, or due to an expansion of irrigated acreage, water quality is generally expected to improve due to implementation of the ILRP General Orders. Because the ILRP General Orders are resulting in greater water quality improvements as the program matures, no significant degradation is expected due to changes in operations or increases in irrigated acreage in the LSJR Irrigation area. On the contrary, water quality within the LSJR is expected to improve relative to existing conditions, largely in part to the completion of the Grasslands Bypass Project and other planned salinity reduction management actions.

Continued implementation of the San Joaquin Real Time Management Program (RTMP) will ensure that WQOs at Vernalis are met and develop the water quality information needed to both evaluate water quality at Crows Landing and Maze Blvd. and document salt management activities in the basin. The RTMP seeks to optimize/maximize the export of salt from groundwater, perched zones, and agricultural drain water from the LSJR Basin while ensuring that salinity objectives are met at Vernalis. The Central Valley Water Board has approved the RTMP in the Basin Plan as an alternative salt management strategy in lieu of monthly salt load allocations enforced by the Central Valley Water Board. The RTMP facilitates the control and timing of wetland, agricultural drainage, and/or other discharges to the LSJR to coincide with periods when the river has capacity to assimilate additional salts up to a WQO. The Eastern San Joaquin Watershed, the Western San Joaquin River and the Grassland Drainage Area Coalitions are members of the RTMP program.

The other regulated entities that are likely to be affected by the proposed EC WQOs are the POTWs from the cities of Modesto and Turlock. While the establishment of future effluent limitations for salinity in the NPDES permits issued to the Cities of Modesto and Turlock for operation of their wastewater treatment facilities are not a component of the proposed action, future salinity-related effluent limitations for these facilities will need to consider the proposed EC WQO of 1,550 μmhos/cm, if adopted. The Central Valley Water Board, the entity responsible for developing effluent limitations and issuing NPDES permits, will need to account for the continued effects of water conservation, water supply constraints, and Extended Dry Periods. The consideration given to implementing the WQOs for NPDES dischargers is described in Chapter 6 (Section 6.2.2) and the proposed requirements are not expected to result in the need to construct supplementary facilities or additions to the existing wastewater treatment facilities in the cities of Modesto and Turlock. Further, any expanded discharge from the POTWs, any new point sources that propose to discharge into the LSJR, and the continued agricultural activities that discharge into the LSJR addressed by the proposed Basin Plan amendment will all be required to comply with regulatory limits developed to protect applicable beneficial uses. When a permittee proposes a new or expanded discharge, they must submit a new report of waste discharge to the Board, and the Board will be required to conduct a new antidegradation analysis and potentially a new reasonable potential analysis before the Board can issue a new permit. In this manner, the Board would ensure that beneficial uses in the LSJR will continue to be protected.

Other programs that do not currently regulate any discharges into the LSJR, but that could in the future, include the Board's stormwater and water quality certification program. However, potential changes in storm water volume due to increased urban development are not expected to have a significant impact to the water quality to the LSJR in the foreseeable future. Small MS4s serving less than 10,000 people and construction sites disturbing between one and five acres of land are required through a general permit administered by the State Water Board to implement Best Management Practices (BMPs) to control 303(d) listed pollutants and other pollutants of concern. In addition, the general permit recently approved incorporates Low Impact Development requirements to reduce urban runoff in areas of new development and redevelopment (Order No. R5-2016-0040). Storm Water General Permit programs will regulate storm water discharges and future construction and industrial activities. However, stormwater has virtually no salt or boron.

Chapter 6's implementation provision to have a re-opener to the Basin Plan ten years after adoption of the Basin Plan Amendment and Chapter 7's water quality monitoring program provide assurance that there will be an ongoing evaluation and assessment of water quality in the river to ensure that potential cumulative effects are not significant.

9.1.4 **Climate Change**

Potential impacts of climate change were evaluated and noted to cause more frequent extended dry periods, additional recycling, conservation and reuse, and reduction in availability of assimilative capacity. To address the potential impacts, WQOs are adjusted during extended dry periods to allow dischargers more flexibility to reuse and conserve limited water resources, which typically increases salinity concentrations. In addition, an option to re-evaluate the objectives and performance goals is identified to allow a review of overall trends in water quality, implementation of management activities and changes in hydrology that may impact assimilative capacity.

9.1.5 **Overall Analysis**

A CEQA analysis and checklist was completed and is provided in Appendix F. The evaluation indicates that the Proposed Project will not cause any potentially significant environmental impacts. Since there was a finding of no impact, no analysis of alternatives to determine whether an alternative could lessen or eliminate significant impacts of the proposed project is required, however, this report includes a discussion of a No Action Alternative and alternatives identifying lower WQOs to provide additional context for decision-making parties. The additional reviews are included in Appendix F.

9.2 **Antidegradation Consideration**

Based on the analysis summarized above and depicted in Figure 6-2, the preferred alternative provides a cap on water quality that prevents conditions worse than baseline and with the inclusion of performance goals, promotes obtaining the best water quality reasonably attainable given ongoing and planned management activities within the basin. Further discussion of antidegradation considerations is provided in Chapter 10, Consistency with Laws, Plans and Policies, Section 10.1.

10 Consistency with Laws, Plans, and Policies

10.1 Antidegradation Policies

The State and Federal Antidegradation Policies are detailed in Chapter 3 (Section 3.7). The following section evaluates whether the proposed Basin Plan Amendments are consistent with the *Federal Antidegradation Policy* and the *State Antidegradation Policy*.

10.1.1 Consistency with the *State Antidegradation Policy*

The *State Antidegradation Policy*, adopted by the State Water Board in October 1968, limits the Central Valley Water Board's discretion to authorize the degradation of high-quality waters. This policy has been incorporated into the Basin Plan. High-quality waters are those waters where water quality is more than sufficient to support the designated beneficial uses.

The proposed Basin Plan Amendments do not themselves authorize the degradation of any high-quality waters. They instead establish salinity water quality objectives (WQOs) in Reach 83 of the Lower San Joaquin River and a program of implementation designed to achieve those WQOs. Any degradation that would occur as an indirect result of the Central Valley Water Board's adoption of the proposed Basin Plan Amendments would occur when the Board prescribes or modifies waste discharge requirements (including NPDES Permits), issues conditional waivers, or issues water quality certifications that authorize waste discharges to the LSJR.

Following the establishment of the salinity objectives proposed by the Basin Plan Amendments, the Central Valley Water Board will still be required to implement the *State Antidegradation Policy* when prescribing or modifying waste discharge requirements, issuing conditional waivers, and issuing water quality certifications that authorize degradation in the LSJR. In the area affected by the proposed Basin Plan Amendments, agricultural discharges are the primary nonpoint source discharges that threaten to degrade water quality with respect to salinity. These discharges will continue to be regulated under waste discharge requirements issued by the Central Valley Water Board through the Irrigated Lands Regulatory Program (ILRP).

Consistent with the *State Antidegradation Policy*, the ILRP currently requires that agricultural discharges implement a suite of management practies that the Central Valley Water Board considers to be the best practicable treatment or control (BPTC) of the wastes in their discharges. The set of management practices imposed by the ILRP require growers to conduct a continuous evaluation of their management practices to ensure they are adequality protective of both groundwater and surface water, require the submittal of regional water quality management plans for areas where irrigated agriculture may be contributing to water quality problems, and require all growers to conduct farm evaluations to ascertain the effectiveness of the management practices that are being implemented on individual farms. Should the monitoring conducted pursuant to the ILRP's waste discharge requirements reveal water quality problems, growers are required to implement practices consistent with specified management plans developed to address the water quality problems.

The Central Valley Water Board is also required to make findings demonstrating that any authorized degradation inheres to the maximum benefit of the people of the state whenever the Central Valley Water Board issues or modifies any order that would authorize the degradation of high-quality waters (including any changes to the ILRP orders). Though the economic discussion in Chapter 8 does not obviate this requirement, this discussion strongly suggests that degradation authorized pursuant to the implementation plan in the proposed Basin Plan Amendments (i.e., degradation that does not result in an exceedance of the WQOs that would be established by the proposed Basin Plan Amendment) would be consistent with the *State Antidegradation Policy.*

10.1.2 Consistency with the *Federal Antidegradation Policy*

The *Federal Antidegradation Policy* requires the protection of existing instream water uses and the level of water quality necessary to protect those uses, requires that where water quality exceeds levels necessary to support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water, such water quality shall be maintained with limited exceptions, and requires that, where high quality waters constitute an outstanding National resource, water quality shall be maintained and protected. (40 C.F.R. 131.12.)

The LSJR is not considered an outstanding National resource. Furthermore, the Basin Plan amendments will not result in an impairment of any existing instream water uses. To the extent that any permits issued under the federal NPDES program are changed due to the adoption of the proposed Basin Plan Amendments, such permit changes would remain subject to stringent antidegradation requirements.

NPDES Permits for the two POTWs are reviewed approximately every five years. At least once during these permit terms (and often more frequently), the Board requires the Dischargers to monitor effluent and upstream receiving water sites for priority pollutants and other constituents of concern. If an NPDES permittee predicts that there will be a substantial change in or expansion of its wastewater discharge, the permittee must submit a new report of waste discharge to the Board and the Board must conduct a new antidegradation analysis and potentially a new Reasonable Potential Analysis before the Board can issue a new permit. Any new point-source discharges to Reach 83 of the LSJR, must also go through the same antidegradation and Resonable Potential Analysis (RPA) analyses as those required of the two existing POTWs.

As described above, discharges from irrigated agriculture are currently regulated under the Board's ILRP. Such discharges fall outside the purview of federal permitting requirements. However, the state's establishment and modification of water quality standards in jurisdictional waterways is subject to federal oversight. As described herein, the proposed Basin Plan Amendments are fully consistent with all applicable federal statutes and regulations that limit the Board's authority to prohibit unreasonable degradation of water quality.

10.2 Consistency with Federal and State Laws

Federal agencies have adopted regulations implementing federal laws to which Central Valley Water Board actions must conform. The following Federal laws were evaluated for this proposed Basin Plan Amendment:

- Clean Water Act
- Federal & State Endangered Species Acts (16 U.S.C. § 1531 et seq., Fish and G. Code §2050-2116 *et seq*.)

These laws and their relevance to the proposed Basin Plan Amendment are described in the following sections in addition to state law.

10.2.1 Clean Water Act

Federal Requirements for Review of Water Quality Standards

Under Section 303(c) of the Clean Water Act, water quality standards adopted by a State that affect waters of the United States are subject to USEPA approval. Water quality standards consist of the designated uses and the water quality criteria to protect these uses. (33 USC §1313 (c)(2)(A) and 40 CFR §131.3(i).) When designating uses, the State must take into consideration the use and value of water for public water supplies, protection and propagation of fish, shellfish and wildlife, recreation in and on the water, agricultural, industrial, and other purposes including navigation. (40 CFR §131.10(a).) When designating uses of a water body and the appropriate criteria for those uses, the State shall ensure that the water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters. (40 CFR §131.10(b).)

By adopting this amendment, the Central Valley Water Board finds that meeting the proposed WQOs in Reach 83 will not impact attainment of salinity objectives downstream in the LSJR at Vernalis (boundary of the Sacramento-San Joaquin Delta. The finding will be verified with water quality information collected under the Real-Time Salinity Management Program (RTMP) that is part of the Control Program for Salt and Boron Discharges to the LSJR adopted in 2004 (Central Valley Water Board, 2004).

Federal Regulations Pertaining to NPDES Permits

Section 402 of the Clean Water Act requires a permitting system which USEPA addressed by promulgating Title 40 Code of Federal Regulations Part 122, which are the regulations pertaining to the NPDES (National Pollutant Discharge Elimination System) program. The State's regulations pertaining to NPDES permits must be consistent with the federal regulations. Title 40 Code of Federal Regulation section 122.44(d)(1)(ii) sets forth the regulations for determining whether a discharge has a reasonable potential to cause or contribute to a violation of water quality standards. It states, "When determining whether a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above a narrative or numeric criteria within a State water quality standard, the permitting authority shall use procedures which account for existing controls on point and nonpoint sources of pollution, the variability of the pollutant or pollutant parameter in the effluent, the sensitivity of the species to toxicity testing (when evaluating whole effluent toxicity), and where appropriate, the dilution of the effluent in the receiving water."

The proposed Basin Plan Amendment does not recommend any new or modification to federal or state NPDES permitting procedures. This Basin Plan Amendment is consistent with federal and state NPDES procedures and depends on the continued implementation of these procedures to provide appropriate protection of the LSJR.

Requirements for Avoiding Wetland Loss

Under Clean Water Act section 404 and the Rivers and Harbors Act of 1899 Section 10, alteration of waterways, including wetlands that affect navigable waters requires a permit from the Federal government and assurance that impacts will be avoided or mitigated. The U.S. Army Corps of Engineers operates the 404 permit program with a goal of achieving "no net loss" of wetlands. For projects proposing unavoidable impacts on wetlands, compensatory mitigation in the form of replacing the lost aquatic functions is generally required. Under authority of Clean Water Act section 401, the State also reviews federally-authorized projects, including permits issued by the US Army Corps of Engineers for dredge and fill activities under CWA section 404 and construction permits issued under Section 10 of the Rivers and Harbors Act, that could have water quality impacts on jurisdictional water bodies.

The proposed Basin Plan Amendment will not authorize any activities that will adversely affect or have net loss to current wetlands.

10.2.2 Federal and State Endangered Species Act

The Federal Endangered Species Act of 1973 (16 U.S.C. § 1531 et seq.) was established to identify, protect and recover imperiled species and the ecosystems upon which they depend. It is administered by the Interior Department's U.S. Fish and Wildlife Service (USFWS) and the Department of Commerce's National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS). The USFWS has primary responsibility for terrestrial and freshwater organisms, while the NMFS has primary responsibility for marine species such as salmon and whales. In addition, the State of California enacted the California Endangered Species Act (Fish & G. Code, sections 2050-2116 *et seq*.), which is administered by the California Department of Fish and Wildlife and similarly maintains State lists of rare, threatened and endangered species.

The proposed Basin Plan Amendment addresses the two ~~most~~ salt-sensitive beneficial uses (MUN and AGR irrigation supply) and is not expected to affect threatened or endangered fish and wildlife (Kennedy/Jenks Consultants, 2010). Therefore, the proposed Basin Plan Amendments are consistent with the Federal and State Endangered Species Acts.

10.2.3 **Consistency with California Water Code 106.3**

In compliance with Water Code section 106.3, it is the policy of the State of California that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. Water Code section 106.3 states that:

a. It is hereby declared to be the established policy of the state that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes.
b. All relevant state agencies, including the department, the state board, and the State Department of Public Health, shall consider this state policy when revising, adopting, or establishing policies, regulations, and grant criteria when those policies, regulations, and criteria are pertinent to the uses of water described in this section.
c. This section does not expand any obligation of the state to provide water or to require the expenditure of additional resources to develop water infrastructure beyond the obligations that may exist pursuant to subdivision (b).
d. This section shall not apply to water supplies for new development.
e. The implementation of this section shall not infringe on the rights or responsibilities of any public water system.

Related resolutions supporting this policy were adopted by the State Water Board (Resolution No. 2016-0010) and Central Valley Water Board (Resolution No. R5-2016-0018).

The proposed WQOs are protective of the potential MUN beneficial use in the LSJR and therefore this amendment is consistent with Water Code section 106.3 and the resolutions listed above.

10.2.4 **Assembly Bill 32 – California Global Warming Solutions Act**

Assembly Bill (AB) 32, is a California State Law that fights global warming by establishing a comprehensive program to reduce greenhouse gas emissions from all sources throughout the state. AB 32 is largely implemented by the California Air Resources Board, which has been directed by AB 32 to adopt regulations to achieve cost-effective GHG emission reductions, thereby mitigating the risks associated with climate change, while improving energy efficiency and expanding the use of renewable energy resources.

The Water Boards are committed to the adoption and implementation of effective actions to mitigate greenhouse gas emissions and to adaptation of our policies and programs to the environmental conditions resulting from climate change. In establishing the proposed salinity WQOs for the LSJR, potential impacts of climate change were evaluated and noted to cause more frequent extended dry periods, additional recycling, conservation and reuse, and reduction in availability of assimilative capacity. To address the potential impacts, proposed WQOs are adjusted during extended dry periods to allow dischargers more flexibility to reuse and conserve limited water resources which typically increases salinity concentrations. In addition, an option to re-evaluate the objectives and performance goals is identified to allow a review of overall trends in water quality, implementation of management activities and changes in hydrology that may impact assimilative capacity.

10.3 **Consistency with State Water Board Policies**

The State Water Board is authorized to adopt state policy for water quality control. (Wat. Code §13140.) State Water Board water quality control plans supersede any regional water quality control plans for the same waters to the extent of any conflict. (Wat. Code §13170.) The following are thirteen State Water Board policies:

1. State Water Board Resolution 68-16, the Statement of Policy with Respect to Maintaining High Quality of Waters in California (*State Antidegradation Policy*)
2. Water Quality Control Policy for the Enclosed Bays and Estuaries of California (Resolution No. 74-43)

3. Sources of Drinking Water Policy (Resolution No. 88-63)
4. Pollutant Policy Document (Resolution No. 90-67)
5. Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304 (Resolution No. 92-49)
6. Consolidated Toxic Hot Spots Cleanup Plan (Resolution No. 99-065 and 2004-0002)
7. Nonpoint Source Management Plan & the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (Resolution No. 99-114 and 2004-0030)
8. Water Quality Enforcement Policy (Resolution No. 2002-0040)
9. Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Resolution No. 2005-0019)
10. Policy for Developing California's Clean Water Act Section 303(d) list (Resolution No. 2004-0063)
11. Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (Resolution No. 2005-0050)
12. Policy for Compliance Schedules in Nation Pollutant Discharge Elimination System Permits (Resolution No. 2008-0025)
13. Policy for Water Quality Control for Recycled Water (Resolution No. 2009-0011)

The thirteen policies are evaluated in the following sections..

10.3.1 State Water Board Resolution 68-16, the Statement of Policy with Respect to Maintaining High Quality of Waters in California (*State Antidegradation Policy*)

This policy is discussed above in Section 8.1 of this staff report.

10.3.2 Resolution No. 74-43: Water Quality Control Policy for the Enclosed Bays and Estuaries of California

This policy was adopted by the State Water Board in 1974 and updated in 1995. This policy provides water quality principles and guidelines for the prevention of water quality degradation in enclosed bays and estuaries to protect the beneficial uses of such waters. The Regional Water Boards must enforce the policy and take actions consistent with its provisions. For the San Francisco Bay-Delta system, the policy requires implementation of a program which controls toxic effects through a combination of source control for toxic materials, upgraded waste treatment, and improved dilution of wastewaters to provide full protection to the biota and the beneficial uses of San Francisco Bay-Delta waters.

The proposed Basin Plan Amendment does not eliminate or contradict the core requirement of the Water Quality Control Policy for the Enclosed Bays and Estuaries of

California that the Central Valley Water Board ensure that persistent or cumulative toxic substances be removed from waste discharges to the maximum extent practicable through source control or adequate treatment. Furthermore, the proposed Basin Plan Amendment does not change the Bay-Delta electrical conductivity WQOs set for the San Joaquin River at Vernalis. Therefore, the proposed Basin Plan Amendments are consistent with this policy.

10.3.3 **Resolution No. 88-63: Sources of Drinking Water Policy**

This policy states that all waters of the state are to be considered suitable or potentially suitable for municipal and domestic supply unless certain exceptions are met.

The proposed Basin Plan Amendment will not change the potential MUN beneficial use designated for the LSJR and is therefore consistent with this policy.

10.3.4 **Resolution No. 90-67: Pollutant Policy Document**

This policy requires, in part, that the Central Valley and San Francisco Bay Water Boards use the Pollutant Policy Document (PPD) as a guide to update portions of their Basin Plans. The PPD requires that the Central Valley Water Board develop a Mass Emissions Strategy (MES) for limiting loads of pollutants that enter the Sacramento-San Joaquin Delta. The purpose of the MES is to control the accumulation in sediments and the bioaccumulation of pollutant substances in the tissues of aquatic organisms in accordance with the statutory requirements of the state Porter-Cologne Water Quality Act and the Federal Clean Water Act.

The proposed Basin Plan amendment addresses salt and boron which do not increase the accumulation of pollutants in sediment or bioaccumulation of pollutant substances in tissues of aquatic organisms; therefore, this Policy is not applicable.

10.3.5 **Resolution No. 92-49: Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304**

The State Water Board adopted this policy in 1992 and updated this policy in 1994 and 1996. This policy contains procedures for the Central Valley Water Board to follow when issuing orders pursuant to Water Code section 13304 that require the cleanup of discharges of wastes that have impacted, or that threaten to impact, waters of the state. The proposed Basin Plan Amendment does not include any change to the procedures pertaining to cleanup and abatement activities. Therefore, this policy is not applicable to the proposed Basin Plan Amendment.

10.3.6 Resolution No. 99-065 & Resolution No. 2004-0002: Consolidated Toxic Hot Spots Cleanup Plan

In June 1999, the State Water Board adopted the Consolidated Toxic Hot Spots Cleanup Plan (Cleanup Plan), as required by California Water Code Section 13394.

The proposed Basin Plan Amendment does not address any of the constituents needing cleanup plans; therefore, the Cleanup Plan is not applicable.

10.3.7 Resolution No. 99-114 & Resolution No. 2004-0030: Nonpoint Source Management Plan & the Policy for Implementation and Enforcement of Nonpoint Source Pollution Control Program

In December 1999, the State Water Board adopted the Plan for California's Nonpoint Source (NPS) Pollution Control Program (NPS Program Plan) and in May 2004, the State Water Board adopted the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (NPS Policy). The NPS Policy explains how State and Regional Water Boards will use their administrative permitting authority under the Porter-Cologne Act to implement and enforce the NPS Program Plan. The NPS Policy requires all nonpoint source discharges to be regulated under waste discharge requirements, waivers of waste discharge requirements, a Basin Plan prohibition, or some combination of these administrative tools. The NPS Policy also describes the key elements that must be included in a nonpoint source implementation program.

The proposed Basin Plan Amendment will not change how the management, implementation or enforcement activities of nonpoint source pollution control programs are regulated.

10.3.8 Resolution No. 2002-0040: Water Quality Enforcement Policy

The State Water Board adopted this policy to ensure enforcement actions are consistent, predictable, and fair. The policy describes tools that the State and Regional Water Boards may use to determine the following: type of enforcement order applicable, compliance with enforcement orders by applying methods consistently, and type of enforcement actions appropriate for each type of violation. The State and Regional Water Boards have authority to take a variety of enforcement actions under the Porter-Cologne Water Quality Control Act. These include administrative permitting authority such waste discharge requirements (WDRs), waivers of WDRs, and Basin Plan prohibitions.

The proposed Basin Plan Amendment does not change how the water quality enforcement actions are taken nor propose any Basin Plan Prohibitions.

10.3.9 Resolution No. 2004-0063: Policy for Developing California's Clean Water Act Section 303(d) List

Pursuant to the Water Code section 13191.3(a), this State policy for water quality control describes the process by which the State Water Board and the Regional Water Boards will comply with the listing requirements of Clean Water Act section 303(d). The Listing Policy establishes a standardized approach for developing California's section 303(d) list to achieve water quality standards and maintain beneficial uses in all of California's surface waters. The Listing Policy applies only to the listing process methodology used to comply with Clean Water Act section 303(d).

Clean Water Act section 303(d) requires states to identify waters that do not meet, or are not expected to meet by the next listing cycle, applicable water quality standards after the application of certain technology-based controls and schedule such waters for development of Total Maximum Daily Loads. (40 CFR §130.7(c) and (d).)

The proposed amendment establishes WQOs to protect beneficial uses in Reach 83 of the LSJR. These objectives will be utilized in the future to determine whether water quality standards are being met in this water body segment.

10.3.10 Resolution No. 2005-0019: Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California

The Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (a.k.a. State Implementation Plan or SIP) applies to discharges of toxic pollutants into the inland surface waters, enclosed bays, and estuaries of California subject to regulation under the Porter-Cologne Water Quality Control Act and the Federal Clean Water Act. Regulation of priority toxic pollutants may occur through the issuance of NPDES permits. The goal of the SIP is to establish a statewide, standardized approach for permitting discharges of toxic pollutants to non-ocean surface waters.

The proposed Basin Plan Amendment addresses salt and boron, which are not priority pollutants.

10.3.11 Resolution No. 2005-0050: Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options

The State Water Board's Impaired Waters Policy incorporates the following:

- Clean Water Act section 303(d) identification of waters that do not meet applicable water quality standards and prioritization for TMDL development;
- Water Code section 13191.3(a) requirements to prepare guidelines to be used by the Regional Water Boards in listing, delisting, developing, and implementing TMDLs pursuant to Clean Water Act Section 303(d) of 33 USC Section 1313(d); and
- Water Code Section 13191.3(b) requirements that State Water Board considers consensus recommendations adopted by the 2000 Public Advisory Group when preparing guidelines.

The Impaired Waters Policy includes the following statements:

A. If the water body is neither impaired nor threatened, the appropriate regulatory response is to delist the water body.

B. If the failure to attain standards is due to the fact that the applicable standards are not appropriate due to natural conditions, an appropriate regulatory response is to correct the standards.

C. The State Water Board and Regional Water Boards are responsible for the quality of all waters of the state, irrespective of the cause of the impairment. In addition, a TMDL must be calculated for impairments caused by certain EPA designated pollutants.

D. Whether or not a TMDL calculation is required as described above, impaired waters will be corrected (and implementation plans crafted) using existing regulatory tools.

D1. If the solution to an impairment will require multiple actions of the Regional Water Board that affect multiple persons, the solution must be implemented through a Basin Plan amendment or other regulation.

D2. If the solution to an impairment can be implemented with a single vote of the Regional Water Board, it may be implemented by that vote.

D3. If a solution to an impairment is being implemented by a regulatory action of another state, regional, local, or federal agency, and the Regional Water Board finds that the solution will actually correct the impairment, the Regional Water Board may certify that the regulatory action will correct the impairment and if applicable, implement the assumptions of the TMDL, in lieu of adopting a redundant program.

D4. If a solution to an impairment is being implemented by a non-regulatory action of another entity, and the Regional Water Board finds that the solution will actually correct the impairment, the Regional Water Board may certify that the non-regulatory action will correct the impairment and if applicable, implement the assumptions of the TMDL, in lieu of adopting a redundant program."

The California 2010 303(d) Integrated report lists portions of the Lower San Joaquin River for boron, chlorpyrifos, DDE, DDT, diazinon, diuron, EC, group A pesticides, mercury, selenium, temperature, toxaphene, unknown toxicity, and alpha-BHC/alpha-HCH. Many of these constituents are already being addressed with a TMDL control program. Because these amendments anticipate a reduction of agricultural discharges, they are not expected to aggravate any impairment caused by agricultural activities.The proposed Basin Plan Amendment also does not affect the process to address impaired water bodies and develop TMDLs.

10.3.12 Resolution No. 2008-0025: Policy for Compliance Schedules in National Pollutant Discharge Elimination System Permits

The Policy authorizes the Regional Water Board to include a compliance schedule in a permit for an existing discharger to implement a new, revised, or newly interpreted water quality objective (WQO) or criterion in a water quality standard that results in a permit limitation more stringent than the limitation previously imposed.

The proposed Basin Plan Amendment does not propose EC WQOs more stringent than the effluent limits in the current NPDES permits, so no compliance schedules are expected to be required following the adotion of the proposed Basin Plan Amendment.

10.3.13 Resolution No. 2009-0011: Policy for Water Quality Control for Recycled Water

This Policy is intended to establish consistent and predictable requirements in order to increase the use of recycled water in California. This policy:

- Establishes mandates for the use of recycled water;
- Requires the development by stakeholders and the adoption by Regional Water Quality Control Boards of regional salt/nutrient management plans;
- Establishes requirements for regulating incidental runoff from landscape irrigation with recycled water;
- Establishes criteria and procedures for recycled water landscape irrigation projects eligible for streamlined permitting;

- Establishes procedures for permitting groundwater recharge projects;
- Establishes procedures for implementing the *State Antidegradation Policy* for recycled water projects;
- Requires the establishment of a scientific advisory panel to advise the State Water Board on regulation of constituents of emerging concern; and
- Establishes actions and incentives to promote the use of recycled water.

The proposed Basin Plan Amendment will not restrict the development or use of recycled water. The goal of the CV-SALTS initiative is to address salinity and nitrate concerns in a consistent and sustainable manner and portions of the comprehensive, Central Valley-wide salt and nitrate management plan developed by CV-SALTS will satisfy requirements of the Recycled Water Policy.

10.4 Consistency with Central Valley Water Board Policies

10.4.1 Urban Runoff Policy

On page IV-14.00 of the Basin Plan, the Central Valley Water Board's Urban Runoff Policy states:

> "a. Subregional municipal and industrial plans are required to assess the impact of urban runoff on receiving water quality and consider abatement measures if a problem exists.
>
> "b. Effluent limitations for storm water runoff are to be included in NPDES permits where it results in water quality problems."

Storm water dischargers to these water bodies are not required to consider abatement measures nor has there been a need to include effluent limitations for these dischargers for salinity.

10.4.2 Controllable Factors Policy

On page IV-15.00 of the Basin Plan, the Central Valley Water Board's Controllable Factors Policy states:

> "Controllable water quality factors are not allowed to cause further degradation of water quality in instances where other factors have already resulted in water quality objective being exceeded. Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of

> the State Water Board or Central Valley Water Board, and that may be reasonably controlled."

There is an expected improvement of water quality due to the proposed Basin Plan Amendment, therefore the proposed Basin Plan Amendment is consistent with the Controllable Factors Policy.

10.4.3 **Water Quality Limited Segment Policy**

On page IV-15.00 of the Basin Plan, the Central Valley Water Board's Water Quality Limited Segment Policy states:

> "Additional treatment beyond minimum federal requirements will be imposed on dischargers to Water Quality Limited Segments. Dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment."

No additional treatment controls are anticipated to meet the proposed WQOs.

10.4.4 **Antidegradation Implementation Policy**

Consistency of the proposed Basin Plan Amendment with the federal and state Antidegradation policies is discussed earlier in Section 8.1.

10.4.5 **Application of Water Quality Objectives Policy**

Excerpts from Policy for Application of Water Quality Objectives are presented below. The full text can be found on page IV-16.00 of the Basin Plan.

> " Water quality objectives are defined as 'the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water, or the prevention of nuisance within a specific area.'… Water quality objectives may be stated in either numerical or narrative form. Water quality objectives apply to all waters within a surface or ground water resource for which beneficial uses have been designated…

> " The numerical and narrative water quality objectives define the least stringent standards that the Regional Water Boards will apply to regional waters in order to protect beneficial uses."

The proposed Basin Plan Amendment establishes numeric WQOs that provide reasonable protection of beneficial uses in the LSJR.

10.4.6 **Watershed Policy**

On page IV-21.00 of the Basin Plan, the Central Valley Water Board's Watershed Policy states:

> "The Regional Water Board supports implementing a watershed based approach to addressing water quality problems. The State and Regional Water Boards are in the process of developing a proposal for integrating a watershed approach into the Board's programs. The benefits to implementing a watershed based program would include gaining participation of stakeholders and focusing efforts on the most important problems and those sources contributing most significantly to those problems.

The proposed Basin Plan Amendment was developed with the assistance of a stakeholder workgroup and is consistent with taking a watershed based approach to addressing water quality issues and concerns.

10.4.7 **Drinking Water Policy for Surface Waters of the Delta and its Upstream Tributaries**

This Policy includes a narrative WQO for *Cryptosporidium* and *Giardia*, along with implementation provisions to maintain existing conditions for public water systems. Applicable provisions from this Policy include the requirements to upstream dischargers when implementation actions are triggered by monitoring at a public water system. In addition, the Policy recommends that the Central Valley Water Board consider the necessity of including monitoring of organic carbon, salinity and nutrients when waste discharge requirements are renewed.

The proposed Basin Plan Amendment does not change the implementation of this Policy and includes salinity monitoring as part of the proposed Monitoring and Surveillance Program.

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