Public Hearing (3/20/13)
Bay-Delta Plan SED
Deadline: 3/29/13 by 12 noon

california water impact network

AQUALLIANCE
DEFENDING NORTHERN CALIFORNIA WATERS

CALIFORNIA SPORTFISHING PROTECTION ALLIANCE
CSPA
* Since 1983 *

FRIENDS OF THE RIVER

RESTORE THE DELTA
Fishable, Swimmable, Drinkable, Farmable

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March 29, 2013

Ms. Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95814-0100

Subject: Comment Letter—Bay-Delta Plan SED

Dear Ms. Townsend and the Members of the Board:

The California Water Impact Network (C-WIN)[1], California Sportfishing Protection Alliance (CSPA)[2], AquAlliance[3], Restore the Delta,[4] and Friends of the River [5] appreciate the opportunity to comment on the "Draft Substitute Environmental Document in Support of Potential Changes to the Water Quality Control Plan for the Bay-Delta: San Joaquin river flows and southern Delta water quality." This letter responds to the State Water Resources Control Board's (hereinafter "SWRCB" or "Board") December 31, 2012, Notice of Filing and of Public

[1] C-WIN is a non-profit, tax exempt California Corporation that advocates for equitable and environmentally sensitive use of California's water, including instream uses. We accomplish this mission through research, planning, public education, and litigation.

[2] The California Sportfishing Protection Alliance (CSPA) is a 501(c)(3) non-profit public benefit conservation and research organization established in 1983 for the purpose of conserving, restoring, and enhancing the state's water quality, wildlife and fishery resources and their aquatic ecosystems and associated riparian habitats. To further these goals, CSPA actively seeks federal, state, and local agency implementation of environmental regulations and statutes and routinely participates in administrative, legislative and judicial proceedings. Where necessary, CSPA directly initiates enforcement actions on behalf of itself and its members to protect public trust resources.

[3] AquAlliance exists to challenge threats to the hydrologic health of the northern Sacramento River watershed.

[4] Restore the Delta is a 10,000-member nonprofit grassroots organization committed to making the Sacramento-San Joaquin Delta fishable, swimmable, drinkable, and farmable to benefit all of California. Restore the Delta works to improve water quality so that fisheries and farming can thrive together again in the Sacramento-San Joaquin Delta.

[5] As California's statewide river conservation organization, Friends of the River's mission is to preserve, restore, and sustain California's free flowing rivers and streams. Since 1973, Friends of the River has successfully lobbied and mobilized public support for the permanent protection of more than 2,100 miles of Wild & Scenic Rivers in California.

Comment Period and Hearing on the Adequacy of the Draft Substitute Document in support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay-Sacrament/San Joaquin Delta Estuary: San Joaquin River Flows and Southern Delta Water Quality.[6] This letter also responds to the Notice of Extension of Public Comment Period, issued January 17, 2013, which extends the time period for commenting on the SED from March 5th to March 29, 2013.

C-WIN, CSPA, AquAlliance, Restore the Delta, and Friends of the River also welcome the Board's decision last fall to include in the administrative record of Phase I the workshop submissions that the Board received at the September, October, and November 2012 workshops that were convened during Phase II activities on the comprehensive review of the Bay-Delta Plan. The submitted testimony by Chris Shutes, Tom Cannon, G. Fred Lee, and Tim Stroshane representing C-WIN, CSPA and AquAlliance are also hereby incorporated by reference to our comments in this letter. We additionally incorporate by reference several previously submitted comments and correspondences from our organizations to the Board, as well as several exhibits incorporated herein.[7]

Our comment letter identifies violations of the federal Clean Water Act (hereinafter "CWA"), the Porter-Cologne Water Quality Control Act (hereinafter "Porter-Cologne"), the Delta Reform Act of 2009, the California Environmental Quality Act and the Public Trust Doctrine. Further, we observe that the State Water Resources Control Board has put forward proposed amendments to San Joaquin River flow and South Delta salinity objectives for the 2006 Water Quality Control Plan for the Bay-Delta Estuary. Under the Clean Water Act, the Board has failed to comply with requirements to protect the most sensitive beneficial uses, and with its own and federal Clean Water Act antidegradation policy for water quality. The Board has failed to formulate these amendments to the 2006 Bay-Delta Plan in such a manner that analyzes the competing demands of all beneficial uses, and instead has devised a plan that puts maintenance of yield to the water rights of the federal Central Valley Project and the State Water Project over all other beneficial uses, whether propertied or not. In essence, the Board conducted its water quality control planning for the outcome of "no net loss to exports" and ignored its responsibilities to evaluate the competing needs of all beneficial uses in the process of developing water quality objectives.

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[6] We note that it is not clear from the notice exactly where the SED has been filed; according to CEQA Guidelines it should be filed with the California Natural Resources Agency.

[7] Incorporated by reference for these comments are:

- Letter from the California Water Impact Network, California Sportfishing Protection Alliance, and AquAlliance to the Board, dated February 8, 2011 providing comments on the November 2010 San Joaquin River flow and South Delta salinity objectives request for additional information by the State Water Board.
- Letter from the California Water Impact Network, California Sportfishing Protection Alliance, and AquAlliance to the Board, dated May 23, 2011, providing comments on the scoping of the Southern Delta Ag and SJR Flow Revised NOP.
- Letter from the California Water Impact Network, California Sportfishing Protection Alliance, and AquAlliance to the Board, dated April 25, 2012, providing comments on the Bay-Delta Plan Supplemental NOP, Comprehensive Review.
- Attached appendices A, B, and C

I. Background

The SED is a substitute environmental document prepared by the State Board during a phased evaluation of the 2006 Bay-Delta Plan, with Phase I focusing on the Lower San Joaquin River flow and south Delta salinity objectives, and Phase II focusing on all other parts of the Bay-Delta Plan. The purpose of the SED is for the board to document its analysis regarding the need for, and effects of, changes to the Bay-Delta plan. The SED proposes new plan amendments to the lower San Joaquin river flow objectives, including along three salmon-bearing tributaries (the Stanislaus, Tuolumne, and Merced Rivers), during the months of February – June. The SED includes scientific information that indicates that higher flows of a more natural pattern are needed from the three eastside salmon-bearing tributaries to the Lower San Joaquin River during the spring (February–June) to protect fish and wildlife beneficial uses (including San Joaquin River Basin fall-run Chinook salmon and other important ecosystem processes). [8]

The preparation of the SED is governed by many different laws, including state CEQA guidelines, water code section 13241, the Public Resources Code (21159), Porter-Cologne, and the Clean Water Act (as it applies to water quality standards promulgated by the Board). Further, portions of water quality control plans that fall under the jurisdiction of the CWA require approval by the U.S. Environmental Protection Agency. These various laws charge the Board with, among other things, reasonably describing and analyzing potentially significant direct and indirect environmental impacts of a project; describing and analyzing reasonably foreseeable methods of compliance with the regulatory requirements of each alternative, analyzing potentially feasible mitigation measures and the economic considerations of establishing objectives in water quality control plans; and analyzing related indirect and induced impacts on the regional economy including estimating the total cost of implementing the water quality control program.

In addition to the various laws mentioned above, governments have a permanent fiduciary responsibility and obligation to protect the public trust.[9] In *National Audubon Society v. Superior Court*, the California Supreme Court held that "the public trust is more than an affirmation of state power to use public property for public purposes. It is an affirmation of the duty of the state to protect the people's common heritage of streams, lakes, marshlands and tidelands, surrendering that right of protection only in rare cases when abandonment of that right is consistent with the purposes of the trust."[10] The act of appropriating water is an acquisition of a property right from the waters of the state, an act that is therefore subject to regulation under the state's public trust responsibilities.

The Sacramento-San Joaquin Bay Delta is both a tideland and a marshland. Therefore the Board has authority to protect the Bay Delta pursuant to the public trust. As an agency of the

[8] SED, Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*

[9] Wrote Justice Racanelli in 1986: "In the new light of National Audubon, the Board unquestionably possessed legal authority under the public trust doctrine to exercise supervision over appropriators in order to protect fish and wildlife. That important role was not conditioned on a recital of authority. It exists as a matter of law."

[10] *California Supreme Court, National Audubon Society, et al., v. The Superior Court of Alpine County and Department of Water and Power of the City of Los Angeles, et al.* (1983), 33 Cal.3d 419, 441 (189 Cal.Rptr. 346, cert. denied, 464 U.S. 977).

state, the Board is charged with ensuring the state of California carries out its fiduciary responsibility to protect air, running water, the sea, and the seashore, "these things that are common to all." The board has invoked its public trust responsibilities in regulating the waters of California and acknowledges that the public trust is one of its ongoing regulatory responsibilities.[11] The Board has also adopted regulations governing how it treats the public trust in matters of the appropriation of water in California.[12] The Public Trust Doctrine provides that no one has a vested right to appropriate water in a manner harmful to the interests protected by the public trust. In accordance with this doctrine, California's constitution promises water rights only up to what is a reasonable use. No one has a right in California to use water unreasonably, not even the federal government.[13] In *United States v. State Water Resources Control Board* (1986, 182 Cal.App.3d 82) determined that the Board had the authority to modify an appropriative water right permit once it had been issued, and that it could reduce the US Bureau of Reclamation's Central Valley Project permits to gain compliance from the Bureau.

II. THE SED DOES NOT MEET THE REQUIREMENTS OF CEQA

Although the SED is, by definition, a supplemental environmental document, the Board must comply with the requirements of the California Environmental Quality Act when adopting water quality control plans. Under CEQA, a "project" to be analyzed is defined as "whole of an action" that would cause direct or reasonably foreseeable indirect physical environmental changes.[14] CEQA defines a "project" as plans or programs in which multiple actions are coordinated or facilitated within a framework of policies that govern the sequence or series of those actions. In performing CEQA analysis of a plan or program, then, agencies are prohibited from "piecemealing" or "segmenting" a project by splitting it into two or more segments.[15] CEQA prohibits piecemealing because to segment a project can submerge the cumulative impact of individual environmental impacts. In *Laurel Heights Improvement Association v. Regents of the University of California,* (1988) 47 Cal. 3d 376, 396 the court declared that environmental reviews must "include an analysis of the environmental effects of future expansion or other action if: (1) it is a reasonably foreseeable consequence of the initial project; and (2) future expansion or action will be significant in that it will likely change the scope or nature of the initial project or its environmental effects."

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[11] State Water Resources Control Board, *Mono Lake Basin Water Right Decision 1631: Decision and Order Amending Water Right Licenses to Establish Fishery Protection Flows in Streams Tributary to Mono Lake and to Protect Public Trust Resources at Mono Lake and in the Mono Lake Basin*, September 28, 1994.

[12] State Water Resources Control Board, California Code of Regulations, Title 23 Waters, Division 3 State Water Resources Control Board and Regional Water Quality Control Boards, January 2011.

[13] California Constitution, Article X, Section 2.

[14] CEQA Guidelines, §15378.

[15] *Burbank-Glendale-Pasadena Airport Authority v. Hensler* (2d Dist. 1991) 233 Cal. App. 3d 577, 592 [284 Cal Rptr. 498] ("This approach ensures 'that environmental considerations not become submerged by chopping a large project into many little ones, each with a potential impact on the environment, which cumulatively may have disastrous consequences."

A. THE SED FAILS TO CONSIDER THE WHOLE OF THE ACTION IN THE SACRAMENTO-SAN JOAQUIN BAY DELTA

In preparation of the SED, the Board has segmented review of the San Joaquin River flow and South Delta salinity objectives from the rest of its activities updating the 2006 Bay Delta Water Quality Control Plan. Specifically, the Board refers in descriptions of its planning process to Phase I being the revision of the flow and salinity objectives, while Phase II is the "comprehensive review" of the 2006 Bay-Delta Plan. The Board has also issued two separate notices of preparation (NOPs) for each segment of its planning process.[16]

In February of 2009, the Board issues a "Notice of Preparation" (hereinafter "NOP") entitled "Update and Implementation of the Water Quality Control Plan for the San Francisco Bay / Sacramento-San Joaquin Delta Estuary." The project purported to analyze "the Bay-Delta watershed and its upstream tributaries and any reservoirs for which water may be used to meet the water quality objectives, including upstream reservoirs and San Luis Reservoir." The area of potential environmental effects encompassed most of the State, including the Bay-Delta watershed, the Trinity River watershed from which water is imported to the Bay-Delta watershed, and areas receiving water exported from the Bay-Delta watershed.[17]

In November of 2009, the State Legislature passed Water Code § 85086 as part of the Delta Reform Act of 2009, which required the Board to develop new flow criteria to protect the public trust.[18] Following extensive testimony, the Board drafted the 2010 Delta Flow Criteria Report, which acknowledged that determining flow criteria for the protection of public trust resources is necessary to "inform planning decisions for the Bay Delta Plan."[19] The report

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[16] State Water Resources Control Board, *Notice of Preparation and of Scoping Meeting for Environmental Documentation for the Update and Implementation of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: Southern Delta Salinity and San Joaquin River Flows*, February 13, 2009, p. 2

> The State Water Resources Control Board…will be the lead agency and will prepare environmental documentation for the potential update and changes to implementation of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary… The proposed Project includes both: 1) the review and update of water quality objectives, including flow objectives, and the program of implementation in the Bay-Delta Plan; and 2) changes to water rights and water quality regulation consistent with the program of implementation. Accordingly, the environmental documentation will identify and evaluate the significant environmental impacts associated with potential changes to the Bay-Delta Plan and potential changes to water rights and other measures implementing the plan that may be needed to ensure the reasonable protection of beneficial uses in the Bay-Delta watershed.

[17] Id.., p. 3.

[18] Water Code § 85086, "For the purpose of informing planning decisions for the Delta Plan and the Bay Delta Conservation Plan [BDCP], the board shall, pursuant to its public trust obligations, develop new flow criteria for the Delta ecosystem necessary to protect public trust resources. In carrying out this section, the board shall review existing water quality objectives and use the best available scientific information. The flow criteria for the Delta ecosystem shall include the volume, quality, and timing of water necessary for the Delta ecosystem under different conditions. The flow criteria shall be developed in a public process by the board within nine months of the enactment of this division. The public process shall be in the form of an informational proceeding...and shall provide an opportunity for all interested persons to participate. The flow criteria shall not be considered predecisional with regard to any subsequent board consideration of a permit, including any permit in connection with a final BDCP."

[19] State Water Resources Control Board, *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem, Prepared pursuant to the Sacramento-San Joaquin Delta Reform Act of 2009,* Resolution No. 2010-0039 (hereafter cited as "2010 Delta Flow Criteria Report.")

identified several flow criteria for the Sacramento and San Joaquin Rivers, as well as for Delta outflow. The report represents a comprehensive review of water quality objectives, a clear list of "species of importance" and their relevant life stages, an analysis of both beneficial uses and water quality objectives, and an analysis of the times in which water is most important to the health of individual species of fish. [20]

Eight months after publishing the 2010 report, in April of 2011, the Board issued a second NOP on the project entitled "Update to the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: Water Quality Objectives for the Protection of Southern Delta Agricultural Beneficial Uses; San Joaquin River Flow Objectives for the Protection of Fish and Wildlife Beneficial Uses; and the Program of Implementation for Those Objectives." However, in this second notice, the Board dramatically limited the scope of review of the project to only two project areas: the South Delta, which encompasses both the service area of the South Delta Water Agency and the State and Federal export pumps, and the major tributaries of the lower San Joaquin River (the Merced, Tuolumne, and Stanislaus rivers), together with the lower San Joaquin River itself. [21] The purpose of the review was limited to evaluation of southern Delta salinity and San Joaquin River flow objectives and their implementation through the Bay-Delta Plan under CEQA. [22]

In January 2012, the Board issued a third NOP for the Bay-Delta Plan's Comprehensive Review, addressing all other elements of the Bay-Delta Plan and or potential changes to protect beneficial uses in the Bay-Delta *other than* San Joaquin river flows or South Delta salinity objectives.[23] In essence, what started in 2009 as a Board analysis of a "whole action" affecting the San Francisco/Sacramento-San Joaquin Bay Delta Estuary had become bifurcated by 2011. The segregation of the Sacramento river from the San Joaquin river is a complete departure from how the Board has historically analyzed Sacramento and San Joaquin River water quality objectives. Dating back to at least 1978, the Board has always reviewed the Sacramento River and San Joaquin River water quality objectives in a unified way, as essential elements in the "whole of an action" undertaken as development of the Bay-Delta water quality control plan.[24] As recently as 2010, the Board considered the two river basins simultaneously.[25] Further, consideration of Delta hydrodynamics is illogical without considering the Sacramento and San

[20] 2010 Delta Flow Criteria Report, Table 2, p. 45-46.

[21] State Water Resources Control Board, *Revised Notice of Preparation and Notice of Additional Scoping Meeting*, 1 April 2011.

[22] Id.., p. 3 ("[the Board] is not currently considering any other changes to the Bay-Delta Plan or any specific changes to water rights and other requirements implementing the Bay-Delta Plan.")

[23] State Water Resources Control Board, *Supplemental Notice of Preparation and Notice of Scoping Meeting for Environmental Documentation for the Update and Implementation of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: Comprehensive Review,* January 24, 2012 ("The State Water Board is not soliciting information regarding these [the San Joaquin River flow and South Delta salinity objective] potential amendments and related SED at this time.")

[24] See State Water Resources Control Board, *Water Quality Control Plan, Sacramento-San Joaquin Delta and Suisun Marsh,* August 1978,Table VI-1, p. VI-29; *Water Quality Control Plan for Salinity, San Francisco Bay/Sacramento-San Joaquin Delta Estuary,* 91-15WR, May 1991, Table 1-1; *Water Quality Control Plan for Salinity, San Francisco Bay/Sacramento-San Joaquin Delta Estuary,* 95-1WR, May 1995, Table 1; and *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary,* December 13, 2006, Tables 1 through 3.

[25] See generally the 2010 Delta Flow Criteria Report

Joaquin rivers simultaneously. First, the hydrodynamics of the Delta are not readily segmented because the Sacramento and San Joaquin River inflows meet in the central and south Delta river channels and are intermingled with tidal flows coming east from the Carquinez Strait and Suisun Bay. Second, when considering water quality, inflows from the San Joaquin River must be analyzed because of their potential effect on waters reaching the central Delta and Old River channels from which state and federal project pumps near Tracy draw water for exports. Third, the Sacramento and San Joaquin River inflows jointly govern the timing and magnitude of salmon recruitment from the ocean and salmon smolt outmigration, as well as the degree to which conditions in the Bay Delta estuary provide habitat for salmon, steelhead, and resident and migratory species like longfin smelt, Delta smelt, and striped bass.

1. THE SED FAILS TO CONSIDER THE EFFECTS OF SALINITY LOADS COMING IN FROM THE WEST SIDE OF THE SAN JOAQUIN VALLEY

The Central Valley Regional Water Quality Control Board has acknowledged that salinity impairments of the state's water bodies are occurring with greater frequency and magnitude. Such impairments in the past have led to the fall of civilizations. Additional salts not discussed in the SED are imported to the San Joaquin River Basin as a result of mixing with salty tidal flows with water in the western Delta before being exported by large pumps located near Tracy. These saltier supplies arrive in the western San Joaquin Valley via the Delta Mendota Canal. The Central Valley Regional Water Quality Control Board estimates that the Delta Mendota Canal imports about 900,000 to 1 million tons of salt each year into the San Joaquin River Basin while the San Joaquin River returns about 922,000 tons of salt to the Delta annually.[26] The conveyance of water through the Delta Mendota Canal is made possible by Board-issued water rights permits to the US Bureau of Reclamation to operate the Central Valley Project and by the Exchange Contract by which senior San Joaquin River water rights holders "exchange" their upper San Joaquin River water rights for imported Sacramento River water delivered to them via the Delta Mendota Canal.

The "Exchange Contract" for this imported water recognized from the outset that salinity in the imported water would be greater than salts naturally occurring in San Joaquin River water. The original Exchange Contract stated that it should not exceed a five-year mean salt concentration of 400 parts per million (see Table A-1 in Appendix 1). Thus, planned importation of water into the San Joaquin River Basin allows as much as a nine-fold increase in salt concentration in water applied to western San Joaquin Valley lands. This is the direct water quality impact of the exchange arrangement at the heart of the creation of the Central Valley Project's Friant Division, the Delta Mendota Canal, and the Jones Pumping Plant. Large amounts of imported water bring large loads of salt to the Basin as well. By piecemealing the project into a multi-part analysis of the Bay-Delta, the Board fails to fully disclose and analyze how salts from the western San Joaquin valley contribute to the salinity loads entering the lower San Joaquin River.

[26] California Regional Water Quality Control Board 2006: Tables 2 through 5

B. THE SED FAILS TO ESTABLISH AN ACCURATE BASELINE FOR THE PROJECT

The baseline environmental setting of the SED does not accurately describe the environmental degradation of the Bay-Delta estuary. An "environmental setting," is defined as "the physical environmental conditions in the vicinity of the project."[27] CEQA Guidelines provide that the existing physical conditions in the vicinity of the project "will normally constitute the baseline physical conditions by which a Lead Agency determines whether an impact is significant."

The SED's analysis of the environmental conditions in the vicinity of the project fails because the SED bifurcates the Lower San Joaquin River and south Delta salinity standards from the Sacramento River, the Delta, and the associated and inseparable hydrodynamic effects on fish and wildlife. It significantly impairs reasonable analysis of the physical conditions within the vicinity of the project when the scope of the project limits analysis of a water system to only one small piece. Second, the SED does not describe existing physical conditions in the vicinity of the project. While the SED acknowledges that the environmental baseline does not reflect full compliance with existing water quality standards, it does not adequately explore how non-compliance has affected fish and wildlife in the area. In describing the "no project alternative," the Board notes that for purposes of a no project analysis, the assumption is that Lower San Joaquin River flows and southern Delta water quality standards would be fully implemented in accordance with the 2006 Bay-Delta Plan flow and salinity objectives. However, the Board fails to mention that since 2000, DWR and USBR have routinely failed to ensure compliance with their permit/license conditions of southern Delta EC objectives."[28] In 2005, after years of non-compliance with the southern Delta salinity objectives, the Board issued a cease and desist order against DWR and USBR for failure to meet the objectives.[29] Specifically considering that the "objectives were first adopted in the water quality control plan in 1978, and there is evidence that salinity is a factor in limiting crop yields for southern Delta agriculture" the Board declared that it would not extend the deadline to meet the objectives beyond July 1, 2009.[30] However, in 2009, the Board rejected its earlier decision and modified the cease and desist order, eliminating the requirement that DWR and USBR comply with the southern Delta salinity standards until an unnamed date in the future.

The SED, however, makes little mention of this routine non-compliance with the salinity standards in the southern Delta, and describes a "no project alternative" as the "*continuation*" of, and full compliance with, the San Joaquin River flow objectives and the southern Delta salinity objectives identified in D-1641.[31] These omissions are a critical flaw in the description and analysis of baseline conditions, since the public may erroneously believe that current water quality and flow objectives are being met. The SED authors did not follow the relevant professional standards for the types of evaluations they conducted. For example, failure to apply

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[27] Cal. Code Regs., tit. 14, § 15125, subd. (a)
[28] WR 2006-0006, Section 4.0, pg. 20
[29] See generally WR 2006-0006
[30] WR 2006-0006, Section 6.0, pg. 27
[31] SED, Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, pg. 8

professional standards when defining the geographic scope of the analysis and failing to address risk and uncertainty, individually, and collectively, render the results fatally flawed.

C. THE SED FAILS TO ANALYZE REASONABLE ALTERNATIVES FOR FLOW OBJECTIVES AND CHOOSES FLOW OBJECTIVES THAT WILL NOT BE PROTECTIVE OF FISH AND WILDLIFE

Previously established water quality and flow objectives have proven inadequate to protect fish and wildlife in the Delta. [32] In 2010 the Board drafted a report entitled *Development of Flow Criteria for the Sacramento –San Joaquin Delta Ecosystem* (hereinafter "Delta Flow Criteria Report" or "2010 Report") in order to develop new flow criteria for the Delta ecosystem necessary to protect public trust resources. The flow criteria developed in the 2010 report were intended to halt population decline and increase populations of certain species and represented the best available fishery and hydrologic science to be had in 2010. Nearly all of the scientists who participated in development of the report agreed that mimicking the natural hydrograph is necessary to improve conditions for native fish species, and to counter invasive species in the Delta. As required by the State Legislature, the Board report included the volume, quality and timing of water necessary for the health of the Delta ecosystem. [33] The report identifies the following criteria for Delta health:

1. 75 percent of unimpaired Delta outflow from January through June;
2. 75 percent of unimpaired Sacramento River inflow from November through June to protect numerous runs of migratory salmon that use the Sacramento River Basin;
3. 60 percent of unimpaired San Joaquin River inflow from February through June to protect juvenile Chinook salmon during their peak emigration period;
4. Increased fall Delta outflow in wet and above normal years;
5. Fall pulse flows on the Sacramento and San Joaquin Rivers to stimulate migrating fish;
6. Flow criteria in the Delta interior to help protect fish from mortality in the central and southern Delta caused by operations of the state and federal water export pumps;
7. 60 percent of 14-day average unimpaired flow at Vernalis;
8. 10-day minimum pulse flow of 3,600 cubic feet per second in late October (e.g., October 15 to 26) at Vernalis;
9. Application of the 2006 Bay-Delta Plan's October flows at Vernalis.[34]

The Board determined that, if these criteria were followed, public trust resources could be protected on the San Joaquin River and throughout the Delta. The basis for these determinations

[32] Id., pgs. 41-98
[33] Water Code § 85086(c).
[34] 2010 Delta Flow Criteria Report, pp. 114-123.

rested on the Board's findings that they would (1) increase juvenile Chinook salmon outmigration survival and abundance and provide conditions that would improve population growth and achieve a doubling of the current salmon population (salmon doubling requirements contained in Section 6900 et seq. of the California Fish and Wildlife Code) and Section 3406 of the CVPIA in more than half of all years; (2) provide flows for adult Chinook salmon that would decrease straying, increase dissolved oxygen concentrations in the San Joaquin River mainstem through the Stockton Deep Water Ship Channel, reduce water temperatures, and improve olfactory homing fidelity; and (3) provide adult Chinook salmon attraction flows.[35] Although the Board qualified its 2010 flow criteria for the San Joaquin River by stating that "these flow criteria do not consider any balancing of public trust resource protection with public interest needs for water," the Board indicates that salmon are the most sensitive species for which it developed public trust-protective flow criteria, as all three of its San Joaquin River inflow criteria directly relate to the sensitivities of salmon populations to changes in and timing of flow through the Bay-Delta Estuary. And yet, despite the extensive background and recent flow recommendations to protect fish and wildlife, the SED largely dismisses the 2010 report and proposes flow objectives for the lower San Joaquin River that are not protective of fish and wildlife.

In the Delta Flow Criteria Report, the Board acknowledges that altering the flows in the lower San Joaquin River to create a more natural flow regime is anticipated to improve a number of ecosystem attributes such as (but not limited to): 1) native fish communities; 2) food web; 3) habitat; 4) geomorphic processes; 5) temperature; and 6) water quality.[36] Major researchers involved in developing ecologically protective flow prescriptions concur that mimicking the unimpaired hydrographic conditions of a river is essential to protecting populations of native aquatic species and promoting natural ecological functions.[37] [38] The San Joaquin River Basin's hydrology has been dramatically altered by water development over the period 1984-2009. In comparing unimpaired with observed (measured) flow conditions for the Basin's rivers, unimpaired flow conditions have been greatly reduced on the major tributaries by water project operations.[39] Annual water flow volumes at Vernalis have reduced over their natural volumes, to 46% of unimpaired flow, while the February through June flow volume have been reduced to a median of 27% of unimpaired.[40] Estimates of flows needed to double salmon production range from 51% to 97% of unimpaired flow; with a greater percentage of unimpaired flow needed in drier years than wet years.[41] And yet, despite the resounding scientific support for using a river's unaltered hydrographic conditions as a foundation for determining ecosystem flow requirements, the SED's proposed flow objectives will do little to improve the conditions for native fish and species.

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[35] 2010 Delta Flow Criteria Report, p. 133, Table 22.
[36] Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, 3-41
[37] Id.
[38] Id.
[39] On the Stanislaus river, actual median flow has fallen relative to unimpaired flows by about 53 percent; on the Tuolumne river, by 74 percent; on the Merced river by 62 percent; and on the Upper San Joaquin River (above the Merced River confluence) by 90 percent.
[40] Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, 3-41
[41] Id. at 3-54

The 2013 SED therefore analyzes four alternatives for flow objectives on the lower San Joaquin River: (1) a no project alternative, (2) 20 percent unimpaired flow, (3) a 40 percent unimpaired flow, and (4) a 60 percent unimpaired flow. The SED describes all the alternatives as "generally consistent with an approach that mimics the natural flow regime to which these fish were adapted."[42] To assess whether it would be possible for the specific flow recommendation that the Board received, the SED compared the flow exceedance curves for the Lower San Joaquin river alternatives 2, 3, and 4 with the different commenters' recommended flow schedules as follows:

1. Contra Costa County Department of Conservation and Development – recommended flow greater than alternative 2;
2. CA Dept. of Fish and Game - recommended flow greater than alternative 2;
3. CWIN/CSPA - recommended flow greater than alternative 2;
4. Bay Institute/National Resource Defense Council - recommended flow greater than alternative 2;
5. American Rivers/Natural Heritage Institute - recommended flow greater than alternative 2;
6. US Dept. of Interior - recommended flow lower than alternative 2;
7. Delta Solution Group - recommended flow greater than alternative 2. [43]

In the Board's 2010 report, *Development of Flow Criteria for the Sacramento –San Joaquin Delta Ecosystem*, the Board determined that approximately 60 percent of unimpaired flow at Vernalis February–June would be fully protective of fish and wildlife beneficial uses in the three eastside tributaries and Lower San Joaquin River when considering flow alone. However, the SED concludes that "the State has determined that 35% of unimpaired flow is required from February through June from each of the Merced, Tuolumne, and Stanislaus Rivers on a 14-day running average, unless otherwise approved by the State Water Board through the adaptive management framework described below." The Board utterly fails to provide a reasoned analysis to justify the reduction in flow for the San Joaquin at Vernalis from the 60 % of unimpaired flow recommended in 2010 to 35 % recommended in the SED. Ambiguities and a lack of crucial information prevent readers of the Draft SED from testing whether the proposed Project and its alternatives can attain the outcomes alleged for them. This 35 % of unimpaired flow objective is not even stated in the amended Table 3 objective in Appendix K of the SED. The Board indicates only that the proposed objective is solely to "maintain flow conditions from the San Joaquin River watershed to the Delta at Vernalis."[44] The Board even fails to state whether or not it used a method to balance the public trust resources, let alone explain what that method was. The Board's proposed water quality objective to govern San Joaquin River flow for fish and wildlife beneficial uses requires only a narrative "value" from February through June in all water years.[45] It proposes to "maintain flow conditions from the San Joaquin River Watershed to the Delta at Vernalis...sufficient to support and maintain the natural production of viable

[42] Id.
[43] SED, Chapter 3, *Alternatives Description* , 3-10
[44] See generally SED, Appendix K, *Revised Water Quality Control Plan*
[45] SED, Appendix K, *Revised Water Quality Control Plan*, pg.1

native San Joaquin River watershed fish populations." No concrete recommendations are given for volume, quality and timing of water necessary to support fish and wildlife, other than to say that the relative magnitude, duration, timing and spatial extent of flows should be correspond to naturally occurring water flows. Under the SED's proposed 35% unimpaired flow, the proposed San Joaquin River flow objectives will be essentially the same as existing flow conditions for the San Joaquin River at Vernalis more than 60% of the time. Therefore, the increase from the current 30% unimpaired flow to the proposed 35% unimpaired flow will result in no net gain of water a majority of the time. The Board seemingly recognizes this, but dismisses it as not significant:

> [T]he time the alternatives are not satisfying the recommendations is offset by the time the alternatives exceed the recommendations. The LSJR alternatives may not satisfy each of the flow recommendations all the time, but the flow schedule-based recommendations are satisfied the majority of the time. Further, adaptive management of flows could increase the amount of time that the flow recommendations are achieved if information indicates that achieving these schedules is more protective of fish and wildlife.[46]

If storage dams on the Stanislaus, Tuolumne, and Merced rivers released 60% of daily unimpaired inflows, calculated on a short-term running average during the months of January through June, the resulting flow-release pattern would closely replicate the natural daily unimpaired flow pattern of each river.[47] In addition, if there was a year-round minimum flow objective of 2000 cfs implemented at Vernalis, it would ensure that at least 1000 cfs passes through the Stockton Deep-water Channel to maintain the dissolved oxygen standard.[48] Further, if the 60% unimpaired flow objective was implemented each January through June for each tributary, flow pulses would more closely match the natural hydrology of each tributary and could easily be synchronized to maximize the overall pulse in the San Joaquin River.[49]

Winter flow pulses provide the natural high-turbidity, high-velocity environment for newly hatched salmon fry to migrate to the Bay-Delta estuary.[50] The Board has recognized that Central Valley fall-run and spring-run Chinook salmon that fry rearing in tidal estuaries including the Bay-Delta is an important life history strategy essential to population production and viability.[51] Therefore, it is important to provide winter (and early spring) pulses and manage Delta operations to create maximum opportunity for fry to reach Suisun Bay. Winter pulses also provide the attraction flows for adult steelhead, and will attract spring Chinook salmon to the Upper San Joaquin River.[52] Further, spring flow pulses are critical for the growth of juvenile

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[46] Id. at 3-23

[47] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg. 4

[48] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg.4

[49] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg. 5

[50] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg. 6

[51] (Appendix C, SWRCB 2012).

[52] Id.

salmon and steelhead rearing in the rivers and for providing enhanced opportunities for juvenile salmon to migrate downstream to and through the Delta to the Bay.[53] These pulses would aid salmon and steelhead passing through the Bay-Delta to reach the ocean.[54] Higher San Joaquin Delta inflow, if allowed to reach the Central and Western Delta as well as Suisun Bay, will also benefit the Bay-Delta ecological food chain by providing more physical space, better water temperatures, protection from predators, and greater food production and availability and sustain conditions for migrating and rearing fishes throughout the system.[55] Spring flow improvements will also enhance spawning, rearing, and migrating conditions for splittail, striped bass, sturgeon, and other fishes, as well as improve water quality of the three tributaries, lower San Joaquin, and the Delta.

Yet, in spite of the many benefits of a 60% unimpaired flow, the Board only recommends a five percent increase in unimpaired flows, meaning the current, poor flow conditions in the Delta will remain during critical time periods for sensitive fish and wildlife. Not only has the Board failed to properly analyze whether its proposed flow objectives will improve the chances of migratory salmon in the San Joaquin River basin, it has failed to undertake and complete the same analysis with respect to estuarine habitat and listed pelagic resident species like longfin smelt and Delta smelt. In effect, the State Water Board has treated the San Joaquin River upstream of Vernalis as an isolated river. It is silent about the fate of fish populations beyond Vernalis that migrate to and through the Delta, and it accomplishes little to increase aquatic life conditions in the San Joaquin River if out-migrating salmon cannot reach Chips Island and the sea. Particle tracking, EC tracking and fish tagging studies all demonstrate that San Joaquin River water and salmon smolts are drawn to the state and federal project pumps. The number of smolts surviving to Chipps Island is in the single digits. There is no equivalent information on fry. The San Joaquin River must be connected to the Bay.

Further, the Board anticipates "no significant or substantial reductions to average annual Delta exports," and little effect on net Delta outflows or the position of X2 for all of the Lower San Joaquin River alternatives.[56] [57] These findings directly contradict the public trust flow requirements that the Board determined were necessary to protect public trust resources in the Bay-Delta Estuary.[58] It is essential that the inadequate fish export facilities in the South Delta be addressed. Even if the Bay-Delta Conservation Plan (BDCP) is ultimately adopted, 50-84% of exports will still come from existing South Delta diversion facilities. BDCP modeling, in the 2012 Effects Analysis on entrainment concludes that South Delta salvage could actually increase for juvenile steelhead (dry & critical years), juvenile Spring-run (above normal & below normal), Fall-run (juvenile in below normal & dry; smolts in all years) and juvenile splittail (all years). Between 2000 and 2011, more than 130 million fish have been salvaged at the South Delta facilities; plus an uncounted number of salmon fry. However, more than a billion fish

[53] Id.
[54] Id.
[55] Id.
[56] SED, p. 5-3, discussion of Impact WS-1 in Table 5-1.
[57] SED, p. 7-8, discussion of Impact AQUA-13 in Table 7-1.
[58] State Water Resources Control Board, *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem, Prepared Pursuant to the Sacramento-San Joaquin Delta Reform Act of 2009,* August 3, 2010, approved in Resolution No. 2010-0039. ("In accordance with the Delta Reform Act, the State Water Board approves the report determining new flow criteria for the Delta ecosystem that are necessary to protect public trust resources…")

additional fish have been lost during this period. For every 100 salmon entering Clifton Court Forebay, only 6 or 7 ultimately survive. Of course, the losses of eggs and larval stages of pelagic species are 100% and Delta smelt losses approach 100%. It is long past time for the Board to require export agencies to replace the 1950 technology screens.

Existing federal and state law at Section 6900 et seq. of the California Fish and Wildlife Code and Section 3406 of the CVPIA requires the doubling of the natural production of Chinook salmon, from the 1967-1991 average. Yet the SED proposes a narrative objective for salmon that is significantly weaker than the existing objective. The current doubling objective is replaced with a vague requirement to simply provide flows that "reasonably" contribute to maintaining a "viable" population of salmon. Doubling from the 1957-1991 average is a quantifiable standard. "Viable" and "reasonable" are subject to differing interpretations are not quantifiable standards. The proposed objective is also significantly weaker than the 1995 USEPA promulgated salmon migration objective at 40 CFR 131.37. The federal numerical objective is designed to achieve the AFRP doubling goal and establishes a smolt survival index based upon the survival of migrating salmon reaching Chipps Island. Compliance is to be measured by annual fish tag monitoring. While the State Board has long ignored the federal standard, it remains federal law.[59] The SED's failure to acknowledge the elimination of the salmon doubling objective in the present Bay-Delta Water Quality Control Plan coupled with the failure to acknowledge, analyze and discuss the present federal regulations at 40 CFR 131.37 violates basic public disclosure and analytical requirements of CEQA. The SED authors have completely failed to undertake a full comprehensive review of all water quality objectives of the Bay-Delta water quality control plan. More importantly, the Board seemingly dismisses many of the conclusions garnered by the 2010 Delta report. In that report, the Board determined the "species of importance" of the estuary, their relevant life stages, an analysis of both beneficial uses and water quality objectives, and an analysis of times in which water is most important to fish health. [60] Relevant to revising the San Joaquin River flow objectives, the 2010 report noted that:

1. San Joaquin River Chinook salmon smolts outmigrate between March and June;
2. San Joaquin River Chinook salmon eggs and fry are vulnerable to temperature, dissolved oxygen conditions, and barrier predation between October and March;
3. Longfin smelt eggs need fresh to brackish water habitat between December and April;
4. Longfin smelt larvae need fresh to brackish water habitat between December and May;
5. Delta smelt larvae and pre-adults need flows for transport and habitat needs between March and November.[61]

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[59] Revised D-1641 failed to incorporate the narrative salmon doubling requirements contained in the 1995 and 2006 Water Quality Control Plan and that there are no equivalent state standards in place to protect the striped bass and splittail spawning and migration beneficial uses in the San Joaquin River comparable to those presently contained in 40 CFR 131.37.

[60] 2010 Delta Flow Criteria Report, Table 2, p. 45-46.

[61] Id.

In disregarding this information, the SED authors justify flow levels that neither protect fish and wildlife beneficial uses in the river nor in the Delta. Instead, the SED authors propose San Joaquin River flow objectives at a percentage of unimpaired flow that maintains or closely approximates the status quo of actual flows in the river. The Board provides no analysis to demonstrate that the Board has balanced the public trust and beneficial uses to arrive at its flow proposal, the Board does little more than advance a flow objective that more easily facilitates water transfers to state and federal water projects to the South.

Appendix K of the SED defines compliance in such a way that flows can be as low as 25% and no more than 45% of February through June unimpaired. A median 35 % of unimpaired flow in February through June will not provide flow magnitudes for productive juvenile rearing habitat or protective emigration habitat in the tributaries, in the San Joaquin, and in the Delta.[62] It will not provide sufficient base flow, flow peaks, or variability to create the benefits that that emulating the natural hydrograph is designed to create. The use of a 14-day running average will further reduce the benefits of a percent-of unimpaired methodology. The flow caps for percent-of-unimpaired diminish the benefits yet again, almost totally limiting floodplain inundation to flood releases. Appendix K of the SED does not define how flow magnitudes and durations will be determined within the effective 25% to 45% water budget, and relies on the creation of an "Implementation Workgroup" and a "Coordinated Operations Group" to determine how those factors will be analyzed and implemented. As described in the SED, adaptive management will be accomplished through the creation of a Coordinated Operations Group (COG) comprised of the Department of Fish and Game, National Marine Fisheries Service and U.S. Fish and Wildlife Service plus representatives of water users on the affected rivers and other representatives deemed appropriate by the State Board's Executive Director. The COG will develop a proposed adaptive management plan for approval by the Executive Director or, depending upon subsequently developed information, the COG may dispense with the unimpaired flow percentage method and, instead, use other management approaches as long as the total quantity of water provided over the entire February through June period is between 25% and 45% of unimpaired flow.

One of the myriad of problems with adaptive management practices are that they are especially vulnerable to funding and political pressure. The SED's failure to identify the specific components and measures of the adaptive management process deprives the public of necessary information upon which to base an opinion of the sufficiency or likely success of implementation and violates the most basic public disclosure, analytical and mitigation requirements of CEQA. The federal Clean Water Act and state Porter-Cologne Act include a built-in mechanism, the triennial or periodic review, for revising water quality regulatory provisions to respond to new scientific information. Although these provisions enable "adaptive management" generally, the EPA supports the idea of the Board's adoption of more explicit scientific experiments in the

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[62] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg. 20

regulatory process.[63] These experiments would need to be scientifically constructed and not likely to adversely affect the aquatic resources being targeted for protection.

Unless specific goals, quantitative objectives, performance measures, milestones and consequences are defined, adaptive management will fail to protect or restore San Joaquin River fisheries. Without public scrutiny, accountability or subsequent environmental analysis, the COG will be able to reduce flows and reservoir storage operations to levels which would likely result in significant and unavoidable impacts that are undisclosed and go unanalyzed in the SED. Only by adopting its public trust Delta inflow and outflow determinations as flow objectives in the Bay-Delta Plan for each major tributary, and applying water rights priorities in that order, can the Board clearly define beneficial and reasonable uses and make appropriate water quality objectives in practical and legally compliant terms. The CWA requires that the protections adopted must be for those beneficial uses that are the most sensitive to impairment from whatever cause. The state's water quality control planning obligations must carry out this responsibility.

D. THE SED FAILS TO ANALYZE REASONABLE ALTERNATIVES FOR SALINITY OBJECTIVES AND CHOOSES SALINITY OBJECTIVES THAT ARE NOT PROTECTIVE OF AGRICULTURE AND FISH AND WILDLIFE

Since 1978, the Board's South Delta salinity objectives regulate salinity concentrations at Vernalis on the lower San Joaquin River and at the interior South Delta monitoring stations at Tracy Boulevard Bridge at Old River, Old River near Middle River, and Brandt Bridge on the San Joaquin River (downstream of the head of Old River). These interior South Delta objectives currently range from 0.7 Electrical Conductivity (EC) during the irrigation season (April 1 through August 31) to 1.0 EC from September 1 through March 31. These objectives have gone unchanged for 35 years. In Water Rights Decision D-1641 (2000) the Board recognized that "the total acreage of lands impacted by rising water tables and increasing salinity is approximately 1 million acres," and the major source of salinity in the San Joaquin River to the South Delta was a result of agricultural drainage generated by lands of the western San Joaquin valley which were irrigated with water exported from the Delta. [64] The Board therefore vested the responsibility for meeting the objectives with the Department of Water Resources and the US Bureau of Reclamation.

In 2011, the most comprehensive study of salinity impacts to Delta agriculture was conducted for the Delta Protection Commission's Economic Sustainability Plan (ESP).[65] The ESP econometric model controlled for a variety of physical (e.g., elevation, soil type,

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[63] December 11, 2012 Environmental Protection Agency, Region IX letter to Thomas Howard, Executive Director of the State Water Resources Control Board, *Re: the Comprehensive Review of the Bay-Delta Water Quality Control Plan*, pg. 3.

[64] State Water Resources Control Board 2000: 82

[65] *Economic Sustainability Plan for the Sacramento-San Joaquin Delta,* chapter 7, Agriculture. The choice of irrigation technologies in California. *American Journal of Agricultural Economics* 67: 224-34; Wu, J. and B. A. Babcock. 1998. The choice of tillage, rotation, and soil testing practices: Economic and environmental implications. *American Journal of Agricultural Economics* 80: 494-511; Wu, J., R.M. Adams, C.L. Kling, and K. Tanaka. 2004. From micro-level decisions to landscape changes: An assessment of agricultural conservation policies. *American Journal of Agricultural Economics* 86: 26-41.

temperature, field size, irrigation water salinity) and market variables (e.g., prices) that impact crop choices. The results showed that the salinity of irrigation water had a large and significant effect on planting decisions in the Delta. The ESP model predicts that the degradation in water quality from moving the standard from 0.7 dS/m to 1.0 dS/m could result in agricultural revenue losses of up to $40 million per year in the South Delta. Not incidental, the loss in revenue from this model is due solely to a shift towards lower-value, more salt-tolerant crops and does not include any loss from lower yields.[66] An independent panel of experts for the Delta Science Program reviewed the ESP and praised the agricultural economics work in the ESP as, "well drafted and used appropriate techniques." Regarding the model for measuring salinity impacts, the reviews commented, "We commend the authors for using this approach," and that it was "state of the art."[67] Finally, the California Department of Water Resources chose the ESP model of salinity impacts on Delta agriculture for their analyses of the Bay Delta Conservation Plan.[68] The DWR's adoption of the ESP model shows that DWR recognizes that the ESP model represents the best available science on salinity impacts on Delta agriculture.

Despite the existence of such a thorough and recent study of salinity impacts to Delta agriculture, the SED authors failed to mention it in their analysis of Delta salinity objectives. Further, the SED authors propose objectives that degrade current salinity objectives in the South Delta. The SED analyzes three alternatives for salinity standards: (1) a no project alternative (in which the Board assumes full compliance with all flow and water quality objectives set forth in the 2006 Bay- Delta Plan as implemented through D-1641 and the National Marine Fisheries Service Biological Opinion on the Stanislaus River), (2) a 1.0 dS/m salinity objective, and (3) a 1.4 dS/m salinity objective. The chosen Board alternative (alternative 2) would relax South Delta salinity objectives during the irrigation season (April 1 through August 31). Such a move is in direct conflict with recent Board decisions, and would have the direct effect of reducing the frequency and magnitude of salinity objective violations by the US Bureau of Reclamation and the California Department of Water Resources. The proposed changes suggest that the southern Delta will be protected even if the salinity standards are relaxed. This conclusion is based entirely upon a report by Dr. Hoffman (2010),[69] in which he overestimates leaching fractions to estimate the potential loss to Delta farmers from changes to salinity. His conclusion is that even if salinity standards were relaxed, salt leaching would adequately protect southern Delta agricultural beneficial uses. Unfortunately, Dr. Hoffman collects no field data on Delta agriculture to test the prediction of his hypothesis. He admits that his conclusions rest heavily on results of 30-year old studies of potted bean varieties that commercial growers no longer use. His analysis entirely disregards the time restraints for such crops as alfalfa (irrigation, field dries out, cutting, mowing, raking, baling, next irrigation) that exacerbate farmers' ability to leach salts from the soil, especially on land in which low permeability soils are involved. Most of the Southern Delta agriculture land is between -5 and +10 feet compared to sea level, making the shallow ground water table inextricably linked to the rising and falling tides. Further, this

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[66] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 17

[67] Adams, R., J. Chermak, R. Gilbert, T. Harris, and W. Marcuson III. *Independent Panel Review of the Economic Sustainability Plan for the Sacramento-San Joaquin Delta,* December 2, 2011.

[68] See page 3 of the scope of work posted at http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/ICF11_Amend1_finalCombined.sflb.ashx

[69] Hoffman, G. 2010. *Salt Tolerance of Crops in the Southern Sacramento-San Joaquin Delta, Final Report.* Prepared for the California EPA and the State Water Resources Control Board.

shallow ground water contains the accumulation of more than fifty years of salt deposits borne out of the Central Valley Project. Thus, when tides rise and fall, salty ground water rises and falls with it, entering crop root zones. Practically, this means that any salts that are able to leach from the soil do not go anywhere. The SED authors assume that agricultural producers would not replace reduced surface flows by increasing groundwater applications, ignoring how agricultural producers operate.[70] As a result, the SED authors overestimate the negative effects of the flow alternatives on agricultural producers.[71] It is baffling that the SED authors support a degradation of water quality standards based on the untested hypothesis of Dr. Hoffman while ignoring compelling evidence, presented in this critique and elsewhere, that his hypothesis should be rejected.[72]

Adding to the problems with the salinity objective analysis, the SED fails to adequately disclose or analyze the effects of salt loading on the west side of the San Joaquin valley and how salt run-off from those areas contributes to the degradation of water quality in the Delta. In 1981 the White House Council on Environmental Quality found that some 400,000 acres of land in the San Joaquin Valley were poorly drained, and that crop yields had declined 10 percent since 1970. The Council stated that with no action the amount of poorly drained land would increase to about 700,000 acres by 2000. The Council reported too that "over the next 100 years" (or by about 2080) "about 1 million acres of agricultural land in the San Joaquin will undergo desertification" if groundwater salinization is not addressed.[73] The San Joaquin Valley Drainage Monitoring Program reported to the Department of Water Resources for 2005 that there are about 1.324 million acres of land with present and potential drainage problems. Over 30 percent of these lands (or 403,000 acres) have groundwater levels between 0 to 5 feet, while another 65 percent (or 857,000 acres) have water tables between 5 and 15 feet below the surface. All of these lands can be considered to have present and potential drainage problems.[74] Not only are the lands of the western San Joaquin Valley drainage impaired, but the water which is applied to them for irrigation comes largely from the Delta Mendota Canal, which has a relatively high salt content. This "recirculation" of salty water further concentrates salts in the soils and return flows:

> Such recirculation can have a large effect on salt fluxes [i.e., movement] because rather than completely leaving the system, such re-circulated salts continued to contribute to any impairments and costs associated with elevated salinity in supply water. (California Regional Water Quality Control Board 2006: 36)

Echoing the State Water Resources Control Board's finding regarding salts in the Delta, salts in the Delta Mendota Canal are found by the Central Valley Regional Board to be the primary source of salt circulating in the San Joaquin River Basin. While the Canal supplies most of the surface irrigation water to this part of the Basin, the Board states that "the quality of this supply may be impaired by the recirculation of salts from the San Joaquin River to the [Canal's] Delta pumping plant." (California Regional Regional Water Quality Board 2006: 41) In addition

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[70] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. pg. 9-11

[71] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. i

[72] For a more detailed analysis of the problems with Dr. Hoffman's report, see generally Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 18-20

[73] Sheridan (1981), pgs. 42-43

[74] California Department of Water Resources, 2010: Table 1

to 1 million tons per year of salt recirculating through the San Joaquin River and the Delta Mendota Canal, the Board estimates that application of salts from soil amendments and groundwater pumping for irrigation in the River Basin adds an additional 500,000 tons of salt per year to the River. This radically changed flow pattern from unimpaired to observed flow in the San Joaquin River Basin changes the Basin's handling of salt circulation as well. According to the California Department of Water Resources, agricultural use of both surface and groundwater sources is the largest source by which salt is mobilized. Adding together groundwater, and surface and subsurface return flows, these sources account for 71 percent of the salt load in the San Joaquin River as measured at Vernalis.

Further, the SED addresses the role of salinity only in the context of the suitability of water for irrigation, and does not consider salinity in terms of its effects on aquatic biota.[75] This omission erases an entire line of analysis that was an important component of earlier SWRCB proceedings on Delta flow and water quality. In examining the spawning of striped bass in the San Joaquin River as far back as 1966-1967, the Board has found that:

> [n]o significant amount of spawning occurred in areas where the total dissolved solids content of the water was above 180 parts per million…TDS values above that level prevented bass from migrating above Stockton in the San Joaquin River…The quality of water in the [Sacramento and San Joaquin) rivers is quite different. In dry years, such as 1966, the flow in the San Joaquin River is greatly reduced and consists largely of irrigation return water having relatively high concentrations of total dissolved solids. In contrast, the Sacramento River is characteristically low in dissolved solids. A dissolved solids gradient is created in the study area by the mixture of water from the two rivers as they are drawn across the central Delta by the U.S. Bureau of Reclamation pumping plant at Tracy, California. The net effect is that water in the San Joaquin River from the study area to its junction with the Sacramento River about 25 miles downstream is primarily Sacramento River water. It is fresher than either the water farther downstream, which is mixed with ocean water, or the San Joaquin River water upstream. Thus, striped bass moving upstream and having made the normal adjustment to fresh water must readjust to more saline water if they continue upstream.[76]

There are a number of fish species in the South Delta and San Joaquin River that, potentially, are adversely affected by salinity: for example, striped bass and splittail. In 1995, the USEPA promulgated standards for a April/May EC objective of 0.44 micro-mhos at Vernalis to protect spawning striped bass and splittail. The USEPA, unlike the current SED, conducted a benefit/cost analysis of the regulatory impacts of the new standards. This economic assessment examined and compared the impacts to agriculture, urban and the regional economy with the

[75] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg. 20

[76] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg. 13, citing Farley (1966) and Radtke and Turner (1967)

benefits to the recreational and commercial fisheries and a health ecosystem. [77] However, the SED inexplicably ignores the 1995 federally promulgated salinity standards for striped bass and splittail spawning and migration.[78] These standards established a salinity standard of 0.44 micro-mhos between 1 April and 31 May for Vernalis, Mossdale, Brandt Bridge to Jersey Point when the San Joaquin River index is greater than 2.5 MAF. The SED further fails to adequately acknowledge the importance of protecting salmon fry emergence and migration. Fry migration peaks in January/February/March while smolt migration peaks in April/May and continues into June. While fry are wild, they cannot be tagged or screened. Their demise is one of the most important causes of the collapse of the fishery. Therefore, the percentage of unimpaired flow provided should extend from January to May.

The SED also fails to analyze effects as they relate to freshwater invertebrates, especially their eggs and at sensitive life stages. Zooplankton is a critical source of food to numerous fish species, with different zooplankton species inhabit freshwater, low salinity zones, and/or high salinity zones. In recent years, Native Copepod and Mysid species have plummeted, as well as the entire phytoplankton community. Yet there is no acknowledgement, analysis or discussion in the SED of the potential salinity impacts to the food chain web. With respect to native plant species, the SED identifies listed plants but contains no analysis of the impacts to riparian and channel vegetation in the South Delta or San Joaquin River. Historically, the Southern and Eastern Delta was dominated by freshwater conditions and once supported myriad native freshwater species. A few of these species include common tules (Scirpus acutus, S. californicus), cattails (Typha spp.), common reed (Phragmites communis), swamp knotweed (Polygonum coccineum), marsh bindweed (Calystegia sepium), bur-reed (Sparganium eurycarpum), cinquefoil (Potentilla anserina), twinberry (Lonicera involucrata), dogwood (Cornus stolonifera), buttonwillow (Cephalanthus occidentale), and willows (Salix lasiolepis, S. lucida). This wetland community was once very common and replicas of these communities still can be found on the channel islands and along the waterside of levees. Others grow in the water itself. Several species of native plants, such as the twinberry plant (Lonicera involucrate), are extremely sensitive to salt. Omitting discussion and analysis of salinity standards to protect estuarine habitat for fish and wildlife is an error. In the preamble to its Final Rule for *Water Quality Standards for Surface Waters of the Sacramento and San Joaquin Rivers, and San Francisco Bay and Delta* (1995), the Environmental Protection Agency disapproved of "the absence of salinity standards to protect the Estuarine Habitat and other fish and wildlife uses in the Suisun, San Pablo, and San Francisco Bays and Suisun Marsh, [as well as] the absence of scientifically supportable salinity standards (measured by electrical conductivity) to protect the Fish Spawning uses of the lower San Joaquin River …[79] Although they have gone entirely enforced, the 1995 EPA salinity standards for fish and wildlife have not been rescinded, and it is

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[77] United States Environmental Protection Agency, Water Management Division (1993), *Regulatory Impact Assessment of the Proposed Water Quality Standards for the San Francisco Bay/Delta and Critical Habitat Requirements for the Delta Smelt.*

[78] 40 CFR 131.37

[79] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg. 14, citing EPA's Water Quality Standards regulations at 40 CFR part 131.37; see *Federal Register*, January 24, 1995, p. 4666.

clear that lowering total dissolved solids and salinity in the lower San Joaquin River will more frequently meet the fish spawning objectives adopted by the EPA. [80]

E. THE SED FAILS TO CONTAIN A REQUIRED ANTIDEGRADATION ANALYSIS

The SED's three-page chapter titled *Antidegradation Analysis* briefly describes and references the state and federal antidegradation policies. It states that "[u]nder its dual legal authority, the State Water Board allocates rights to the use of surface water and, together with the nine regional water quality control boards (Regional Water Boards), takes actions to ensure the highest reasonable quality for waters of the state through administration of the Porter-Cologne Act and portions of the CWA."[81] The Federal Antidegradation Policy states that "[t]he 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." [82] EPA Region 9's guidance on implementing antidegradation policy states that "[a]ll actions that could lower water quality in Tier II waters require a determination that existing uses will be fully maintained and protected." [83] The SED states that "Under its dual legal authority, the State Water Board allocates rights to the use of surface water and, together with the nine regional water quality control boards (Regional Water Boards), takes actions to ensure the highest reasonable quality for waters of the state through administration of the Porter-Cologne Act and portions of the CWA."[84]

The CWA requires the full protection of identified beneficial uses. The Federal Antidegradation Policy, as required in 40 CFR 131.12 states, "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." EPA Region 9's guidance on implementing antidegradation policy states, "All actions that could lower water quality in Tier II waters require a determination that existing uses will be fully maintained and protected."[85] According to the SED, the Delta and San Joaquin River are Tier II waterbodies, meaning that any revisions to water quality standards for these water bodies must include an antidegradation analysis. Therefore, in order to properly conduct an antidegradation analysis, the Board must first analyze and establish that the proposed standard will remain protective of beneficial uses and then establish that any lower water quality is necessary to accommodate important economic or social development. The SED fails in both regards, as it is entirely devoid of analysis regarding impacts to identified beneficial uses and fails to include a benefit and costs assessment rendering the change necessary to important economic or social development. The antidegradation analysis is so poor that it even fails to

[80] Appendix A, Tom Cannon, *Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries,* pg. 14
[81] SED, Chapter 1, *Introduction,* 1.3, pg. 1-3
[82] 40 CFR 131.12
[83] EPA, Region 9, Guidance on Implementing the Antidegradation Provisions of 40 CFR 131.12, page 7.
[84] SED, Chapter 1, *Introduction,* 1.3, pg. 1-3
[85] EPA, Region 9, Guidance on Implementing the Antidegradation Provisions of 40 CFR 131.12, page 7.

describe how antidegradation policies are implemented.[86] While the Board may envision updating its antidegradation policy, the present antidegradation policy is valid and binding on this process, and cannot wait for the implementation phase to be analyzed. An antidegradation analysis cannot be conducted for an unpredictable action. Here, the proposed replacements for present water quality standards are less stringent but implementation is spread over years and largely assigned to an undefined adaptive management process with undeterminable results. Further, an antidegradation analysis requires a balancing of the common good similar to a public trust balancing. The common good cannot be "balanced" against uncertain standards and uncertain requirements leading to unknowable outcomes from a vague and undefined adaptive management process. The absence of a defensible antidegradation analysis prevents the public from understanding the nature of the proposed standards and providing informed comments in the public review process, thereby violating CEQA's fair disclosure requirements.

F. THE SED FAILS TO ANALYZE REASONABLE ALTERNATIVES FOR RESERVOIR OPERATIONS THAT WOULD RESPOND TO FLOW OBJECTIVES, AND THUS FAILS TO DISCLOSE POTENTIAL IMPACTS THAT COULD RESULT FROM CHANGES IN STORAGE

The draft water quality objectives for fish and wildlife beneficial uses as shown in the Substitute Environmental Document's (SED) Appendix K do not specify reservoir operations. However, the modeling analysis in the SED assumes that the operators of the major storage reservoirs, when implementing the proposed instream flows on the San Joaquin tributaries, will allow minimal change on reservoir levels and carryover storage. The modeling analysis thus concludes that changes in reservoir levels and carryover storage will have no significant impacts on the environment, including fish and wildlife beneficial uses. This analysis and resulting finding relating to impacts thus depend on at least one of several unsupported assumptions:

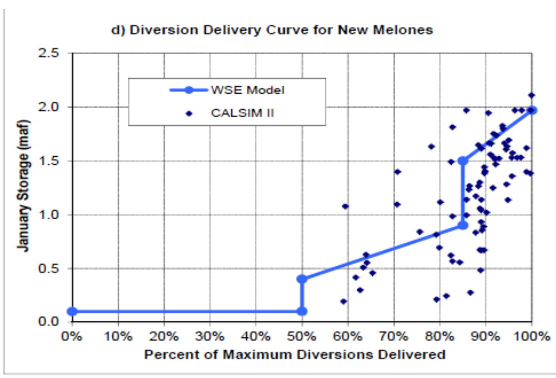
1. That the objectives will require the operators to operate to historic conditions;
2. That the Board can and will in the future write enforceable conditions to require the operators to operate to historic conditions;
3. That in the absence of such explicit enforceable conditions, the operators will in any case operate to historic conditions, even though the San Joaquin Tributaries Authority (SJTA) and Bureau of Reclamation (BOR) have made written and oral statements in this proceeding that operating to historic reservoir levels while implementing new flows would be against the interests of their contractors.

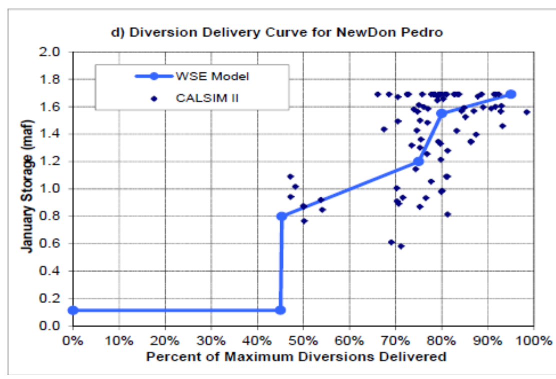
The draft water quality objectives for fish and wildlife beneficial uses assign responsibility for implementation to an Implementation Workgroup and a Coordinated Operations Group. This approach 1) improperly substitutes the unknown future actions of governance structures outside the Board's authority for a definition of the Board's project that allows identification of impacts; 2) does not evaluate reasonably foreseeable impacts to fish, wildlife, water temperatures and hydropower from different reservoir operations; 3) does not allow comparison and evaluation of

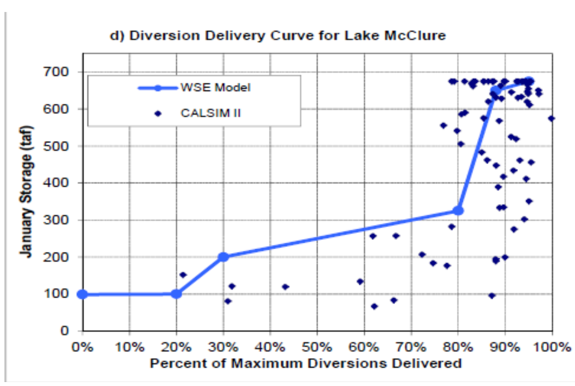
[86] State Water Board's *Administrative Procedures Update on antidegradation analysis* (APU-90-004) or the State Water Board's 1987 guidance memorandum implementing federal antidegradation policy by its then Chief Counsel William Attwater.

the most environmentally protective alternative(s) for reservoir operations to mitigate reasonably foreseeable impacts; and 4) does not allow comparison and evaluation of the costs, benefits and tradeoffs of different reservoir operations to inform reasoned decision making.

The draft water quality objectives set forth in Appendix K of the SED do not set rules for storage in each of the main storage reservoirs on the major San Joaquin tributaries (New Melones on the Stanislaus, New Don Pedro on the Tuolumne, New Exchequer/Lake McClure on the Merced). However, the Water Supply Effects (WSE) model that Board staff used to analyze the effects of different alternatives contains a modeling assumption that assumes that end-of-September storage and end-of-January storage will be very close to historic storage levels. The rule curves for reservoir operations are set forth in Appendix F1, in figures F.1-1 (Stanislaus), F.1-2 (Tuolumne), and F.1-3 (Merced), on pages F.1-21, F.1-22, and F.1-23 respectively. In each respective figure, graph (d) shows the rule curves. Staff provides a narrative description of the application of the rule curves on pages F.1-19 and F.1-20. There are three interrelated major variables in the operation of each major storage reservoir: instream flow releases, diversions, and storage. Each variable affects water available for the others. Staff's modeling assumes different levels of instream flow for various alternatives. The rule curves for each reservoir show the allowed amount of diversion for each tributary for each year as a function of end-of-January storage in the respective storage reservoir. The allowed diversion amounts were calculated based on a regression; the data points from which these regressions were derived are also shown as part of graph (d) of Figures F.1-1, F.1-2 and F.1-3 (below).







Making end-of-January storage define levels of diversion for the subsequent irrigation season contains some simplifying assumptions. The largest and most significant assumption is that precipitation after February 1 of any given year will not be allowed to make up for low storage on January 31. Thus, for instance, in 1982, a year of copious precipitation, the WSE allows diversion levels from the Tuolumne River of less than 80% of maximum because the elevation of New Don Pedro Reservoir on January 31 was less than 1.5 million acre-feet (MAF). This is in spite of the fact that large flood releases from into the Tuolumne downstream of La Grange were made well into July.

One net effect of the simplification of pegging allowed diversions to end-of-January storage is to push the consequences of each water year into the next year. Allowed diversions are based in significant part on precipitation from the previous year. The benefit of a high volume water year is captured in high reservoir carryover storage, which in turn tends to allow high diversion volumes the following year even if precipitation in this second year is low. Another important effect is that it is impossible to analyze the effects of differing flow requirements on a year-to-year basis. Indeed, the SED compares the effects of various flow alternatives on diversions over the entire 80+ year period of record, not by comparing diversions in any given year with the baseline diversions in that year.

The SED's approach to carryover storage appears to stem from the real concern that the SJTA irrigation districts will make up for increased instream flows by making up for as much as they can from storage, and by reducing diversions as little as possible. As the SJTA stated on April 30, 2012, in an unsolicited comment letter from Valerie Kincaid to the Board:

> The implementation of the rule curves would reduce water delivery by pushing water into storage. The effect of pushing water into storage instead of allowing water to be delivered masks the impacts of the proposed regulation to the extent the impacts are measured by reservoir storage. A more realistic depiction of operations would result in impacts in water storage at the reservoirs, in addition to impacts to water delivery. Staff's rule curves result in little to no impact to storage. A completely different outcome would occur if the rule curves recognized that reservoirs will be operated to maximize water deliveries.[87]

The rule curves developed to model the alternatives analyzed in the SED are not explicit as part of the draft water quality objectives to protect fish and wildlife beneficial uses as shown in the SED's Appendix K. So the rule is set on a back door basis as a modeling artifact.

Thus, rather than defining a project, its impacts, and potential mitigations for these impacts in accordance with CEQA, the SED analysis defines the desired result of an impacts analysis while transferring implementation requirements to another entity to meet the desired result. Rather than use the SED to support the project, the SED makes a key finding while requiring undefined future actions to define a project whose very goal is to support this key finding. To compound the problem, the objectives not only do not examine reservoir operational scenarios, they push operations to an "Implementation Workgroup." However, the validity of the SED analysis, which finds no significant impact to fisheries, water temperature, cold water

[87] Letter from Valerie Kincaid to SWRCB, April 30, 2012, p. 4.

availability, and hydropower, relies on the fact that Implementation Workgroup will not modify the rule curve to allow significant effects from changes in storage operations. If the Workgroup were to reduce the carryover storage requirements of these rule curves, several of the SED's findings of no significant impacts would not stand. This approach is doubly flawed: first, it assigns vital decisions to a group external to the Board without guidelines; and second, it bases a finding of no significance on a modeling artifact that the tributary operators in the workgroup are certain to reject.

The SJTA and BOR, in oral presentations to the Board on March 21, 2013, described to the Board many impacts to fisheries, water temperature and hydropower that they argue would occur as a result of Staff's preferred alternative. The vast majority of these impacts stem from changes to reservoir levels. The SJTA and BOR simply cast aside the rule curves for the WSE model, including notably the end-of-September storage target. They modeled the impacts of the preferred alternative according to how they think they might operate if required to release 35% of February - June impaired flow. Though backed by more in-depth analysis of operations, the SJTA and BOR statements of impacts of scenarios also contain within them embedded *choices* of how to manage the variables of storage and diversions. Till now, the rules that SJTA and BOR adopted for their analyses are unknown; all that is known, as stated above, is that they would increase storage withdrawals. It is also unknown how SJTA and BOR might operate under requirements to release different percentages of February – June unimpaired. The SED should have examined a series of potential reservoir operations scenarios and evaluated different impacts to storage as alternatives, by modeling those scenarios with clear modeling assumptions and rules. Then the SED should have analyzed the impacts of those different operational scenarios, including, incrementally, the effects to fisheries, water temperature, cold water availability, hydropower, and other potential categories that may be affected. The SED should have analyzed each of the storage operation scenarios, in turn, with each of the flow alternatives. Such analysis is vital to fulfill the role of the SED in helping decision makers balance impacts and benefits.

The SED should have analyzed the reservoir rule curves as currently modeled in the SED as one *alternative* for reservoir operations (this could have been called the "minimum impact to storage alternative"). The Board should have developed in the draft narrative objectives a narrative standard that described the rule curves, both to describe the alternative and to show that it is feasible. The SED should have analyzed the reservoir operations as generally proposed by the SJTA and the BOR in oral presentations on March 21, 2013 should also be modeled as alternatives (this could be called "the minimum impact to diversions alternative"). It is reasonably foreseeable that, unless explicitly constrained, reservoir operators will draw water out of storage to meet water deliveries of their customers and contractors as much as possible. The SED should have analyzed the impacts of such operation and iteratively used modeling tools to develop intermediate or possibly completely different alternatives for reservoir operations. Staff should have evaluated key metrics to define alternatives. For instance, the presenter from BOR on March 21, 2013 described how reservoir levels that BOR projected under its own proposed operational response to the preferred flow alternative would threaten the 15% reserve margin for power reliability required by the North American Electricity Reliability Corporation and the Western Electricity Coordinating Council. Staff might have considered a potential violation of the reserve margin as metric in developing reservoir operations scenarios.

In summary, the SED should have developed a suite of alternatives for reservoir operations and analyzed the impacts of flow alternatives under these different reservoir operation scenarios using clearly defined quantifiable and enforceable rules. By failing to conduct this analysis, the SED has allowed the SJTA and BOR to present competing versions of operations, and to argue that their modeling is more credible than Staff's. These dueling models and dueling impacts analyses defeat the purpose of environmental review: to support clear and reasoned decision making.

G. THE SED FAILS TO CONDUCT A PROFESSIONAL ECONOMIC ANALYSIS

Economics is the study of how societies use scarce resources to produce valuable goods and services and distribute them among different individuals.[88] The scarce resource the Board must allocate among competing demands is the San Joaquin River and, more specifically, the quantity and quality of its waters.[89] When the *SED Report*'s authors state they have "evaluated a number of different 2006 Bay-Delta-Plan amendment alternatives for State Water Board consideration"[90] and their "economic analysis … will help inform State Water Board's consideration of potential changes … related to LSJR flows and southern Delta water quality objectives,"[91] they appear to have adopted the approach emedded in the definition of economics: "If you were asked to evaluate the desirability of some proposed action, you would probably begin by attempting to identify both the gains and the losses from that action. If the gains exceed the losses, then it seems natural to support the action." [92] [93] Identifying "the gains and the losses" begins by grouping the gains and losses—the economic effects—into three categories: economic values, economic impacts, and economic equity.[94] For evaluating "the desirability of some proposed action," "[n]ormative economics considers 'what ought to be'—value judgments, or goals, or public policy" [95] whereas "[p]ositive economics…is the analysis of facts and behavior in an economy, or 'the way things are'."[96]

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[88] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 1, citing Samuelson, PA and WD Nordhaus. 2010. *Microeconomics*, 19th ed. New York: McGraw-Hill Irwin, p.4. Dr. Samuelson was a Nobel laureate in economics and Institute Professor at MIT. Dr. Nordhaus is Sterling Professor of economics at Yale University. For similar definitions of economics, see practically any other introductory economics textbook, as well as Pearce's MIT Dictionary of Economics, Pearce, DW, ed. 1992. *The MIT Dictionary of Modern Economics*, 4th ed. Cambridge: The MIT Press, p.121.

[89] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 1

[90] *SED*, p.ES-2

[91] *SED, Evaluation of San Joaquin River Flow and Southern Delta Water Quality Objectives and Implementation*, Chapter 18, p.18-2.

[92] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 2

[93] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 2 citing Tietenberg and Lewis, p.46.

[94] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 2 citing Appendix C, ECONorthwest. 2013. *Bay-Delta Water: Economics of Choice*.

[95] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 3 citing Samuelson, P.A. and W. Nordhaus. 2005. *Economics,* 18th ed. New York: McGraw-Hill Irwin. p. 746. Dr. Samuelson, Nobel laureate in economics and Institute Professor at MIT, died in 2009. Dr. Nordhaus is Sterling Professor of economics at Yale University.

[96] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 3 citing Samuelson and Nordhaus. 2005. p. 746.

Under CEQA, project-related social or economic effects are not, as a general rule, required to be analyzed; however, a lead agency may decide to include an assessment of economic or social effects in an EIR, particularly if these effects are perceived as being important or substantial. As discussed in Section 15131 of the Guidelines for Implementation of the California Environmental Quality Act (CEQA Guidelines), economic or social information may be included in an EIR in whatever form a lead agency desires. However, Water Code Section 13241 states that "economic considerations" *should* be considered in establishing water quality objectives. Compliance with these statutory provisions typically involves quantifying the costs to affected parties (e.g., farmers and water districts), and assessing potential impacts on affected local and regional economies of related changes in economic activity.[97]

The SED uses IMPLAN for economic modeling, which is described as "the most widely used economic input-output model for assessing regional economic impacts of regulatory and policy actions."[98] The SED authors used an IMPLAN-based model of the Madera, Merced, and Stanislaus counties to represent the larger agricultural area in the lower San Joaquin River watershed.[99] However, in the context of the *SED Report*, the results from IMPLAN's snapshot overestimate the negative economic impacts of the flow alternatives:

> Input-output analysis approach employed by IMPLAN usually overestimates indirect job and income losses. One of the fundamental assumptions in input-output analysis is that trading patterns between industries are fixed. This assumption implies that suppliers always cut production and lay off workers in proportion to the amount of product supplied to farms or other industries reducing production. In reality, businesses are always adapting to changing conditions. When a farm cuts back production, some suppliers would be able to make up part of their losses in business by finding mew markets in other areas. Growth in other parts of the local economy is expected to provide opportunities for these firms. For these and other reasons, job and income losses estimated using input-output analysis should often be treated as upper limits on the actual losses expected (SWRCB 1999)."[100]

Even though the Board acknowledges that their IMPLAN analysis overstates the true employment and income impacts of the flow alternatives, they apparently ignored this fact when selecting their preferred alternative of 35 percent unimpaired flows.[101] The Board compounded or magnified the "worst case" results from their SWAP analysis by using the SWAP results as input into their IMPLAN analysis, which also produced its own "worst case" output.[102]

Assuming for the sake of argument that the SED's IMPLAN results reflect the economic impacts of the flow alternatives, the employment impacts of even the 60 percent flow alternative represents a negligible portion of total employment in the affected counties.[103] The negative

[97] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. pg. 4
[98] SED, *Evaluation of San Joaquin River Flow and Southern Delta Water Quality Objectives and Implementation*, Chapter 18, 18-20.
[99] Id.
[100] SED 2012, page G-29.
[101] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 13-14
[102] Id.
[103] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 14

employment impacts of the 60 percent flow alternative of 1,432 represent just 0.4 percent of the total. The *SED Report* admits these losses are exaggerated. A more reasonable estimate of economic losses is likely to be less than half the amount estimated in the *SED*, which would represent approximately 0.2 percent of the counties' economies.[104] If the SED was to include San Joaquin County,[105] the negative employment impacts of the 60 percent flow alternative represent just 0.23 percent of the four counties' total employment of 625,178.[106] Halved to be more reasonable, this represents approximately 0.1 percent of the counties' economies.[107] These results offer no support of the Board's preferred flow alternative, 35-percent unimpaired flow. The available evidence supports a preferred alternative closer to, if not, the 60-percent flow alternative.

H. THE SED FAILS TO ADEQUATELY DESCRIBE THE IMPACTS OF ITS CHOSEN ALTERNATIVES FOR BOTH THE LOWER SAN JOAQUIN RIVER FLOW OBJECTIVE AND THE SOUTH DELTA SALINITY OBJECTIVES

The fundamental flaw with the Board's analysis of the project impacts is that the Board has failed to analyze the entire project. Information concerning flow needs of fish and wildlife beneficial uses in the San Joaquin river basin was used by the Board to develop a range of potential San Joaquin river flow alternatives to protect fish and wildlife beneficial uses. The Board acknowledges that "while aquatic resources in the SJR basin have been adversely impacted by numerous factors, flow remains a key factor and is the focus of the State Water Board's current review."[108] However, the Board notes that the alternatives chosen do not necessarily represent the alternatives that will be evaluated in the SED, which was prepared in support of potential amendments to the SJR flow objectives in the Bay-Delta Plan, and not necessarily in support of flow objectives to protect fish and wildlife.[109] The ranges of alternatives presented in the SED are based on minimum flow requirements of 20%, 40%, and 60% of unimpaired flow from the SJR tributaries during the months of February through June.[110] The Board's chosen alternative, a 35% unimpaired flow, falls in the range of 20%-40%, meaning that depending on the time of year, unimpaired flow can fall substantially below the 35% average unimpaired annual flow. The Board fails to provide an analysis to justify the reduction in flow for the San Joaquin at Vernalis from the 60 % of unimpaired flow recommended in 2010 to 35 % recommended in the SED. The Board gives little to no explanation for its determination that 35

[104] Id.
[105] This is a reasonable addition, because economic impacts of a flow alternative would be felt in San Joaquin County, where South San Joaquin Irrigation District and Stockton East Water District are located. In addition to the farms themselves, most of the labor force and input suppliers for farms in these districts will be located in San Joaquin County, primarily Stockton, which also is the primary location of workforce and suppliers for farms within the South Delta Water Agency territory.
[106] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document,* pg. 14
[107] Id.
[108] SED, Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, 3-1
[109] SED, Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, 3-13
[110] SED, Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, pg. 1-3

% of unimpaired river flow will improve or protect the fish and wildlife in the Bay Delta estuary. Further a 35% unimpaired flow is not explicitly analyzed in the preceding chapters of this SED, and there is no discussion of how or why 35% was selected. Instead, the Preferred LSJR Alternative falls within the range of alternatives analyzed in those chapters (20-60 percent of unimpaired flows) and is, accordingly, "encompassed by those analyses." [111]

A number of other factors (e.g., non-native species, exposure to contaminants, nutrient loading, climate change) require evaluation as potential contributors to the degradation of fish and wildlife beneficial uses in the SJR basin and Delta. Even with a full description of individual impacts of lower San Joaquin River flows and south Delta salinity objectives, the SED cannot possibly disclose, much less analyze, the individual impacts of the project when it limits the project to such a small portion of the water system. For example, the Draft SED finds that the revised San Joaquin River flow and South Delta salinity objectives will not affect state and federal exports and will have no change to Delta outflows or the size of X2. Yet, the Board makes these findings without analyzing water quality objectives for Sacramento River inflows, changes to export/inflow ratios, Delta Cross Channel closure objectives, Suisun Marsh objectives, Old and Middle River reverse flow objectives, or other changes to water quality objectives that are reasonably foreseeable impacts to the water feeding into, and coming out of, the area they are analyzing in Phase I of their project analysis.

Further, federal Clean Water Act regulations require that water quality objectives be set so as to protect the most sensitive beneficial use in the water body, however the Board's proposed San Joaquin River flow objectives do not achieve the necessary protection. Instead, the Board narrowly focuses on how it regulates San Joaquin River flow at Vernalis, and seeks to maintain existing conditions that fail to protect the pelagic and migratory beneficial uses of fish and wildlife, rather than improve or increase the protection for these beneficial uses.[112]

III. THE SED DOES NOT COMPLY WITH THE REQUIREMENTS OF THE CLEAN WATER ACT

The primary purpose of water quality control planning under the CWA is to prepare or develop comprehensive programs for preventing, reducing, or eliminating the pollution of the navigable water and ground waters and improving the sanitary condition of surface and underground waters. In the development of such comprehensive programs, "due regard shall be given to the improvements which are necessary to conserve such waters for the protection and propagation of fish and aquatic life and wildlife, recreational purposes, and the withdrawal of such waters for public water supply, agricultural, industrial, and other purposes."[113] The Board fails to consider new water quality objectives for the most sensitive beneficial uses in the Bay-Delta Estuary under the federal CWA and its implementing regulations administered by the US Environmental Protection Agency (hereinafter "EPA.") The goals of the CWA include restoring and maintaining the chemical, physical, and biological integrity of the Nation's waters through the elimination of discharged pollutants; protecting and propagating fish, shellfish, and wildlife; prohibiting discharge of toxic pollutants; and to recognize, preserve, and protect the primary

[111] SED, Chapter 20, *Preferred LSJR Alternative and SDWQ Alternative*, pg.20-1
[112] Draft SED, p. 2-13.
[113] 33 USC § 1252

responsibilities and rights of states to prevent, reduce, and eliminate pollution, plan the restoration, preservation, and enhancement of land and water resources. Research priorities funded under the CWA are intended to foster prevention, reduction and elimination of pollution in the waters of the United States. The heart of water quality control under these laws is first the designation of the beneficial uses to be protected, and second the setting of standards, criteria, and objectives that provide reasonable protection for those beneficial uses.

The Board is obligated by the CWA to operate a "continuing planning process," by which the Board submits any revisions or new water quality standards to the EPA Administrator for review. Such standards are to consist of "designated uses" and water quality criteria or objectives that represent the level of protection for the beneficial use. These standards are intended to protect the public health and enhance water quality while taking into consideration the needs of public water supplies, fish and wildlife, recreation, and agricultural and industrial uses.[114] Under Porter-Cologne, beneficial uses may include domestic, municipal, agricultural and industrial water supplies; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.[115] Since 1991, the Board has designated 17 specific beneficial uses of water in its Bay-Delta Estuary water quality control plans, including recreation and preservation and enhancement of fish and wildlife resources.[116] [117] Thus, in determining the amount of water available for appropriation, the board must take into account the amount of water needed to remain in the source for protection of beneficial uses.[118] Despite this charge, the State Water Resources Control Board does not use its water quality control powers to materially improve water quality in the South Delta and the lower San Joaquin River. On the contrary, the Board's proposed actions would relax existing standards and maintain insufficient flow objectives for fish and wildlife, diminishing water quality and further harming the Delta.

The SED recommends a flow objective for the San Joaquin River of 35 % of unimpaired flow that is well below the 60 % flow that the Board identified in 2010 as protective of fish and wildlife. The SED should have first identified the various water demands for beneficial uses, which of the beneficial uses are the most sensitive, the increment of flows available for riparian and appropriative consumptive use, and then proposed flow objectives in accordance with those findings. Yet, the Board failed to comply with this method at each step. First, the Board has not designated beneficial uses for which its proposed South Delta salinity objective are intended to

[114] 33 U.S.C. 1313 (c)(2)(A). ("Enhance" means to "intensify, increase, or further improve the quality, value, or extent of" something. One meaning of "propagate" is to "cause (something) to increase in number or amount." "Restore" can mean to "return (someone or something) to a former condition, place, or position.") In general, the plain language of Clean Water Act policies on protection of beneficial uses is not merely intended to maintain water quality but to increase or improve water quality as well as to return water quality to former conditions of chemical, physical, and biological integrity.
[115] California Water Code §13050(f)
[116] These beneficial uses include: municipal and domestic supply, industrial service supply, industrial process supply, agricultural supply, groundwater recharge, navigation, contact and non-contact water recreation, shellfish harvesting, commercial and sport fishing, warm fresh water habitat, cold fresh water habitat, migration of aquatic organisms, spawning, reproduction and/or early development of fish, estuarine habitat, wildlife habitat, and rare, threatened or endangered species' habitats.
[117] California Water Code §1243
[118] California Water Code Section §1243.5

protect. Second, the Board proposes San Joaquin River flow objectives that maintain the status quo, albeit through a new method of regulation. Third, the Board fails to include an analysis of water availability or to take full account of competing demands for water from all beneficial uses in that context. Finally, the Board fails to address water quality as it relates to dissolved oxygen standards or to temperature. Old River experiences frequent fish kills caused by low dissolved oxygen, which has long been known to the Regional Board.[119] Dissolved oxygen results collected at the real time monitoring station in Old River at Tracy Wildlife Association reveals that dissolved oxygen levels cycled as low as 0.5 mg/l mid-April through mid-August of 2012. Specific dissolved oxygen standards need to be established in Old River to protect beneficial uses.

In order to begin to mimic natural hydrologic conditions in the estuary, water temperature must be taken into account. Despite this logical analysis, the SED fails to propose any objectives to protect the identified beneficial uses of cold fresh water habitat; migration of aquatic organisms; spawning, reproduction and/or early development of fish; and rare, threatened or endangered species' habitats from elevated temperatures. The San Joaquin River (Merced to Delta boundary), the lower Stanislaus, the lower Tuolumne and the lower Merced Rivers are identified by the CWA as impaired waterbodies because of elevated temperatures.[120] The SED analyzed the impacts resulting from changes in exposure of fish to stressful water temperatures (AQUA-4) of each of the alternatives and concluded that lower unimpaired flow increased significant impacts while increased flows decreased impacts. While CEQA is served by a comparison of the relative significant impacts between the considered alternatives, the federal CWA is not. The SED is reviewing a water quality control plan developed pursuant to the CWA, and the CWA requires the protection of identified beneficial uses.

Under modeled baseline conditions, water temperatures potentially causing thermal stress in rearing and outmigrating juvenile salmon and steelhead frequently occur during the spring months on the Stanislaus, Tuolumne, and Merced Rivers as well as in the lower San Joaquin River. In the summer, flows met the USEPA recommended criterion for summer rearing <10 - 40% of the time and exceeded lethal levels <10% of the time in the Stanislaus and Merced Rivers. Water temperatures suitable for adult salmon and steelhead migration in September were exceeded in the lower San Joaquin River and major tributaries. In the lower San Joaquin River, temperatures potentially causing mortality or creating a migration barrier for adult salmon in September occurred greater than 90% of the time. Suitable temperatures for Chinook salmon spawning and incubation in the Stanislaus, Tuolumne, and Merced Rivers generally did not occur until late October or November. In October, spawning and incubation criterion were met 50% of the time in the Tuolumne River and 10% of the time in the Stanislaus and Merced Rivers. In November, spawning and incubation criterion were met 70% of the time in the Tuolumne River and 40-50% of the time in the Stanislaus and Merced Rivers. Water temperatures exceeding lethal levels for Chinook salmon spawning and incubation would occur <10-30% of the time in October and <10% of the time in November in the Stanislaus, Tuolumne and Merced Rivers. For the lower San Joaquin River, temperatures exceeded lethal levels for Chinook salmon spawning and incubation >90% of the time in October and <20% in

[119] Several years ago, CSPA took Regional Board staff (including Mark Gowdy) on a trip on Old River and showed them a massive fish kill caused be anoxic conditions.
[120] CWA Section 303(d); SED, Chapter 5, *Water Supply, Surface Hydrology, and Water Quality*, pg. 5-13

November.[121] Under the SED flow objective Alternative 2 (20% unimpaired flow), the percentage of temperatures exceeding USEPA criterion in the lower San Joaquin, Stanislaus, Tuolumne and Merced Rivers increased.[122] Under Alternative 3 (40% unimpaired flow), while the percentage of temperatures exceeding USEPA criterion decreased from baseline, significant exceedances still existed. [123] Under Alternative 4 (60% unimpaired flow), the percentage of temperature exceeding USEPA criterion further decreased, however exceedances still existed.[124]

Despite the San Joaquin, Stanislaus, Tuolumne and Merced Rivers being listed as impaired waterbodies due to elevated temperatures, and despite temperatures on these rivers exceeding USEPA criterion, there are no proposed objectives in the SED to protect the identified beneficial uses of cold fresh water habitat; migration of aquatic organisms; spawning, reproduction and/or early development of fish; and rare, threatened or endangered species' habitats from elevated temperatures. This fails to comply with the requirements of the federal CWA.

IV. CONCLUSION

Central Valley waterways are so polluted and fisheries so seriously depleted that immediate action to protect these resources must be implemented. Despite the long existence of prohibitions in the state Constitution against the unreasonable use and diversion of water, the Water Code, the public trust doctrine, state and federal endangered species acts, water quality acts, Fish & Game code, and Central Valley Project Improvement Act, the lists of impaired waterways and endangered species lengthen decade by decade. The SED report is so replete with errors of omission and commission, that some alone compromise the entire report. The cumulative errors of the SED, taken together, simply beg too many questions across too many parts of the SED Report for it to meet basic professional standards.[125] Rather than disclose the evidence-based reasoning that led them from the alternatives (for flows and water quality), the SED authors merely identify the alternatives they prefer. This not only fails to inform the Board adequately, but utterly fails to inform the public.

Very Truly Yours,

Michael B. Jackson

Michael B. Jackson
Attorney at Law

Attachments: Appendix A - C

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[121] SED, Chapter 7, *Aquatic Resources*, pg. 7-89.
[122] SED, Chapter 7, *Aquatic Resources*, pgs. 7-90 through 7-94.
[123] SED, Chapter 7, *Aquatic Resources*, pgs. 7-94 through 7-98.
[124] SED, Chapter 7, *Aquatic Resources*, pgs. 7-98 through 7-101.
[125] Appendix B, ECONorthwest, *Critique of Substitute Environmental Document*, pg. 3

Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries

Report Prepared by
Thomas Cannon
Consultant

Prepared for
California Sportfishing Protection Alliance

Photo of fall Chinook salmon from Yolo Bypass, March 2013. (Photo by Jacob Katz)

March 2013

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San Joaquin River Flow Recommendations

Introduction

The California Sportfishing Protection Alliance (CSPA) asked me for my opinion and recommendations on flows and standards needed to protect Chinook salmon, steelhead, and other fish populations in the San Joaquin River and its major tributaries. CSPA also asked me to review the State Water Resources Control Board's (Board's) Substitute Environmental Document (SED) for the *Evaluation of San Joaquin River Flow and Southern Delta Water Quality Objectives and Implementation,* released on December 31, 2012. This report responds to CSPA on these matters.

In the SED, the Board finds that higher and more variable flows in the major San Joaquin River tributaries and in the San Joaquin River at Vernalis are needed to support salmon and steelhead populations in these rivers as well as their migratory and rearing habitat in the lower San Joaquin River within the Delta. The target tributaries are the Stanislaus, Tuolumne, and Merced rivers (Figure 1). Neither the Board in the SED nor I in this report address the upper San Joaquin above the Merced River or the three Delta tributaries (Mokelumne, Cosumnes, and Calaveras Rivers).

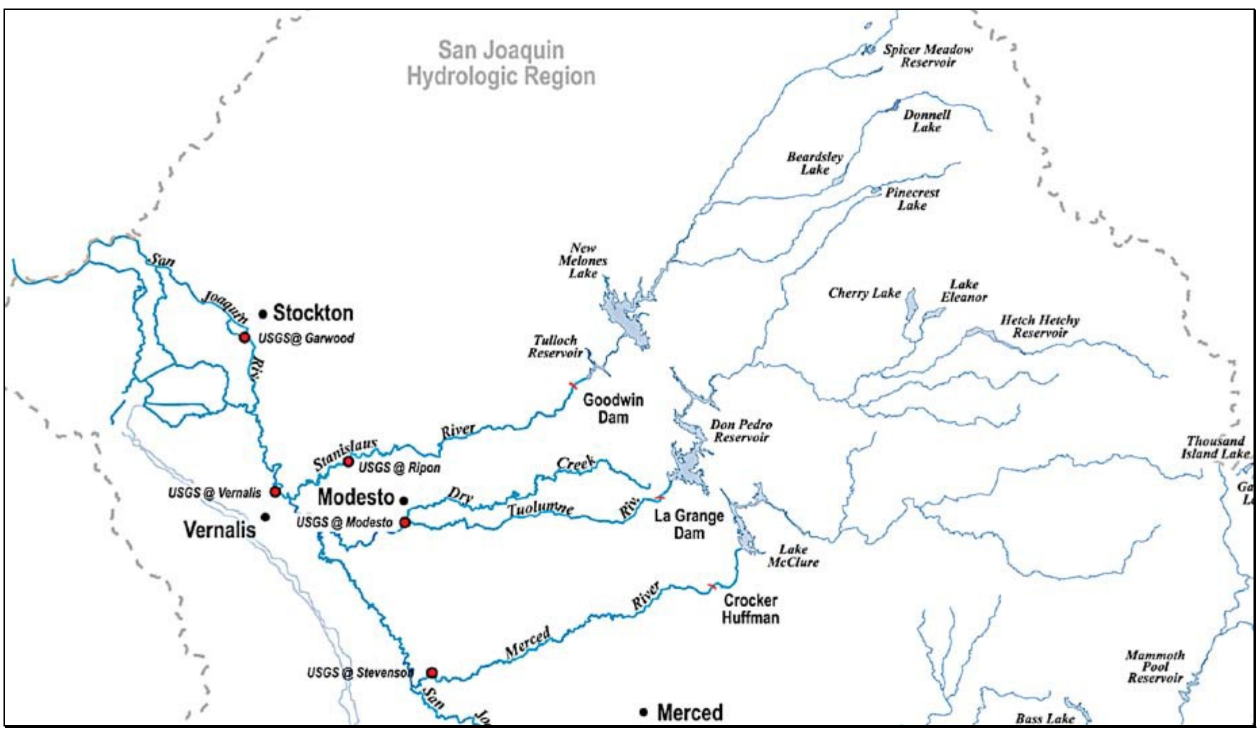

Figure 1. Lower San Joaquin River and its three main tributaries below Merced, California. (Source: Appendix C, SWRCB 2012)

Large mainstem water supply reservoirs on the Stanislaus, Tuolumne, and Merced and associated water supply developments have markedly altered the rivers flow regimes to the point that existing salmon and steelhead populations in these rivers are now threatened with extinction.[1] While the annual salmon runs vary widely, there has been a continuing long-term downward trend in escapement in each of these rivers (see Figure 2 below). Salmonid populations in these tributaries need flows of higher magnitude and greater variability to recover. Higher flows will improve connectivity with the Delta and San Francisco Bay, and will provide better rearing and migration habitat in the three tributaries, the lower mainstem San Joaquin River, and the Delta. Furthermore, an increase in the amount of water from the San Joaquin watershed that reaches San Francisco Bay will increase in the production of anadromous adult salmonids from the entire Central Valley, not just the San Joaquin River.

After a comprehensive review of the case, evidence, science, and issues before the Board, I offer the following recommendations regarding the flow needs of the San Joaquin River specifically for the three mainstem tributaries, the Stanislaus, Tuolumne, and Merced Rivers.

- A replication of the unimpaired flow pattern in each of these rivers must be restored to allow salmon and steelhead populations to respond positively toward recovery. My specific recommendation is to allow 60% of the January through June unimpaired flow of these rivers to reach the Delta at Vernalis in a natural annual and seasonal flow pattern.

- I also recommend pulse flows in the fall to improve the success of adult salmon migrating into the San Joaquin and operational measures to ensure the successful out-migration of young salmon to the sea. The purpose of this report is to recommend conditions that would lead to recovery of the salmon and steelhead populations of the three San Joaquin tributaries, not to balance benefits or effects among beneficial uses.

My recommendations would provide a flow regime that more closely follows the natural seasonal flow conditions to which native migratory salmonid fish are adapted. The flow regimes that I recommend do not represent exact alternatives that are evaluated in the SED. However, they do represent fundamental elements of the flow regimes that the Board analyzes in the SED. The range of San Joaquin River flow and southern Delta salinity patterns proposed in this recommendation are also included in the alternatives analyzed in the SED.

Proposed Actions

Change Tributary Reservoir Operations and Flow Release Patterns

The major storage dams on the Stanislaus, Tuolumne, and Merced rivers should release 60% of daily unimpaired inflows, calculated on a short-term running average, during the months of January through June. The resulting flow-release pattern will thus closely replicate the natural daily unimpaired flow pattern of each river. In addition, there should be a year-round minimum flow of 2000 cfs at Vernalis as a lifeline flow for the lower San Joaquin River and the Delta and to ensure that at least 1000 cfs passes through the Stockton Deep-water Channel to maintain the

[1] *Biological and Conference Opinion on the Long-Term Operations of the Central Valley Project (CVP) and State*

dissolved oxygen standard.[2] Application of this minimum flow would incrementally increase the cumulative January to June flow to somewhat greater than 60% in drier years.

Maximize San Joaquin Delta Inflow to the Bay

There are several actions that would maximize the amount of San Joaquin inflow as measured at Vernalis that passes through the Delta to the Bay. First, the Delta Cross Channel (DCC) on the Sacramento River should be kept open as much as possible to ensure positive net tidal flows at Jersey Point. Second, the Head of Old River Barrier (HORB[3]) should be kept closed as much as possible other than providing flows needed to maintain circulation and water quality in South Delta channels. Third, negative flows in the lower San Joaquin River within the Delta, and in Old River and Middle River should be reduced or eliminated. Fourth, San Joaquin flows should be coordinated with Bay-Delta hydrodynamic factors including Sacramento River Delta inflow levels, DCC and HORB operations, Delta exports, local rainfall, and in-Delta seasonal, monthly, and daily tidal conditions.

Emulate Natural Flow Pulses

Given the 60% of unimpaired January through June criterion for each tributary, flow pulses will occur more or less simultaneously in winter and spring in each of the tributaries. Operators should adjust the releases over a short term (days) to maximize the magnitude of the overall pulse in the San Joaquin River by synchronizing flow releases with the other tributaries, with local rainfall, and with runoff. Such operations would observe flood safety requirements. However, the flow caps for percent of unimpaired flow for each of the tributaries as stated in the SED are extremely conservative, and would eliminate much of the high flow benefit that the percent-of-unimpaired approach is designed to create. Equally, the proposal in the SED to operate tributary reservoirs on a 14-day running average would result in a smoothing of flows, greatly reducing the benefits of high flows and daily variability. The Board should evaluate operations that capture as much as possible the benefits of high flows by eliminating the tributary flow caps, and should also evaluate shorter running averages (such as 3-day or 4-day) for daily reservoir operations.

In addition, fall pulses are needed to stimulate adult salmon upstream migrations from the ocean, Bay, Delta, and San Joaquin River into the spawning grounds of the tributaries. I recommend a modification of the date-certain approach to fall attraction flows that has been historically applied in the San Joaquin basin. When rainfall events occur between October 1 and October 31, fall pulses should be timed to enhance and extend the associated natural flow increases. In the absence of such natural events, the fall pulses should begin on November 1.

To maximize the benefits in the Delta, the Board should be particularly strict in requiring positive flows in the Delta portion of the San Joaquin River at Jersey Point, and in Old River and Middle River during Delta inflow pulses from the San Joaquin. The importance of these positive flows is increased even further when the DCC is closed and when the HORB is open.

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[2] http://www.gfredlee.com/SJR-Delta/SJRIssuesEngineerogram.pdf
[3] For more on HORB see: http://baydelta.wordpress.com/2010/06/23/the-head-of-old-river-barrier-and-a-delicate-balance-of-species-and-exports/

Purpose and Need

The proposed flows will provide more natural flow pulses in the fall, winter, and spring. They will also provide higher base flows in the winter and spring. Salmon and steelhead are adapted to each of these natural flow patterns.

Fall rainfall pulses provide the olfactory stimuli to attract spawners to their spawning rivers. Fall pulses stimulate spawning by freshening water, cleaning gravels, and lowering water temperatures. Fall pulses also stimulate the river and Bay-Delta food chains on which young salmon will depend.

Winter flow pulses provide the natural higher-turbidity, higher-velocity highways for newly hatched salmon fry to migrate to the Bay-Delta estuary. It is a well-established fact for Central Valley fall-run and spring-run Chinook salmon that fry rearing in tidal estuaries including the Bay-Delta is an important life history strategy essential to population production and viability (Appendix C, SWRCB 2012[4]). Therefore, it is important to provide winter (and early spring) pulses and manage Delta operations to create maximum opportunity for fry to reach Suisun Bay. Winter pulses also provide the attraction flows for adult steelhead, and in the future will be important for attracting restored spring Chinook salmon to the Upper San Joaquin River.

Spring flow pulses are critical for the growth of juvenile salmon and steelhead rearing in the rivers and Bay-Delta, and for providing enhanced opportunities for juvenile salmon to migrate downstream to and through the Delta to the Bay. Such pulses help all the salmon and steelhead rearing in and passing through the Bay-Delta to get successfully to the ocean. Spring pulses are also important to upstream migrating adult steelhead, and in the future will be important for attracting restored spring Chinook salmon to the Upper San Joaquin River.

Higher overall flows between pulses also provide more and better in-channel and in some cases floodplain rearing habitat for young salmon and steelhead. Higher flows provide more physical space, better water temperatures, protection from predators, and greater food production and availability. Higher flows also sustain conditions for migrating and rearing fishes throughout the system. Spring flow improvements will also enhance spawning, rearing, and migrating conditions for splittail, striped bass, sturgeon, and other fishes, as well as improve water quality of the three tributaries, lower San Joaquin, and the Delta (e.g., salinity and water temperature).

Basic Rationale

The relationship between San Joaquin flows and the salmon populations has been noted for decades as seen in Figure 2 below. This highly significant relationship shows that when average lower San Joaquin River flows fall below the 5,000 cfs level during winter and spring,

[4] See: http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/2012_sed/docs/2012ap_c.pdf

subsequent adult escapement falls, often sharply, two years later. The cause is generally believed to be poor survival of young salmon migrating down the rivers through the Delta during the year when flows were lower. The resulting poor escapement further confounds the recovery of the population by limiting subsequent escapement from poor egg production (Figure 3). In other words, it may take several years and generations for recovery to occur after the initial population collapse. This is a likely cause of poor response to two recent years of higher flows (2005-2006).

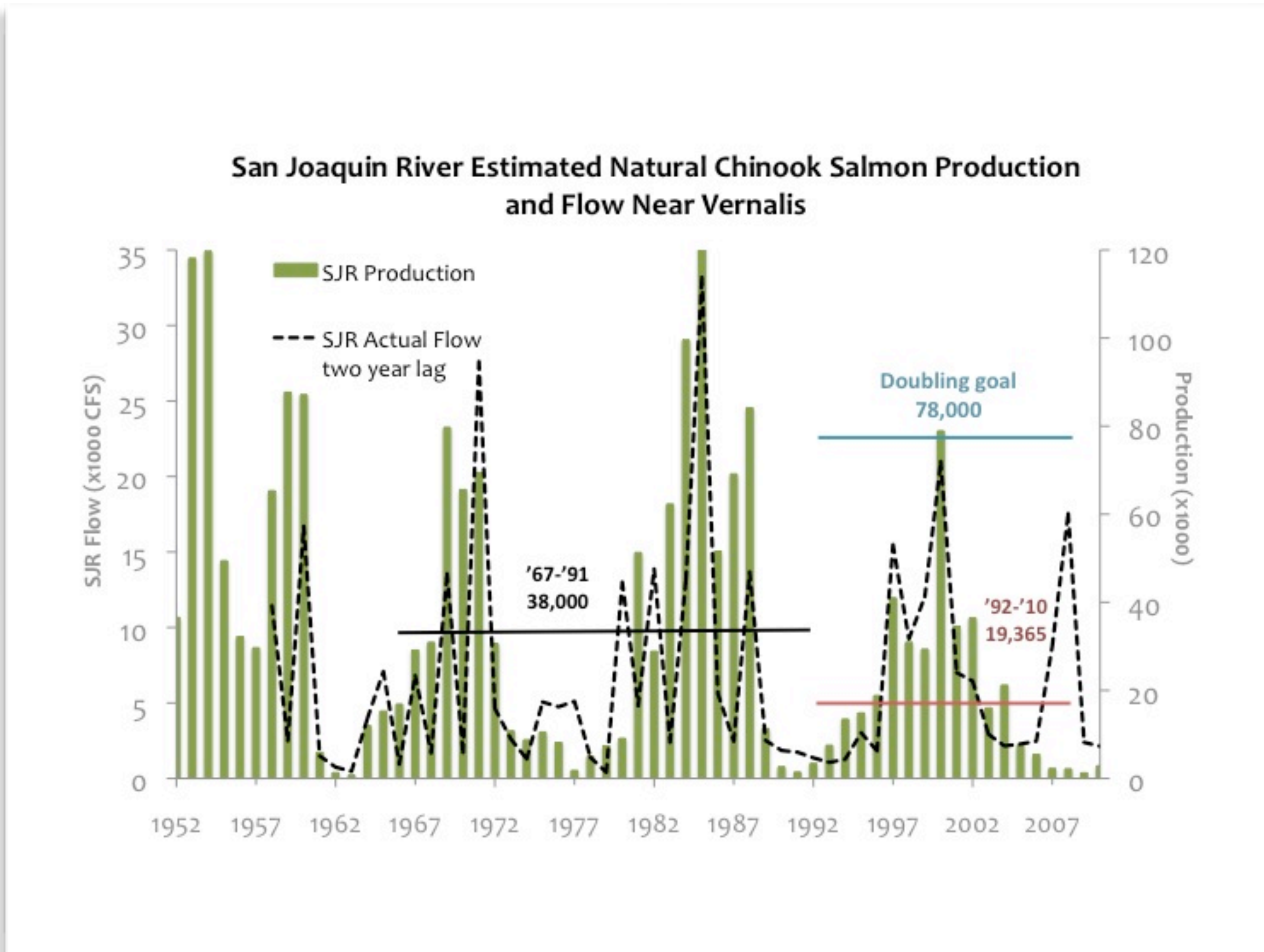

Figure 2. San Joaquin salmon production as related to San Joaquin flow two years earlier. (Source: Appendix C, SWRCB 2012)

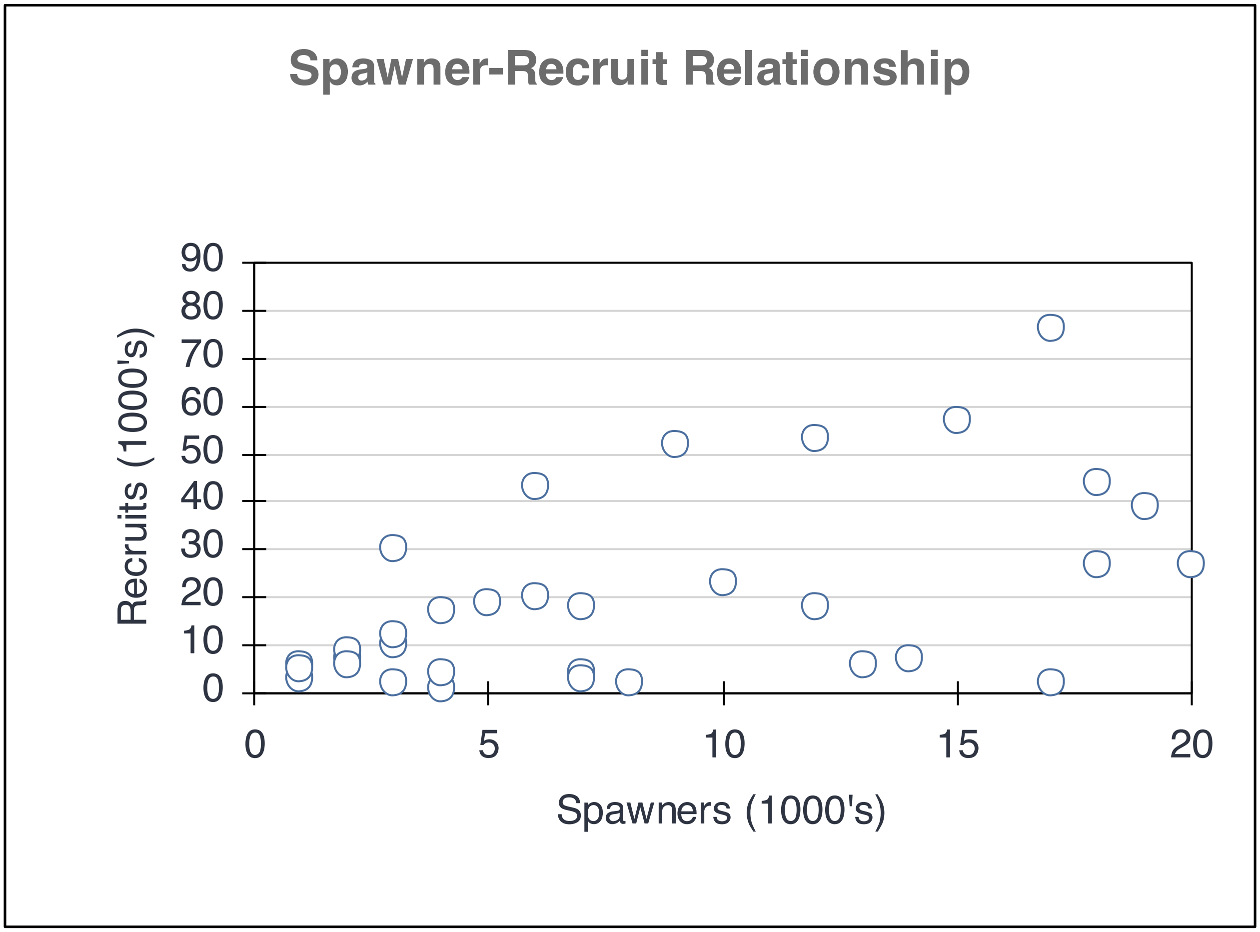

Figure 3. Spawner-recruit analysis for three tributaries combined: X-axis: number of spawners from Figure 2. Y-axis: recruits (spawners three years later). (Source: the author).

The escapement trend took a severe turn for the worse in the last decade. No positive response occurred following the 2005-2006 wet period. There are several explanations, which more likely overlap than conflict. These include unproductive ocean conditions, increased Delta exports (Figure 4), and a low number of spawners as an artifact of previous years with low escapement. While ocean conditions cannot be changed, it is essential to improve on the anthropogenic causal factors as soon as possible.

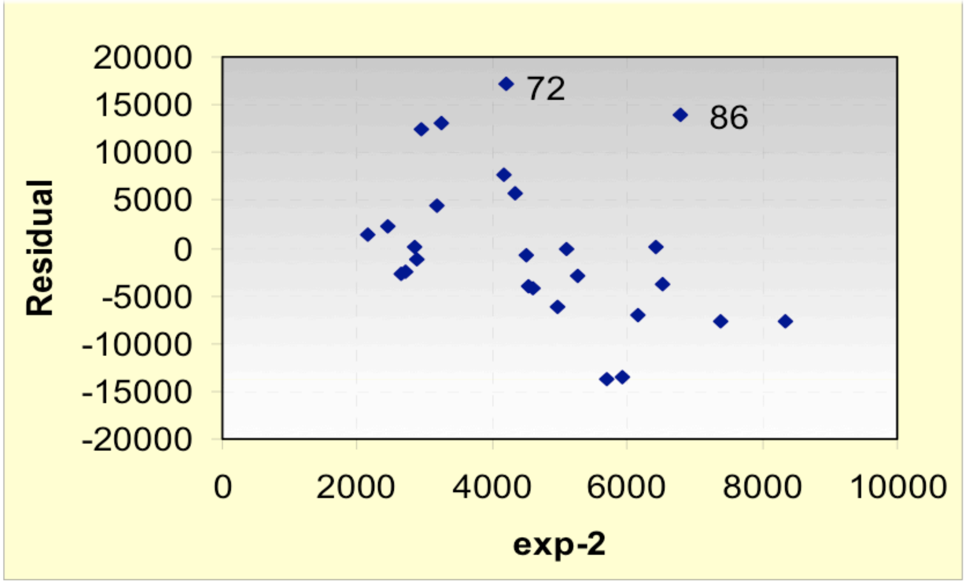

Figure 53. Residuals of regression of escapement, flow, and escapement two years earlier versus export level in April-May two years earlier for only low flow years. The relationship is marginally significant with 1972 and 1986, and highly significant without these years.

*Figure 4. Analysis of residual (unexplained) error in relationship between April-May San Joaquin flow two years earlier and salmon escapement to the San Joaquin not including the past ten years (numbers from Figure 2). Residual error is plotted against South Delta exports in April-May two years earlier (**exp-2**). Simply interpreted, the significant relationship means that lower than expected salmon population levels in the San Joaquin tributaries may be due in part to higher Delta exports.* (Source: the author)

Rationale for Release of 60% of January – June Unimpaired Flows

Sixty percent of the unimpaired flow in the January – June time period is needed for two reasons: (1) to keep winter-spring total flow levels in drier years above the 5000 cfs level as shown in Figure 2, as this by itself would help reduce the dramatic population collapses that occur in dry years; and (2) to emulate the magnitude and frequency of flow pulses and baseline flows in the unimpaired flow patterns of the three tributaries in winter and spring in all water-year types (Figure 5). As can be seen in Figure 5, 60% of the January – June unimpaired daily flow in a dry year barely retains the pulses in the pattern. Retention of 60% of unimpaired flows (including pulses) in wet years ensures that the major factors that influence migration and habitat will continue to provide much of their functional purposes and the large escapement levels of the historical period as seen in Figure 2. There is also a substantial body of evidence that higher Delta inflows and outflows benefits salmon production and migration success in the Delta and

Bay (Section 3, Appendix C, SWRCB 2012). The evidence also suggests that the benefits would extend to other resources including striped bass, sturgeon, splittail, and food chain production.

October 2011 SJR Flow and Southern Delta Salinity Technical Report

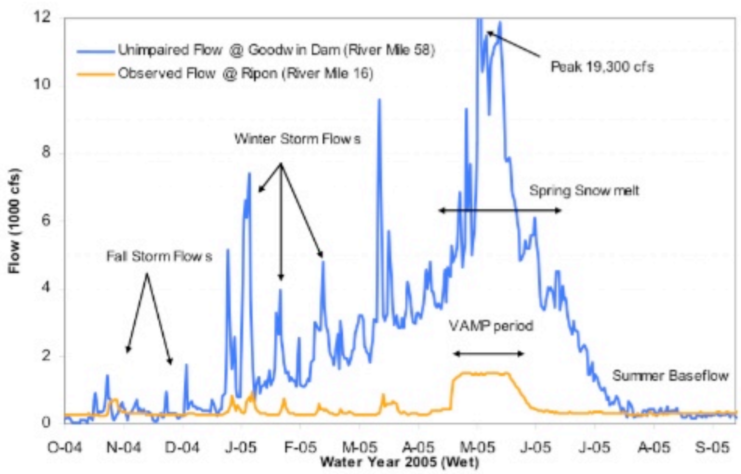

Figure 2.1. Typical Stanislaus River Annual Hydrograph of Daily Average Unimpaired and Observed Flows during a Wet Water Year (2005) Illustrating Important Hydrograph Components

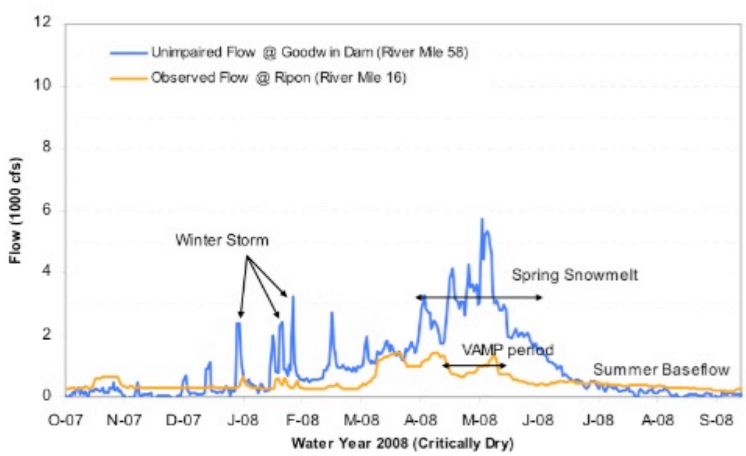

Figure 2.2. Typical Stanislaus River Annual Hydrograph of Daily Average Unimpaired and Observed Flows during a Critically Dry Water Year (2008) Illustrating Important Hydrograph Components

2-2

Figure 5. Actual and unimpaired flows in a typical recent wet and dry year for the Stanislaus River. (Source: SED, Appendix C, SWRCB 2012)

This report recommends San Joaquin tributary flows as a percent of unimpaired in the months of January through June, rather than the months of February through June recommended in the SED. Flows in the month of January are at least as important as those from February through June for purposes of protecting and improving San Joaquin watershed salmonid populations. The month of January is very important because many Chinook fry emerge and move downriver in this month (Figures 6-8). Many fry also reach the Delta and are salvaged at Delta Pumping Plants (Figure 9). Because the fish facilities are not efficient in collecting fry (25-40 mm), the number salvaged is not representative of the total numbers entering, moving through, and rearing in the Delta. Enhancing fry movement in January (and February) is important because cold waters typical of the month (10ºC or less) minimize the vulnerability of fry to the many warm-water Delta fish predators. Getting young salmon to the Bay and Delta as early as possible shortens their tenure in the rivers, limits their exposure to predators, accelerates their growth, and ensures early entrance to the ocean, a well known positive factor in Chinook salmon production.

Minimum flows for the Merced and the Tuolumne should be prescribed in the new FERC licenses for the Merced River Project and the Don Pedro Project (both currently being relicensed by FERC) to protect and enhance steelhead in July through December; flows prescribed in the OCAP Biological Opinion for salmonids help to protect and enhance steelhead on the Stanislaus. The recommended year-round minimum flow of 2000 cfs at Vernalis may also improve flows for steelhead in one or more individual tributaries.

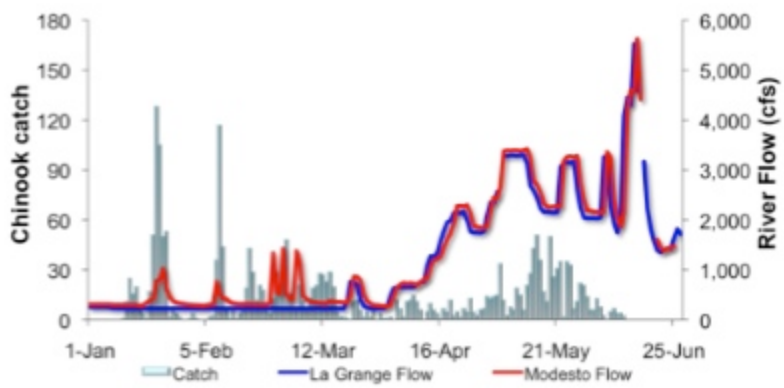

Figure 9. Daily Chinook salmon catch at Waterford and Tuolumne River flow recorded by La Grange (LGN) and Modesto (MOD), 2010.

Figure 6. Chinook catch in screw trap in Tuolumne River at Waterford (Source: Fishbio Newsletter, Vol. 2012, Issue 16)

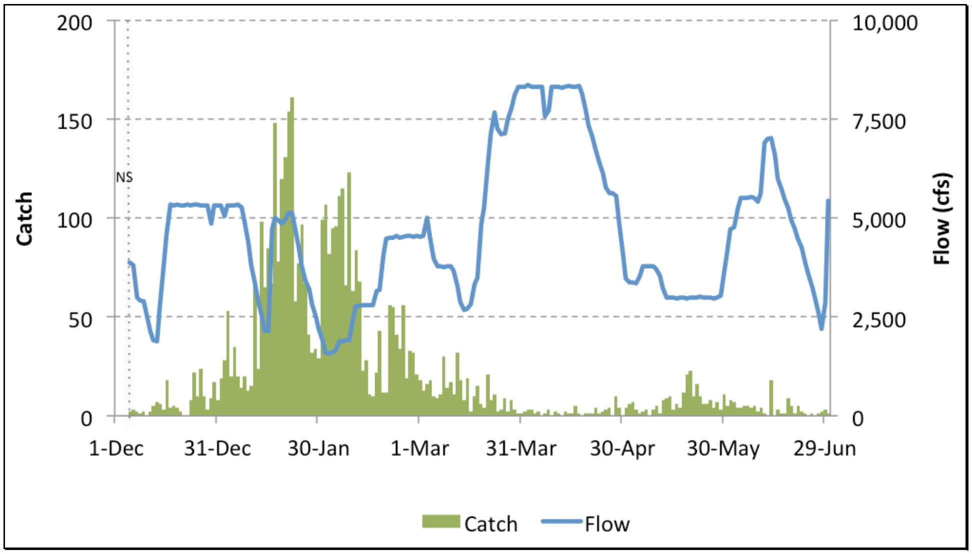

Figure 7. Chinook catch in screw trap in Tuolumne River at Waterford and river flow at La Grange (LGN) during 2011. (Source: Sonke et. al. 2012)

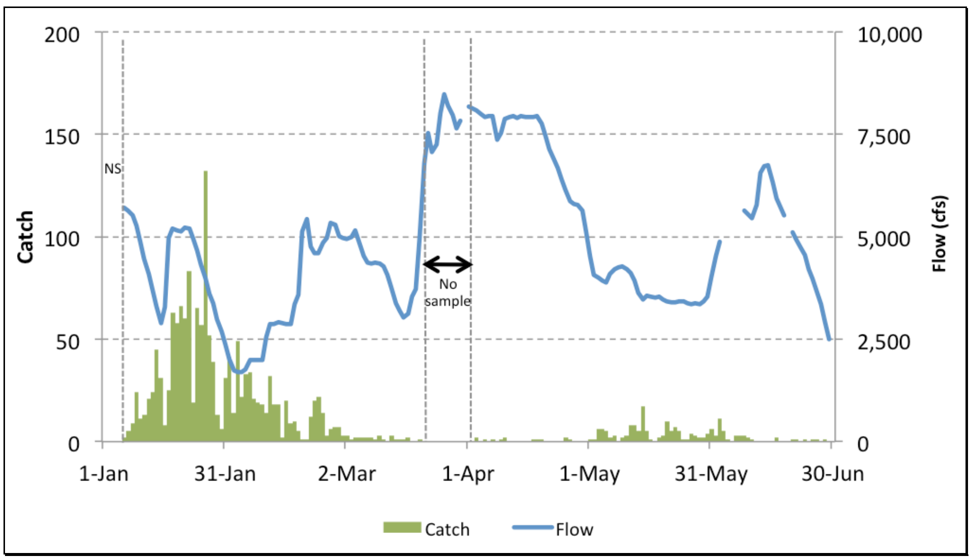

Figure 8. Chinook catch in screw trap in Merced River at Grayson and river flow at Modesto (MOD) during 2011. (Source: Sonke et. al. 2012)

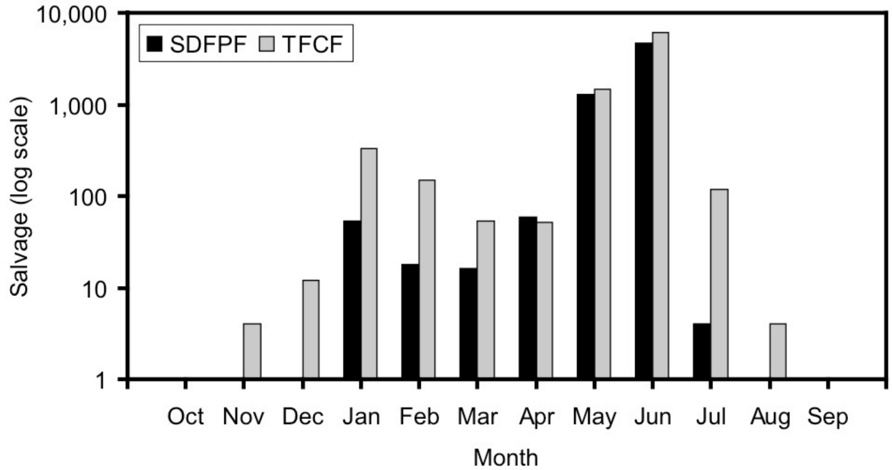

Figure 6 Monthly salvage of wild, fall-run Chinook salmon at the SDFPF and the TFCF, 2011. The logarithmic scale is $\log_{10}$.

Figure 9. Monthly salvage at Byron (SDFPF) and Tracy (TFCF) fish facilities in 2011. (Source: IEP Newsletter, Winter 2012)

Higher flows will greatly improve spawning and rearing habitats from the tributary tailwaters, down through the lower San Joaquin River, and through the Delta to the Bay (EPA 2012; Moyle et. al. 2012).

Salinity Has Important Effects on Fish

The SED addresses the role of salinity in the context of the suitability of water for irrigation, but does not consider salinity in terms of its effects on aquatic biota. This omission erases an entire line of analysis that was an important component of earlier SWRCB proceedings on Delta flow and water quality.

In examining the spawning of striped bass in the San Joaquin River, Farley (1966) concluded: "*No significant amount of spawning occurred in areas where the total dissolved solids content of the water was above 180 parts per million*[5]*; in 1964 TDS values above that level prevented bass from migrating above Stockton in the San Joaquin River*."

Radtke and Turner (1967) found:

> *"The quality of water in the two rivers [Sacramento and San Joaquin] is quite different. In dry years, such as 1966, the flow in the San Joaquin River is greatly reduced and consists largely of irrigation return water having relatively high concentrations of*

[5] A rough approximation conversion: [(TDS)ppm = Conductivity µS/cm x 0.67]. [Example: 180 ppm = 240 X 0.67]

total dissolved solids. In contrast, the Sacramento River is characteristically low in dissolved solids. A dissolved solids gradient is created in the study area by the mixture of water from the two rivers as they are drawn across the central Delta by the U.S. Bureau of Reclamation pumping plant at Tracy, California. The net effect is that water in the San Joaquin River from the study area to its junction with the Sacramento River about 25 miles downstream is primarily Sacramento River water. It is fresher than either the water farther downstream, which is mixed with ocean water, or the San Joaquin River water upstream. Thus, striped bass moving upstream and having made the normal adjustment to fresh water must readjust to more saline water if they continue upstream."

Radtke and Turner concluded that their study demonstrated "*…that 350 ppm is the critical concentration and helps explain the erratic [striped bass] spawning migrations that have occurred in the past in the San Joaquin River above Stockton*." They noted that "*with some proposed water development plans, the entire spawning migration in the San Joaquin River could be threatened.*" (Note: this spawning segment of the striped bass population has been virtually non-existent for decades.)

The Environmental Protection Agency wrote in its preamble to its Final Rule for *Water Quality Standards for Surface Waters of the Sacramento and San Joaquin Rivers, and San Francisco Bay and Delta* (1995):

"In addition to its general finding that the 1991 Bay/Delta Plan did not contain sufficient criteria to protect the designated uses, EPA also disapproved the absence of salinity standards to protect the Estuarine Habitat and other fish and wildlife uses in the Suisun, San Pablo, and San Francisco Bays and Suisun Marsh, the absence of scientifically supportable salinity standards (measured by electrical conductivity) to protect the Fish Spawning uses of the lower San Joaquin River" … .[6]

In the Final Rule, EPA specified salinity levels for the months of April and May much lower than those currently proposed in the SED, to protect fish migration and spawning in the San Joaquin River in the South Delta and upstream:

"The State Board's 1991 Bay/Delta Plan established objectives of 1.5 mmhos/cm EC at Antioch and 0.44 mmhos/cm EC at Prisoners Point in April and May. EPA disapproved these objectives, in part, because they are not adequate to protect spawning habitat in the reach farther upstream between Prisoners Point and Vernalis. EPA also disapproved the 1991 Bay/Delta Plan spawning criteria because they were not based on sound science. The State Board explained that the 1.5 mmhos/cm EC criteria at Antioch was intended to protect spawning habitat upstream of Antioch (near Jersey Point), not at the Antioch location itself. The State Board acknowledged that ``the use of 1.5 [mmhos/cm] EC at Antioch appears not to be generally appropriate, and proposed that a thorough review of this [criterion] be undertaken at the next triennial review'' (1991 Bay/Delta Plan, p. 5±32). EPA found this unproven approach of setting criteria downstream in hopes of attaining different criteria upstream deficient, and disapproved

[6] EPA's Water Quality Standards regulations at 40 CFR part 131; see *Federal Register*, January 24, 1995, p. 4666.

it….. EPA believes there is substantial scientific evidence indicating that increased salinities in the designated reaches of the San Joaquin River do in fact have an adverse effect on fish spawning".[7]

The EPA preamble also notes that striped bass are not the only species that would benefit from spawning standards for salinity:

> *"EPA believes that salinity problems in the lower San Joaquin affect aquatic species other than the striped bass. Recent research findings of USFWS (Meng 1994) suggest that the spawning habitat for the Sacramento splittail (currently proposed for listing as threatened under the ESA) is also being adversely affected by increased salt loadings in the lower San Joaquin. Accordingly, these criteria are consistent with a multiple species approach"*.[8]

Though they have not been enforced, the 1995 EPA salinity standards have never been rescinded.

Higher inflows from the San Joaquin will help protect fish spawning in the lower San Joaquin River and Delta by lowering total dissolved solids and salinity in the lower San Joaquin River. The recommended higher San Joaquin River inflows to the Delta will improve salinity levels in the lower San Joaquin River to more frequently meet the fish spawning objectives adopted by EPA in 1995.

Delta Operations Must Allow Migration to Suisun Bay

The benefits of increasing the flow releases in the San Joaquin River and its tributaries will be greatly diminished if the water released into the San Joaquin does not reach the Bay. Unfortunately, Delta operations today are such that in drier years almost none of the water from the San Joaquin escapes the Delta[9] and reaches Suisun Bay (also noted by SWRCB 2012, NMFS 2009). Present operations of the Delta Cross Channel (DCC) (closed most of December-June period) and Head-of-Old-River Barrier (HORB) (frequently open), in combination with Delta exports, cause most of the San Joaquin inflow at Vernalis to be directed into Old River and Middle River to the south Delta export facilities.

Salmon fry, fingerlings, and smolts moving downstream into the Delta from the San Joaquin tributaries follow the net flows to the screened entrances to the South Delta pumping plants. Those large enough to be salvaged at the fish collection facilities must first avoid many predators in front of the screens and then survive a truck trip to Sherman Island in the West Delta. Those too small to be salvaged (fry) generally do not survive. Smolts migrating down the San Joaquin River to the Delta have a similar problem successfully making it through the Delta (Vogel 2005).

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[7] *Id*, p. 4698.
[8] *Id*.
[9] http://www.water.ca.gov/iep/docs/pod/GrossEtAl_POD3D_Particle_tracking_2010.pdf

The present operation that emphasizes closing the DCC from December to June and keeping the HORB open runs counter to the barriers' original purposes. The DCC was constructed in the 1950s to ensure that more of the higher quality Sacramento water reached the Tracy Pumping Plant in the South Delta. Existing water quality standards and biological opinions require the DCC to be closed much of the December to June period to minimize the movement of Sacramento salmon into the interior Delta, not recognizing (or ignoring) the severe consequences to San Joaquin salmon.

The HORB was installed in 1963 to limit negative flows in the lower San Joaquin River caused by the Tracy Pumping Plant pulling water upstream in the San Joaquin into the head of Old River. The negative flows were detrimental, but low dissolved oxygen in the Stockton Ship Channel also disrupted salmon migrations. The HORB remains open more often than not today[10] to protect delta smelt living in the Central Delta from being drawn to the export pumps in the South Delta, again sacrificing San Joaquin salmon to protect other fish populations from the effects of reverse flows in Old River and Middle River.

The benefits of having a greater proportion of San Joaquin River flows reach Suisun Bay outweigh the potential negative effects on Sacramento salmon and delta smelt that might arise from these recommended changes in DCC and HORB operations. Recommendations in the 80's that the DCC be closed in winter and spring were derived from experiments that showed Sacramento salmon drawn into the interior Delta had a lower survival, based on tag release data for hatchery salmon smolts.[11] The present author's personal review of that data found very poor survival (and high salvage rates at South Delta export fish facilities) for tagged hatchery salmon groups released in the Mokelumne channels below the DCC *when the DCC was closed*. For releases at the same locations when the DCC was open, survival was higher, and similar to survival rates for salmon released in the lower Sacramento River above and below the DCC. Many years have passed and more studies have been conducted since then with similar results.

A more recent approach (Perry et. al. 2010, Perry et. al. 2012) followed survival of pit-tagged hatchery salmon smolts released in the river below Sacramento. The authors compared survival rates of tagged fish that followed different migration routes through the Delta. The approach was new because the tagged fish had the same beginning and end points. The authors determined the migration routes using pit-tag detection arrays positioned strategically throughout the Delta. Results of the study (Figure 10) show that pit-tagged hatchery salmon released in the lower Sacramento with the DCC open (December 5, 2006) had a survival rate that was similar to the combined survival rate of salmon that migrated through the Sacramento River and Steamboat-Sutter sloughs. On the other hand, survival was much lower for fish that passed

[10] "*The HOR barrier (HORB) has been installed in most years during the fall (roughly between September 30 and November 15) since 1968, and in some years during the spring (roughly between April 15 and May 30) since 1992. In general, the HORB was not installed during the spring in years with higher flows. In addition, the HORB has not been installed in the spring since 2007 due to a court order. A non-physical fish barrier was installed in its place in 2009 and 2010. When the physical barrier at HOR is installed, the flow into Old River is reduced to between 20% and 50% (Jones and Stokes 2001). Data from Jones and Stokes (2001) further suggests that the agricultural barriers alone (when physical barrier at HOR was not installed), reduces flow into Old River for all pumping ranges, and reduced the effects of increased pumping on water levels and circulation*.". (SWRCB 2012)

[11] This work is summarized in in Perry et. al. 2010.

through Georgiana Slough in January 2007 when the DCC was closed. In both papers, the authors point to the overall higher survival of fish that do not pass through the interior Delta. Singer et. al. (2012) also note low survival of tagged Sacramento fish that pass through the East Delta (with the DCC closed).

The authors noted that less Sacramento water entered the interior Delta with the DCC closed[12]; however, this extrapolation from water to fish fails to consider comparable circumstances for fish emigrating from the San Joaquin. The experiment did not have groups of San Joaquin tagged salmon under the two circumstances to compare. Effectively, the tagged fish from the Sacramento that passed through DCC or Georgiana Slough can be considered a surrogate for those San Joaquin salmon juveniles that successfully reach the mouth of the Mokelumne River.

TABLE 1.—Route-specific survival through the Sacramento–San Joaquin River Delta ($\hat{S}_h$) and the probability of migrating through each route ($\hat{\psi}_h$) for acoustically tagged fall-run juvenile Chinook salmon released on 5 December 2006 and 17 January 2007. Also shown is population survival through the delta, which is the average of route-specific survival weighted by the probability of migrating through each route; NA = not applicable.

Migration route	$\hat{S}_h$ (SE)	95% profile likelihood interval	$\hat{\psi}_h$ (SE)	95% profile likelihood interval
		5 December 2006		
Sacramento River	0.443 (0.146)	0.222–0.910	0.352 (0.066)	0.231, 0.487
Steamboat and Sutter sloughs	0.263 (0.112)	0.102–0.607	0.296 (0.062)	0.186, 0.426
Delta Cross Channel	0.332 (0.152)	0.116–0.783	0.235 (0.059)	0.133, 0.361
Georgiana Slough	0.332 (0.179)	0.087–0.848	0.117 (0.045)	0.048, 0.223
All routes	0.351 (0.101)	0.200–0.692		
		17 January 2007		
Sacramento River	0.564 (0.086)	0.403–0.741	0.498 (0.060)	0.383, 0.614
Steamboat and Sutter sloughs	0.561 (0.092)	0.388–0.747	0.414 (0.059)	0.303, 0.531
Delta Cross Channel	NA		0.000	NA
Georgiana Slough	0.344 (0.200)	0.067–0.753	0.088 (0.034)	0.036, 0.170
All routes	0.543 (0.070)	0.416–0.691		

Figure 10. Summary table from Perry et. al. (2010). Mean survival rate and standard errors are in first column. Confidence intervals are in second column. Proportion of tagged individuals taking each route is in third column, along with the confidence intervals in column 4. Note route-survival rates in second column are from Sacramento River releases upstream of the DCC.

In sum, three elements are needed to protect emigrating San Joaquin River salmon: 1) high flows through the DCC (DCC open); 2) high San Joaquin inflows; and 3) high outflows at Jersey Point ("Q-West") (see Figure 11, location E). This will protect Sacramento salmon and move them to Suisun Bay and at the same time greatly improve successful emigration of San Joaquin salmon to Suisun Bay.

Keeping the HORB closed will help San Joaquin salmon to reach the mouth of the Mokelumne (near location C in Figure 11) and Jersey Point. Negative flows from the Central Delta (moving from location C to location D in the chart) increase, however, with the HORB closed, because the South Delta pumping plants then draw more water from the north ends of

[12] *"Thus, on average, we suspect that the closure of the Delta Cross Channel will reduce the proportion of the fish entrained into the interior Delta by reducing the fraction of the mean discharge entering the interior Delta.*" (Perry et. al. 2012, p. 153)

Old and Middle rivers. The effects of the resulting negative flows in Old and Middle River will be substantially diminished with the DCC open.

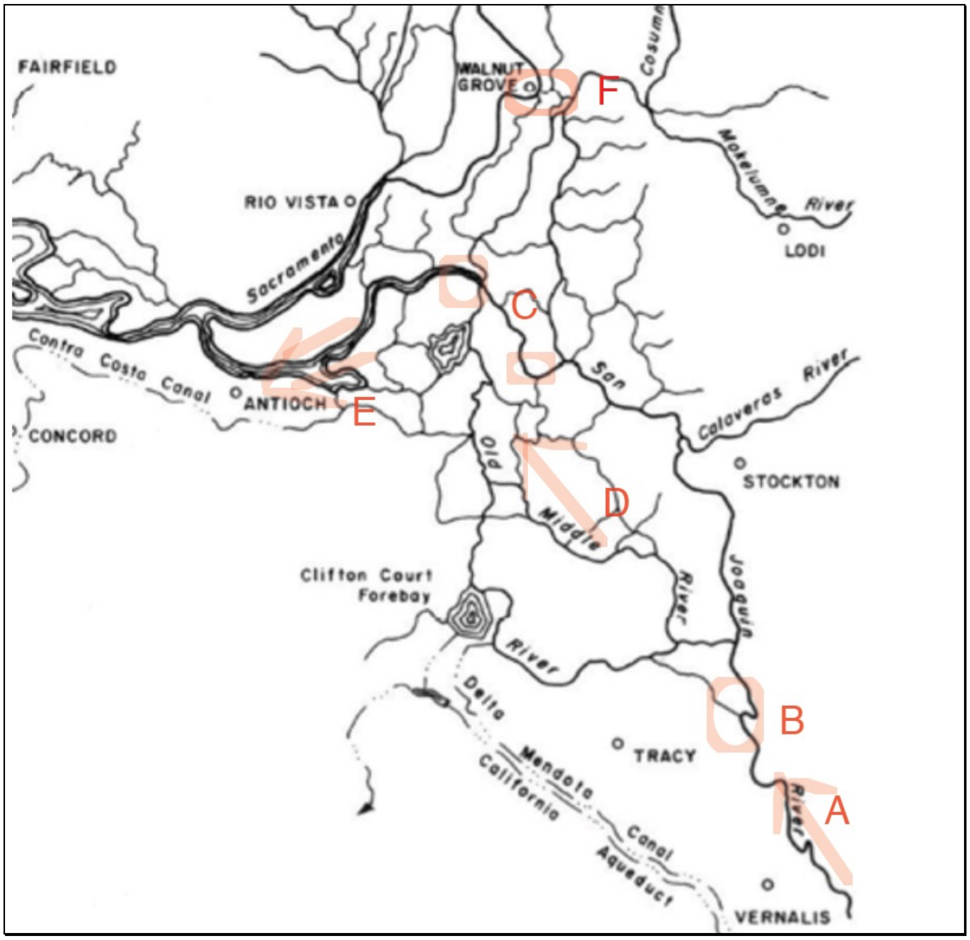

Figure 11. Locations:

A -Vernalis San Joaquin Flow
B -Head-of-Old-River Barrier
C -net flows in outlets of Old and Middle Rivers
D -net flow direction in Old and Middle Rivers between South Delta Pumping Plants and river mouths on Lower San Joaquin River in Central Delta.
E -net flow in Lower San Joaquin River below mouth of Old River as measured at Jersey Point
F -Delta Cross Channel

A screened gate at the HORB could let some San Joaquin River flow into upper Old River to meet some of the export demands and reduce the negative flows in lower Old and Middle rivers, while protecting emigrating San Joaquin juvenile salmon from being drawn into the interior Delta. It might also increase the range of operation: HORB at present is not functional at flows greater than about 8000 cfs. Replacement of the fish screens and other facilities at the entrances to the south Delta pumping plants is also desperately needed to reduce the present losses of Sacramento and San Joaquin salmon and numerous other species.

Higher San Joaquin Delta inflow, if allowed to reach the Central and Western Delta as well as Suisun Bay, will also benefit the Bay-Delta ecological food chain. The Independent Science Panel explained:

> "*While San Joaquin River flows are hydrologically less important, there is an increasing recognition of their disproportionately strong role in Bay-Delta productivity. While phytoplankton resources in the estuary are considered relatively poor (Jassby et al. 2002), the lower San Joaquin River represents a relatively enriched region (Lehman 2007). The contribution of these resources to the downstream food web is strongly regulated by San Joaquin River flow. Food web effects may not be limited to phytoplankton as San Joaquin River inflow is hypothesized to be one of the primary sources of the calanoid copepod Pseudodiaptomus forbesi. P. forbesi is a major food for key fishes such as delta smelt (John Durand UC Davis/San Francisco State University studies reported in Baxter et al. 2010). The bottom line is that San Joaquin River inflow appears to play a relatively strong role as a source of high-quality phytoplankton and fish-prey organisms*."[13]

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[13] Available at:
http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/cmnt091412/randy_baxter.pdf

Future Considerations

These same recommendations (i.e., 60 % of unimpaired flow) and rationale will also be applicable to the upper San Joaquin River above Merced once fall-run and spring-run Chinook salmon are restored to that portion of the river. Fall-run have already been reintroduced to the upper San Joaquin below Friant Dam, and have been observed spawning in that reach. A captive broodstock program is a principal component for producing the quantity of eggs and juveniles needed to achieve the Restoration Program's reintroduction goals for spring-run salmon. Eggs from the captive broodstock should be available to the Program beginning in 2015. The number of eggs available is expected to increase over time, thus allowing the Restoration Program to plan focused releases of spring-run salmon into the San Joaquin River. These initial releases are expected to result in some adult spring-run salmon returning to the system within three to five years.

Conclusion

The flow proposal presented in Appendix K of the SED is inadequate. The SED provides no justification for why the proposed 35% of February through June unimpaired flow is sufficient. Appendix K of the SED defines compliance in such a way that flows can be as low as 25% and no more than 45% of February through June unimpaired. The *Delta Flow Criteria Report* (SWRCB 2010) found that 60% of February through June unimpaired flow was needed as a flow requirement at Vernalis; the Board has provided no science to show why so much less flow will protect San Joaquin and Delta fisheries, or why January should not be included.

Thirty-five percent of February through June unimpaired flow will not provide flow magnitudes for productive juvenile rearing habitat or protective emigration habitat in the tributaries, in the San Joaquin, and in the Delta. It will not provide sufficient baseflow, flow peaks, or variability to create the benefits that that emulating the natural hydrograph is designed to create. The use of a 14-day running average will further reduce the benefits of a percent-of-unimpaired methodology. The flow caps for percent-of-unimpaired diminish the benefits yet again, almost totally limiting floodplain inundation to flood releases.

Appendix K of the SED does not define how flow magnitudes and durations will be determined within the effective 25% to 45% water budget. It requires creation of an Implementation Workgroup and a Coordinated Operations Group. The processes that these groups will conduct are left to be determined by the groups, as are the performance measures and decision points which might lead them to recommend modifications of operations.

The SED separates elements that are fundamentally connected in the context of biological resources in the San Joaquin watershed and the Delta. The SED does not consider San Joaquin tributary flows in combination with different operations of the DCC gates, HORB, and South Delta export facilities, or in combination with reverse flows, or in combination with the need for San Joaquin River water to reach Suisun Bay. The SED does not consider the effects of salinity and salinity requirements on aquatic biota.

Literature Cited and Summaries

Environmental Protection Agency (EPA). 2012. Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, EPA's Action Plan. Available at: http://www.epa.gov/sfbay-delta/pdfs/EPA-bayareaactionplan.

>>Migratory fish rely on diverse habitats during different life stages and they require appropriate cues and connections to guide them to those habitats. Juvenile salmon use flow as the primary cue to maneuver from their spawning grounds through the rivers to the estuary. Salinity gradients and tidal action can then guide them to the ocean. Adult fish follow the unique chemical signature of their natal stream, although straying is common. Along these migratory paths, contaminants, high temperatures, low dissolved oxygen, physical barriers, and predators may interfere with migratory success. Thus, salmon management requires a watershed approach to ensure a connected and unblocked migratory corridor. (EPA 2012: 26)

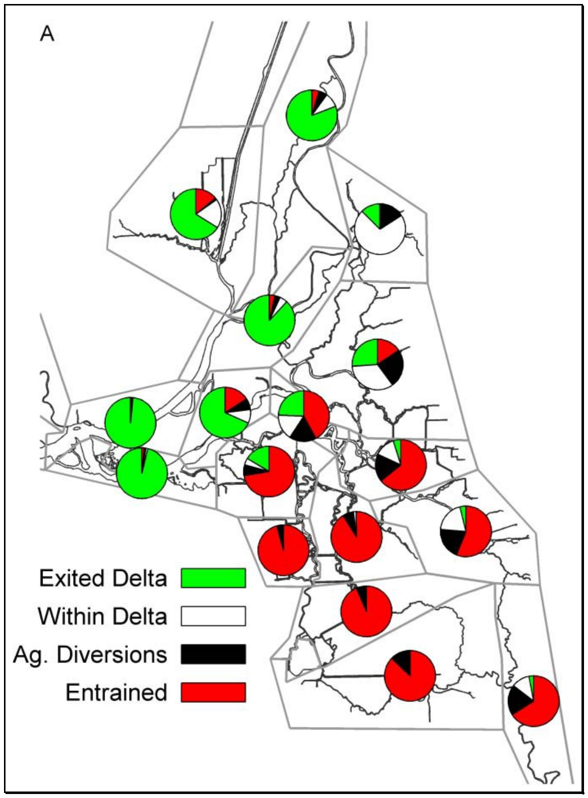
Migratory passage along the San Joaquin River is a beneficial use that may not be adequately protected. Outmigrating juveniles have some protection; adults migrating back to their natal streams have little protection. The absence of migratory cues for returning adult San Joaquin fish has not been comprehensively addressed in a regulatory framework.

Although critical, the remediation of temperature and dissolved oxygen alone is unlikely to restore depleted salmon stocks unless water from the San Joaquin River and its tributaries supports a migratory corridor to and from the Estuary during both the season of adult upmigration and young outmigration.

Environmental Protection Agency (EPA), Federal Register January 24, 1995, *Water Quality Standards for Surface Waters of the Sacramento and San Joaquin Rivers, and San Francisco Bay and Delta, California; Final Rule.*

Gross, E. S. and others. 2010. POD3D particle tracking modeling study. Prepared for Interagency Ecological Program (IEP). www.water.ca.gov/iep/docs/pod/GrossEtAl_POD3D_Particle_tracking_2010.pdf

Author's note: The paper included this figure showing the fate of particles on April 11, 2007 from different points in the Delta after 60 days. Conditions: DCC was closed with 2000 cfs San Joaquin inflow to Delta. Note the very small percentage of particles (green) that are able to exit the Delta to the Bay from the lower San Joaquin River. At 7000 cfs San Joaquin flow, the proportion exiting the Delta is higher at about 20% (with DCC closed). If the DCC were kept open with the HORB in place, (conditions not modeled by the study) the proportion would be significantly higher.



>> *The authors noted*: The estimates of delta smelt distribution and, in particular, hatching distribution, are highly relevant to ongoing policy decisions. Any project that modifies flow pathways and mixing in the Delta is likely to decrease entrainment of fish from some regions and increase entrainment of fish from other regions. Therefore, in order to confidently estimate impacts of such project, it is critical to estimate the distribution of delta smelt and any other relevant fish species. Hydrodynamic and particle tracking modeling tools, particularly if applied in a probabilistic framework, will be useful supplements to ongoing observational programs in estimating the distribution and entrainment of delta smelt and other species for current conditions and different Delta operations scenarios.

Independent Science Panel, submittal to Workshop #2 for Phase II of the Update of the Bay-Delta Water Quality Control Plan, September 14, 2012. Available at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/cmnt091412/randy_baxter.pdf

Moyle, P., W. Bennett, J. Durand, W. Fleenor, B. Gray, E. Hanak, J. Lund, and J. Mount. 2012. Where the Wild Things Aren't: Making the Delta a Better Place for Native Species. Public Policy Institute of California, San Francisco, CA. 55p. Available at: http://www.ppic.org/content/pubs/report/R_612PMR.pdf

>> Furthermore, there is reason to believe that proportionate impacts of salmon entrainment that are expressed as a proportion of juvenile production would also significantly underestimate the population level effect of entrainment on Chinook salmon

populations. DFG and NMFS have not updated the estimated survival to the Delta in the JPE calculation to account for recent acoustic tag data on survival to the Delta. (NMFS 2012b: 7) For instance, recent studies of late fall run Chinook salmon released in 2007 with acoustic tags found that the average survival rate was only 3.9% for the migration from Battle Creek / upper Sacramento River release site to the ocean and that survival from the release site to the Delta was below 40% in all three years and was below 20% in 2007. (Michel 2010: 8 and Fig. 4). Thus current estimates of entrainment at the pumps may substantially underestimate the fraction of the population that is taken, as well as the population level effects of this entrainment.

National Marine Fisheries Service (NMFS). 2009. Biological Opinion on proposed long term operations of the Central valley Project and State Water Project. Available at: http://www.swr.noaa.gov/ocap/NMFS_Biological_and_Conference_Opinion_on_the_Long-Term_Operations_of_the_CVP_and_SWP.pdf]

National Marine Fisheries Service (NMFS). 2012. Delta hearing exhibit. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/nmfs/nmfs_summary.pdf

>>Entrainment and low survival rates through the Delta remain a concern for steelhead from the San Joaquin River basin, Sacramento River basin, and eastside tributaries. Although there is no population estimates for Central Valley steelhead, the 2009 NMFS biological opinion continues use of an incidental take limit of 3,000 wild steelhead that is not based on a measure of steelhead abundance. (NMFS 2011b at 53-54) Salvage of wild steelhead in 2011 (738) was lower than in 2010 (1,029), with the highest monthly salvage of wild steelhead observed in June 2011. (NMFS 2011b: 54, 68) The seasonal salvage for hatchery steelhead in 2011 was the lowest observed in the past 11 years. (NMFS 2011b: 54).

Moyle et al 2012 attributes harm to native species living in or passing through the Delta as well as the degradation of water quality and habitat to key stressors working singly and in combination. These stressors include alteration of flows, channelization of waterways, discharge of pollutants, introduction of non-native species, and the diversions of water from the system. Their analysis identifies five core premises that have strong scientific support including that the most restrictive physical and biological constraints on the system include limits on the availability of fresh water, and the domination of the ecosystem by invasive species. The report recommends five key components of a strategy for recovery and reoperation of the delta, the first of which is that natural processes place limits on all water and land management goals.

Perry, R. W., J. R. Skalski, P. L. Brandes, P. T. Sandstrom, A.P. Klimley, A. Ammann, and B. MacFarlane. 2010. *Estimating Survival and Migration Route Probabilities of Juvenile Chinook*

Salmon in the Sacramento–San Joaquin River Delta. North American Journal of Fisheries Management 30:142–156. DOI: 10.1577/M08-200.1

>> Juvenile salmon entering the interior delta must traverse longer migration routes and are exposed to entrainment at the water pumping projects, both of which may decrease survival of fish using this migratory pathway…. To date, the proportion of fish migrating through the interior delta has not been estimated, yet such estimates are critical to understand the relative effect of water management actions on the population as a whole (Newman and Brandes 2009)…. Coincident with lower river discharge, fish released in January took substantially longer to migrate through the Delta and exhibited higher variation in travel times relative to fish released in December (*Author's note: DCC was open in December and closed in January*). At 500 m3/s (*18,000 cfs*) 35 % went into interior Delta (*via DCC and Georgianan Slough with DCC open*) compared with 11 % (*via Georgiana Slough with DCC closed*)…. Coincident with lower river discharge, fish released in January took substantially longer to migrate through the delta and exhibited higher variation in travel times relative to fish released in December. In general, similar to our study, these studies found that survival of fish released into the interior delta via Georgiana Slough was lower than survival of fish released into the Sacramento River downstream of Georgiana Slough (*with DCC closed)*… This evidence continues to support the hypothesis that survival for fish migrating through the interior delta is lower than for fish that remain in the Sacramento River (*with DCC closed)*. Closure of the Delta Cross Channel reduces channel capacity of the Sacramento River at the second river junction, which slightly increases the proportion of river flow diverted into Sutter and Steamboat sloughs.

>> *See figure below:*

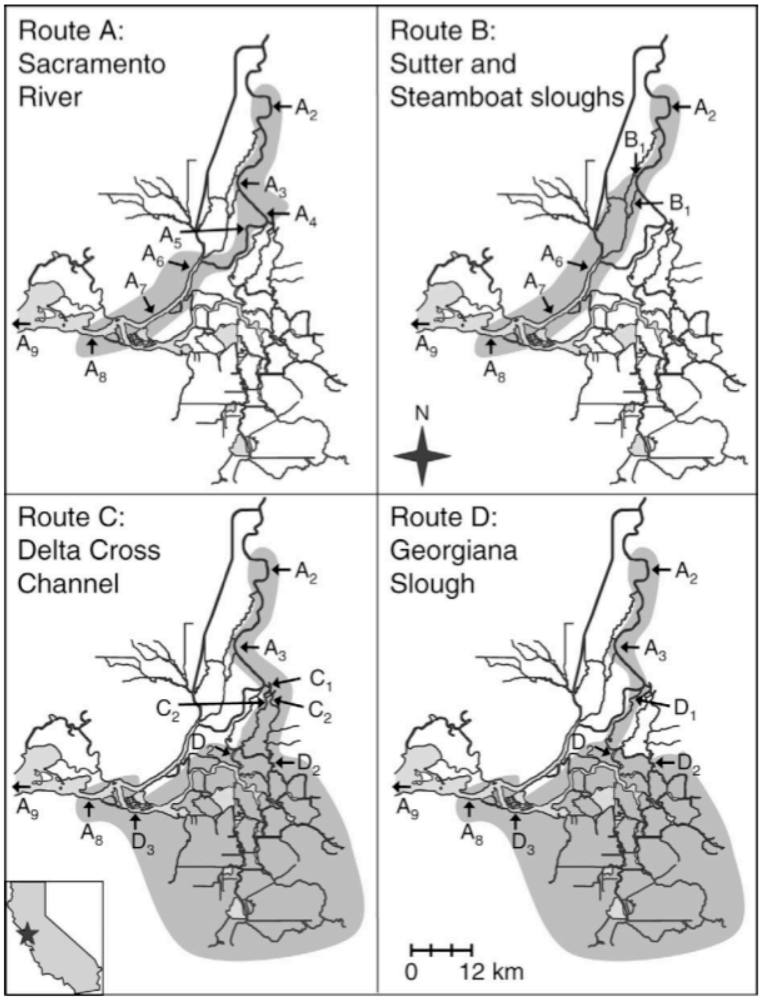


FIGURE 1.—Maps of the Sacramento–San Joaquin River Delta, with shaded regions showing the river reaches that comprise four different migration routes. Arrows show the locations of the telemetry stations specific to each route. The delta extends from station A_2 at Freeport to station A_8 at Chipps Island. The first river junction occurs where Sutter and Steamboat sloughs (B_1) diverge from the Sacramento River at station A_3. The second junction occurs where the Delta Cross Channel (C_1) and Georgiana Slough (D_1) diverge from the Sacramento River at station A_4. For routes C and D, the interior delta is the large shaded region to the south of station D_2. Telemetry stations with the same label (B_1, C_2, and D_2) were pooled as one station in the mark–recapture model. Station A_3 was not operational during the first release in December 2006. Station A_9 pools all of the telemetry stations in San Francisco Bay downstream of A_8. The release site (rkm 92) was 19 rkm upriver of station A_2 (rkm 73).

Perry, R. W., P. L. Brandes, J. R. Burau, A. P. Klimley, B. MacFarlane, C. Michel, and J. R. Skalski. 2012. *Sensitivity of survival to migration routes used by juvenile Chinook salmon to negotiate the Sacramento-San Joaquin River Delta*. Environ. Biol. Fish. DOI 10.1007/s10641-012-9984-6]

Radtke, L and Turner, J, *High Concentrations of Total Dissolved Solids Block Spawning Migration of Striped Bass, Roccus saxatilis, in the San Joaquin River, California***,** Delta Fish and Wilflife Study, California Department of Fish and Game, 1967.

Singer, G., A. R. Hearn, E. D. Chapman, M. L. Peterson, P. E. LaCivita, W. N. Brostoff, A. Bremner, and A. P. Klimley. 2012. Interannual variation of reach specific migratory success for Sacramento River hatchery yearling late-fall run Chinook salmon (Oncorhynchus tshawytscha) and steelhead trout (Oncorhynchus mykiss). Environ Biol Fish DOI 10.1007/s10641-012-0037-y

> >> It has been suggested that fish entrained in the East Delta have lower survival rates than other routes (Perry et al. 2010), although it is important to note that Perry defined "survival" as migration to Chipps Island. This was consistent with our results - throughout the duration of our study, fish migrating through the East Delta had lower overall survival than fish choosing either the West Delta or the mainstem Sacramento River, with the exception of West Delta steelhead in 2009 (Fig. 6). (p. 15) Although their study did not directly examine why survival was lower in the East Delta routes, the authors note that migratory survival is generally inversely related to migratory distance, and note that fish entrained into the East Delta have a longer route to the ocean and potentially encounter the CVP and SWP pumps.
>
> Additionally, the Operations Criteria and Plan (OCAP) Biological Assessment (BA) (USBR 2008) contains regressions of monthly steelhead salvage at the Central Valley Project and State Water Project pumping facilities, which shows a significant relationship between number of steelhead salvaged and the amount of water exported during the months of January through May, the same time that our tagged fish where in the Sacramento River Watershed. Our study suggests that entrainment in the east delta was negatively correlated with success to the ocean."

Sonke, C.L., S. Ainslehy, and A. Fuller. 2012. Outmigrant Trapping of Juvenile Salmon in the Lower Tuolumne River, 2011. FISHBIO report. Oakdale, CA 95361. Available at: http://www.tuolumnerivertac.com/Documents/2011%20Tuolumne%20RST%20Annual%20Report_final.pdf

SWRCB. 2012. SED Technical Report and Appendices. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/2012_sed/docs/2012ap_c.pdf

> > >The SED and supporting appendices have determined that the Preferred LSJR Alternative would generally increase mean annual river flows relative to baseline conditions, with that increase occurring mainly in the spring months. As a result, the quantity of surface water available for diversion in the three tributaries would generally be reduced. This would have a potentially significant impact on agricultural production dependent on these diversions and the associated sectors of the economy, particularly in the Tuolumne and Merced River watersheds where baseline flows on those rivers are lower than on the Stanislaus River. There may also be significant indirect impacts on groundwater and other resources if there is an increase in groundwater pumping in response to reduced surface water diversions.
>
> *Author's note: The Board is proposing that the operators of each major storage dam on the San Joaquin tributaries release 35% of the unimpaired inflow in the months of*

February through June. The SWRCB 2010 Delta Flow Criteria Report recommended that the release from the San Joaquin to the Delta should be 60% of unimpaired in the months of February through June; we were told that this was already a compromise, since for the Sacramento watershed the 2010 Delta Flow Criteria Report recommends release of 75% of unimpaired inflow.

>> Fall-Run Chinook Salmon Flow Needs: Flows in the SJR basin affect various life stages of fall-run Chinook salmon including: adult migration, adult spawning, egg incubation, juvenile rearing, and outmigration to the Pacific Ocean. Analyses indicate that the primary limiting factor for salmon survival and subsequent abundance is reduced flows during the late winter and spring when juveniles are completing the freshwater rearing phase of their life cycle and migrating from the SJR basin to the Delta (February through June; DFG 2005a, Mesick and Marston 2007, Mesick et al. 2007, Mesick 2009). As such, while SJR flows at other times are also important, the focus of the State Water Board's current review is on flows within the salmon-bearing tributaries and the SJR at Vernalis (inflows to the Delta) during the critical salmon rearing and outmigration period of February through June.

>> In late winter and spring, increased flows provide improved transport downstream and improved rearing habitat for salmon migration. These flows may also provide for increased and improved edge habitat (generally inundated areas with vegetation) in addition to increased food production for the remainder of salmon that are rearing in-river. Later in the season, higher inflows function as an environmental cue to trigger migration of smolts, facilitate transport of fish downstream, and improve migration corridor conditions (USDOI 2010). Specifically, higher inflows of various magnitudes in spring support a variety of functions including: maintenance of channel habitat and transport of sediment, biota, and nutrients (Junk et al. 1989). Increased turbidity and more rapid flows, may also reduce predation of juvenile Chinook salmon (Gregory 1993; Gregory and Levings 1996, 1998). Higher inflows also provide better water quality conditions by reducing temperatures, increasing dissolved oxygen levels, and reducing contaminant concentrations. NMFS has determined that each of these functions is significantly impaired by current conditions.

>> Studies that examine the relationship between fall-run Chinook salmon population abundance and flow in the SJR basin generally indicate that: 1) additional flow is needed to significantly improve production (abundance) of fall-run Chinook salmon; and 2) the primary influence on adult abundance is flow 2.5 years earlier during the juvenile rearing and outmigration life phase (AFRP 2005, DFG 2005a, Mesick 2008, DFG 2010a, USDOI 2010). These studies also report that the primary limiting factor for tributary abundances are reduced spring flow, and that populations on the tributaries are highly correlated with tributary, Vernalis, and Delta flows (Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001b, Mesick and Marston 2007, Mesick 2009, Mesick 2010 a-d).

>>Analyses have been conducted for several decades that examine the relationship between SJR fall-run Chinook salmon survival (escapement) or abundance (e.g., adult

Chinook salmon recruitment) and flow. Specifically, analyses have also been conducted to: 1) evaluate escapement (the number of adult fish returning to the basin to spawn) versus flow 2.5 years earlier when those salmon were rearing and outmigrating from the SJR basin; and 2) to estimate juvenile fall-run Chinook salmon survival at various reaches in the SJR basin and the Delta versus flow. For example, flows from March through June have been correlated to the total number of smolt outmigrants within a tributary (Mesick, et al. 2007, SJRRP 2008). Figure 3.8 suggests that prolonged late winter and spring flows in the Tuolumne River are an important factor in determining smolt survival rate (Mesick 2009). Additionally, adult Chinook salmon is thought to be highly correlated with the production of smolt outmigrants, which are highly correlated to spring flows, for each of the major SJR tributaries (Mesick and Marston 2007, Mesick, et al. 2007)...... Kjelson et al. (1981) found that peak catches of salmon fry often follow flow increases associated with storm runoff, suggesting that flow surges influence the number of fry that migrate from spawning grounds into the Delta and increase the rate of migration for fry. Kjelson et al. (1981) also found that flows in the SJR and Sacramento River, during spawning and rearing periods, influence the numbers of juvenile Chinook salmon that survive to migrate to the Delta. In addition, observations made in the SJR basin between 1957 and 1973 indicate that numbers of Chinook spawners are influenced by the amount of river flow during the rearing and outmigration period (February to June) 2.5 years earlier. As a result, Kjelson et al. (1981) found that flow appears to affect juvenile survival, which in turn affects adult abundance. In testimony before the State Water Board in 1987, Kjelson again reported that data indicate that the survival of fall-run salmon smolts migrating from the SJR basin through the Delta increases with flow. Kjelson found that increased flows also appear to increase migration rates, with smolt migration.... Mesick (2009) found that since the 1940s, escapement has been correlated with mean flow at Modesto from February 1 through June 15 (2.5 years earlier), and that flows at Modesto between March 1 and June 15 explain over 90 percent of the escapement variation. This correlation suggests that escapement has been primarily determined by the rate of juvenile survival, which is primarily determined by the magnitude and duration of late winter and spring flows, since the 1940s.

Vogel, D. 2005. The effects of Delta hydrodynamic conditions on San Joaquin River juvenile salmon. May 2005. Natural Resources Scientists, Inc. Red Bluff, CA.

>>"Fish movements into Turner Cut appeared to be a principal route for fish entry into areas south of the San Joaquin River and to a lesser extent, Columbia Cut or Middle River….The second interesting finding from these studies was the fact that most fish, once they left the San Joaquin River, did not get back to the mainstem. This finding was unexpected at the time because it was assumed that fish moving into the south Delta channels for reasons solely attributable to the tidal effects (e.g., during a flood tide) would move back out into the San Joaquin River during the change in tidal phase (e.g., an ebb tide). Empirical data were collected that demonstrated some of those fish kept moving in a southerly direction toward the export facilities. Some of the fish entering channels south of the San Joaquin River were tracked several miles into those channels. It was particularly evident that net southerly movement was rapid. Within a period of just several days, some fish were located far south in Middle River and Old River. It was

also evident that the lowest "entrainment" of fish off the mainstem occurred when the net reverse flows and SWP and CVP exports were lowest.

When radio-tagged smolts were released in Old River nine miles north of Clifton Court (CC) during combined exports in the range of 8,000 – 11,000 cfs, it was estimated that about two-thirds of the fish were entrained into the export facilities during the study period. Generally, the fish exhibited a rapid, southerly migration pattern in concert with the high southerly flow direction caused by medium export levels damping out or eliminating northerly or downstream flows in Old River.

The mechanisms explaining how and why salmon smolts can be diverted off the mainstem San Joaquin River into channels south of the Delta remain unknown. Also, it appears that some smolts, once they move into those south channels, do not re-emerge back into the San Joaquin to continue normal migration toward salt water. This latter phenomenon is also not understood. Because of net reverse flows that fish encounter in specific channels south of the San Joaquin River, outmigrating salmon apparently have difficulty re-emerging back into the mainstem. The magnitude of the net reverse flows increases with closer proximity to the south Delta export facilities. Once salmon enter this region of the Delta, the fish likely experience high mortality rates.

Author's Note: These VAMP studies (experiments) were conducted most often with the DCC closed, thus making longer still the long odds of survival of salmon migrating down the San Joaquin River to the Delta toward the Bay. There was little chance that the VAMP experiments would provide good survival for San Joaquin River salmon , with slightly higher San Joaquin River flows not being high enough, reduced export levels not being low enough, and the DCC being closed.

Thomas Cannon

Statement of Qualifications

I am a fisheries biologist and statistician with degrees in fisheries biology (B.S.) and biostatistics (M.P.H) from the University of Michigan. As an estuarine fisheries ecologist, I began my study of estuary ecosystems on the Hudson River Estuary from 1972-1977. Turner and Kelly's 1966 DFG Bulletin 136 and Turner and Chadwick's 1972 paper on Bay-Delta striped bass versus outflow and exports were the bible for management of striped bass East Coast estuaries. The concept that estuary fish populations were controlled by outflow via survival of larvae and juvenile fish was new to estuarine science. During my years on the Hudson River, I consulted on several occasions with DFG scientists. Pete Chadwick, DFG's lead Delta scientist, was a consultant to the Hudson River program.

I began working on Central Valley fisheries in 1977 and have more than 35 years experience in Delta fishery issues. From 1977-1980, I was project director of Bay-Delta ecological studies for PG&E's Bay-Delta power plants study programs, which evaluated the effects of power plant operations on the Bay-Delta ecosystem. From my experience working on estuaries it was obvious to me that the Bay-Delta was unique in not only having large power plants, but also unprecedented large water diversions that had great effects on outflow during critical spring-summer months.

From 1980-82, I was a consultant to the State Water Contractors focusing on the effects of D-1485 and the development of a new Two Agency Agreement between DWR and DFG. I also was a consultant to the National Marine Fisheries Service where I assessed the importance of the Bay-Delta as a nursery area for Central Valley salmon. I was also a member of the State Water Resources Control Board's Striped Bass Working Group charged with evaluating why the D-1485 Standards were not protecting the Bay-Delta ecosystem and the striped bass population.

From 1986-1987, I was a consultant to the State Water Contractors and US Bureau of Reclamation on developing new water quality standards. From 1994-1995, I was again a consultant to the State Water Contractors and the California Urban Water Agencies, working on the 1995 Bay-Delta Water Quality Standards and how the new standards would affect the Bay-Delta ecosystem.

From 1995-2002, I was a staff consultant to the CALFED program where I worked on various projects including the Anadromous Fish Restoration Program (AFRP), Ecosystem Restoration Program Plan, the Delta Entrainment Effects Team, the Tracy Technical Advisory Team, the Environmental Water Account, CVPIA Environmental Impact Statement, and the Delta Cross Channel Through Delta Facility evaluation team. Between 2000 and 2004, I participated in many AFRP projects involving flow-habitat relationships in the lower American, Cosumnes, Calaveras, and Stanislaus Rivers. I also participated in project planning and environmental assessments of the Delta Wetlands Project, the Montezuma Wetlands Project, and many other Bay-Delta development and restoration projects including PG&E's Delta Power Plants HCP.

In 2002, I participated in a DFG review of the status of the striped bass population. From 2002 to 2005, I was involved in activities related to the Striped Bass Stamp Program including stocking and tagging striped bass and as the California Striped Bass Association's representative on the DFG/DWR Four Pumps Mitigation Committee.

More recently I have advised the California Striped Bass Association on proposed new striped bass fishing regulations, and advised USBR staff on the merits of the proposed new Fall X2 Standards. From 2002 through 2010, I have been involved in developing and evaluating many estuary habitat restoration projects including sites in the Yolo Bypass, the Delta, and Suisun Bay. Over the last decade, I have been a consultant to CSPA member organizations and, since 2012, have advised the California Sportfishing Protection Alliance on flow and other measures needed to protect fisheries in the Delta Estuary and its tributaries.

Critique of Substitute Environmental Document

In Support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay-Sacramento/San Joaquin Delta Estuary: San Joaquin River Flows and Southern Delta Water Quality

March 2013

Prepared for:

Michael Jackson

ECONorthwest
ECONOMICS • FINANCE • PLANNING

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Executive Summary

In December 2012, the State Water Resources Control Board (Board) issued its *Public Draft Substitute Environmental Document in Support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay-Sacramento/San Joaquin delta Estuary: San Joaquin River Flows and Southern Delta Water Quality (SED Report)*. The purpose of the *SED Report*, as we understand, is to evaluate alternatives to determine the preferred alternative. Michael Jackson asked us to critique the *SED Report*.

In the following sections of this report we describe our critiques in detail. A summary of our major critiques includes the following.

The *SED Report* Authors Could Have Chosen to Meet the Professional Standards, but They Didn't

The authors fail to meet the professional standards for the evaluations they conducted. For examples, they fail to meet the professional standards with the geographic scope of the analysis, with the categories of economic effects (economic values, economic impacts, and economic equity), and with risk and uncertainty. As a result, they render the results fatally flawed.

The *SED Report* Authors Selected Their Preferred Alternatives for Flows and Water Quality without Disclosing Their Reasoning

In selecting their preferred alternatives for flows and water quality, the authors again fail to meet the professional standards. They select their preferred alternatives without disclosing the progression of their reasoning from evidence to conclusion. As a result, they fail to reach a reasoned and reasonable conclusion. Among the questions begged, How exactly does 35 percent flow strike a balance among competing beneficial uses, including the public trust?

The *SED Report* Authors Overestimate the Negative Effects of the Flow Alternatives on Agricultural Producers

By assuming that agricultural producers would not compensate for the reduced surface flows with groundwater, the authors ignore the actual behavior of agricultural producers . As a result, the authors overestimate—perhaps markedly—the negative effects of the flow alternatives on agricultural producers.

The SWAP Model Overestimates the Negative Effects on Agricultural Producers

Researchers comparing the SWAP model's results with actual conditions found SWAP overstated job losses by approximately 65 percent. They question the SWAP model's validity. The *SED Report* authors failed to adjust their findings accordingly.

The *SED Report* Authors' IMPLAN Analysis Contains a Number of Shortcomings

IMPLAN can describe economic changes only over the short-run. But the flow and water-quality alternatives would affect economic activity over the long-run, decades or generations. While the *SED Report* authors acknowledge that as a result, their IMPLAN analysis overstates the negative employment impacts of the flow alternatives, they fail to adjust their findings and fail to address the long-run effects that their IMPLAN analysis doesn't address.

The authors also acknowledge that their IMPLAN analysis overstates the negative employment impacts of the flow alternatives.

The Economic Loss to Agriculture from 60% Unimpaired Flow Would Be a Negligible Share of the Three-County Economy

The employment impacts of even the 60 percent flow alternative represents a negligible portion—approximately 0.2 percent—of the total employment in the three counties (Merced, Madera, and Stanislaus).

The *SED Report* Authors' Analysis Ignores or Underestimates the Economic Benefits of Flow Alternatives and Current Salinity Standards

The authors fail to address the full range of economic effects of the flow and salinity alternatives. They address the costs of flow alternatives to agricultural producers in the upper San Joaquin, and the extent to which crops currently produced by Delta growers could tolerate higher salinity concentrations. But they ignore the economic effects on threatened or endangered species; the benefits of lower salinity concentrations on Delta growers; and the benefits of higher flows and lower-salinity concentrations on Delta habitats and species.

The *SED Report* Authors Ignore Recent Peer-Reviewed Research on Salinity

The authors ignored a comprehensive analysis of salinity impact to Delta agriculture, a part of the Delta Protection Commission's Economic Sustainability Plan. The reseachers found up to $40 million per year in lost agricultural production from moving from 0.7 dS/m to 1.0 dS/m. The

California Department of Water Resources chose the ESP model of salinity impacts on Delta agriculture for their analyses of the Bay Delta Conservation Plan.

The *SED Report* Authors Ignore Evidence of Salinity Damage

The authors ignored the evidence of salinity damage under the current standards as reported in the Draft EIR for the Bay Delta Conservation Plan, in the Economic Sustainability Plan, and by the South Delta Water Agency.

The *SED Report* Authors Rely on the Deeply Flawed Report by Dr. Hoffman

The authors' proposed increase in salinity standards rests entirely on a report by Dr. Hoffman. Dr. Hoffman admits his conclusions rest heavily on results of 30-year old studies of potted bean varieties that commercial Delta growers no longer use. But the authors ignore compelling evidence to the contrary that Dr. Hoffman's hypothesis should be rejected.

Rather Than Address Current Salinity Problems, the *SED Report* Authors Propose Increasing Allowable Salinity Concentrations

Salinity concentrations in the Delta regularly exceed current allowable amounts, and have done so for some time. Also, salinity concentrations below those the authors propose harm Delta agriculture. Instead of solving the problem by dealing with its causes, the authors propose simply increasing the amount of salinity allowed. And the authors try to counter all the evidence against this dodge with a 30-years old, severely criticized study of potted beans.

I. Introduction, Context, and Opinion

A. Introduction and Context

In 2010, the California State Water Resources Control Board (Board) issued its *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem* (*Flow Report*). In December 2012, the Board issued its *Public Draft Substitute Environmental Document in Support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay-Sacramento/San Joaquin Delta Estuary: San Joaquin River Flows and Southern Delta Water Quality* (*SED Report*). Had the waters of the San Joaquin and Sacramento Rivers been abundant, we[1] doubt the Board would have issued either report. But abundance doesn't rule these waters; scarcity does. And there's the rub.

The *SED Report* authors, on behalf of the Board, focus on the San Joaquin River. In our comments here, Michael Jackson asked us to focus on the *SED Report* and evaluate the authors' analysis. While scarcity rules the San Joaquin River and thereby presents a challenge to the Board, it also gives the Board a powerful approach to facing the challenge.

> *Economics is the study of how societies use scarce resources to produce valuable goods and services and distribute them among different individuals.*[2]

Embedded in this definition is the origin of economics itself, namely allocating scarce resources among competing demands. Also embedded in it is the approach the Board can and should adopt to face its challenge.

The scarce resource the Board must allocate among competing demands is the San Joaquin River and, more specific, the quantity and quality of its waters. Examples of San Joaquin River goods and services are agricultural goods and ecosystem services. When the *SED Report* authors state they have "evaluated a number of different 2006 Bay-Delta-Plan amendment alternatives for State Water

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[1] Throughout this report, "we," "our," and "us" refer to ECONorthwest employees, Ed MacMullan, Philip Taylor, Dr. Bryce Ward, and Dr. Ed Whitelaw. Dr. Jeffrey Michael also assisted ECONorthwest with portions of this review.

[2] Samuelson, PA and WD Nordhaus. 2010. *Microeconomics,* 19th ed. New York: McGraw-Hill Irwin, p.4. Dr. Samuelson was a Nobel laureate in economics and Institute Professor at MIT.. Dr. Nordhaus is Sterling Professor of economics at Yale University. For similar definitions of economics, see practically any other introductory economics textbook, as well as Pearce's MIT Dictionary of Economics, Pearce, DW, ed. 1992. *The MIT Dictionary of Modern Economics*, 4th ed. Cambridge: The MIT Press, p.121.

Board consideration"[3] and their "economic analysis … will help inform State Water Board's consideration of potential changes … related to LSJR flows and southern Delta water quality objectives,"[4] they appear to have adopted the approach that's embedded in the definition of economics, the approach that employs the best practices for the economic analyses the Board needs.[5] That's good, because its underlying logic rests on over a century of professional economic literature[6], in Federal and many state—including California—public documents[7], and textbooks.[8] It's also straightforward and compelling:

> *If you were asked to evaluate the desirability of some proposed action, you would probably begin by attempting to identify both the gains and the losses from that action. If the gains exceed the losses, then it seems natural to support the action.*[9]

Identifying "the gains and the losses" begins by grouping the gains and losses—the economic effects—into three categories: economic values, economic impacts, and economic equity.[10] These are not terms of art in economics. They simply provide a convenient, and technically sound, means of distinguishing among the many, disparate economic effects changes in natural resources can cause. Also, economists have published on each of the effects in the three categories.

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[3] *SED Report*, p.ES-2

[4] *SED Report*, p.18-2.

[5] Throughout the *SED Report* appear many similar descriptions of what the *SED Report* authors have included in the *SED Report* or what it will do for the Board.

[6] See, for example, Marshall, A. 1890. *Principles of Economics*. London: Macmillan and Co.; Leontief, WW. 1951. *The Structure of the American Economy, 1919-1939: An Empirical Application of Equilibrium Analysis*. Oxford: Oxford University Press.

[7] See, for example, Water Resources Council. 1983. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. Washington, D.C.: U.S. Government Printing Office.; Department of Water Resources. 2008. *Economic Analysis Guidebook*. State of California.; National Center for Environmental Economics. 2010. *Guidelines for Preparing Economic Analyses*. U.S. Environmental Protection Agency.

[8] Tietenberg, T and L Lewis. 2012. *Environmental & Natural Resource Economics,* 9th ed. Upper Saddle River: Pearson Education. Not incidental, many universities in California have adopted this textbook in environmental and natural resource economics, including UC Berkeley, UCLA, UC San Diego, UC Santa Barbara, Stanford, and USC. So, too, have universities elsewhere, including Massachusetts Institute of Technology, Harvard University, University of Texas, Oregon State University, Wake Forest University, University of North Texas, Texas A&M University, University of Wyoming, Purdue University, and New York University.

[9] Tietenberg and Lewis, p.46.

[10] We describe these in detail in ECONorthwest (2013), *Bay-Delta Water: Economics of Choice*. We present the relevant excerpt from the report in the appendix.

As for describing and calculating the economic effects in each of the three categories, there are many professionally sound methods. And for evaluating "the desirability of some proposed action," consider these two definitions.

> *Normative economics considers 'what ought to be'—value judgments, or goals, or public policy.*[11]

> *Positive economics…is the analysis of facts and behavior in an economy, or 'the way things are'.*[12]

These two definitions apply directly to the challenge the Board faces.

> *The normative dimension helps to separate the policies that make sense from those that don't. Since resources are limited, it is not possible to undertake all ventures that might appear desirable so making choices is inevitable.*[13]

The implications for the *SED Report* are clear. For an evaluation, an assessment, or a "balancing" to meet professional standards, it must include a normative criterion—conditions as they should be—and a descriptive criterion—conditions as they are. Too often where it matters, the *SED Report* authors omit either one or both of these criteria.

B. Opinion

The *SED Report* is replete with errors of omission and commission. Some of them alone compromise the entire report. And the cumulative errors of omission and commission, taken together, simply beg too many questions across too many parts of the *SED Report* for it as a whole or part by part to meet basic professional standards.

And failing to meet the professional standards matters. For example, the authors fail to disclose evidence-based reasoning that led them from the alternatives (for flows and water quality) they identified to the alternatives they prefer. This in turn, if proffered, would fail to inform the Board adequately. Arguably, it would misinform the Board.

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[11] Samuelson, P.A. and W. Nordhaus. 2005. *Economics*, 18th ed. New York: McGraw-Hill Irwin. p. 746. Dr. Samuelson, Nobel laureate in economics and Institute Professor at MIT, died in 2009. Dr. Nordhaus is Sterling Professor of economics at Yale University.

[12] Samuelson and Nordhaus. 2005. p. 746.

[13] Tietenberg and Lewis, p.46.

II. The SED Report's Economic Analysis

A. The SED Report Authors Could Have Chosen to Meet the Professional Standards, but They Didn't.

1. Consider this extended excerpt from the *SED Report Chapter 18, "Economic Analysis"*:

   "Under CEQA, project-related social or economic effects are not, as a general rule, required to be analyzed in CEQA documents; however, a lead agency may decide to include an assessment of economic or social effects in an EIR, particularly if these effects are perceived as being important or substantial. As discussed in Section 15131 of the Guidelines for Implementation of the California Environmental Quality Act (CEQA Guidelines), economic or social information may be included in an EIR in whatever form a lead agency desires. The guidelines also indicate that social and economic issues may be discussed in an EIR when they are linked to physical change …

   Water Code Section 13241 states that "economic considerations" should be considered in establishing water quality objectives. In practice, compliance with these statutory provisions *typically* involves quantifying the costs to affected parties (e.g., farmers and water districts), and assessing potential impacts on affected local and regional economies of related changes in economic activity. Evaluation of other potential economic effects, such as water quality benefits, *typically* is conducted more qualitatively.[*emphasis added*]"

   Any project-level changes to water rights or other measures that may be needed to implement any approved changes to the 2006 Bay-Delta Plan will be considered in a subsequent proceeding and would require project-level analysis as appropriate. Therefore, the economic analysis presented in this chapter, which summarizes results from topic-specific analyses presented elsewhere in this SED and its appendices, is limited by the programmatic nature of this document. (p.18-1, 18-2)

2. Consider our comments:

   a. Consider these terms: "an assessment of economic or social effects"; important or substantial [effects]"; "economic or social information may be included in an EIR in whatever form a lead agency desires"; "social and economic issues … linked to physical change"; "'economic considerations' should be considered"; "compliance *typically* involves" [*emphasis added*]; "assessing potential impacts on affected local and regional economies of related changes in economic activity"; "Evaluation … water quality benefits, *typically* is conducted more qualitatively" [*emphasis added*]; "economic analysis … limited by the programmatic nature of this document."

b. None of the terms in #2a, as used in the extended selection from Chapter 18, is a term of art in economics (except possibly "local and regional economies"). In its entirety, the selection leaves the *SED Report* authors great leeway in what they could have done to prepare Chapter 18. But without rigorous definitions of these terms, we're left with ambiguities throughout. What they chose not to do is heed the relevant, readily and widely accessible professional standards, e.g., 1983 P&G[14], 2008 CA DWR[15], 2010 EPA[16]. The question begged, of course is, Why? We don't try to answer.

B. The Failure to Meet the Professional Standards Matters

1. Failing to get the correct geographic scope of the economic analysis could render the results fatally flawed. Consider the questions one should ask to define the relevant geography for "consideration," "assessment," or "evaluation," all terms contained in the excerpt above. What biophysical resources would the Board's decision affect? How does the combined affect of the drainage from Mud Slough and Salt Slough into the San Joaquin and the SED salinity and flow alternatives affect the biophysical resources in the portion of the San Joaquin in the Planning Area and further downstream? How would the salinity and flow alternatives affect biophysical resources in the Delta, including species at risk of extinction?

2. Failing to address all the potential economic effects could render the results fatally flawed. The relevant categories of economic effects are: economic values; economic impacts; and economic equity.[17] For

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[14] Water Resources Council. 1983. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. Washington, D.C.: U.S. Government Printing Office.

[15] Department of Water Resources. 2008. *Economic Analysis Guidebook*. State of California.

[16] National Center for Environmental Economics. 2010. *Guidelines for Preparing Economic Analyses*. U.S. Environmental Protection Agency.

[17] See appendix. ECONorthwest. 2013. *Bay-Delta Water: Economics of Choice*.

example, what are the questions one should ask to identify the relevant populations and thereby describe the economic equity or environmental justice. Who are the stakeholders affected over the relevant geography and how would they be affected? What would be the distributional effects—who enjoys the benefits and who bears the costs—of the economic outcomes of the alternatives?

3. Failing to address risk and uncertainty adequately could render the results fatally flawed.

    a. Consider all the *SED Report*'s Chapter 18 (Economic Analysis) says about risk and uncertainty.

        "**Risk:** The lower flows may substantially decrease the quantity and quality of spawning, rearing, and migration habitat; increase exposure of fish to pollutants; increase predation risks; and substantially change fish transport flows. Changes in flow, water temperature, and water quality also may increase fish disease risk." (p.18-17)

        "**Uncertainty:** The extent that economic values associated with recreation on the Merced and Tuolumne Rivers would be affected is uncertain, primarily because reliable data on use by activity and the relationship between changes in flows and use are not known. However, for purposes of developing a worse-case, planning-level scenario affecting potential displacement of recreational activities, the recreational use information in Table 18-10 is used to assess order-of-magnitude effects on recreation benefits and spending." (18-17)

    b. Consider our comments:

        i. Contrast the treatment that the *SED Report* authors give risk and uncertainty with the treatment (CA DWR 2008) and (EPA 2010) gives these two factors. The contrast is stark.

        ii. The fact that risk-aversion applies to actions that threaten natural assets and ecosystem services[18] compounds the *SED*

[18] Field, B.C. 1994. *Environmental Economics*. p.129; Goodstein, 1999. E.S. *Economics and the Environment*. p.150; Lesser, J.A., D.E. Dodds, and R.O. Zerbe, Jr.. 1997. *Environmental Economics and Policy*. p.406

Report authors' error of omission. But the authors fail even to mention it.

C. The SED Report Authors Selected Their Preferred Alternatives for Flows and Water Quality without Disclosing Their Reasoning

1. Consider these excerpts from the *SED Report*:

   "The State Water Board's 2010 report, *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem*, determined that approximately 60 percent of unimpaired flow at Vernalis February-June would be fully protective of fish and wildlife beneficial uses in the three eastside tributaries and LSJR when considering flow alone." (p.3-4)

   "The Goal of the Preferred LSJR Alternative is to protect fish and wildlife by supporting and maintaining the natural production of viable native SJR watershed fish populations migrating through the Delta. The Preferred LSJR Alternative established February-June flow requirements of 35 percent of unimpaired flow, ….. The 35 percent unimpaired flow requirement would strike a balance between providing water for the protection of fish and other competing uses of water, including agriculture and hydropower generation." (p.ES-2, 3)

   "The LSJR alternatives and SDWQ alternatives analyzed in the preceding chapters and in the appendices were selected in order to evaluate and compare the different environmental, economic, and hydropower effects of a broad range of conceivable LSJR flow and southern Delta water quality requirements. The preferred alternatives were identified after reviewing and considering this information and information included in the administrative record for this substitute environmental document (SED)." (p.20-1)

   "The Preferred LSJR Alternative (35 percent unimpaired flow) is not explicitly analyzed in the preceding chapters of this SED. Instead, the Preferred LSJR Alternative falls within the range of alternatives analyzed in those chapters (20-60 percent of unimpaired flows) and is, accordingly, encompassed by those analyses." (p.20-1)

   "Since the preferred LSJR Alternative (35 percent unimpaired flow) falls between LSJR alternative 2 (20 percent unimpaired flow) and LSFR Alternative 3 (40 percent unimpaired flow), in order to determine the level of impact under the Preferred LSJR Alternative, impacts determinations under LSJR Alternatives 2 and 3 were evaluated." (p.20-1)

2. Consider our comments:

    a. Among the most important professional standards in economics and courtrooms is demonstrating explicitly the progression in reasoning from evidence to conclusion. Attempting it implicitly simply doesn't cut it. To the best of our knowledge, the excerpts above constitute the *SED Report* authors' progression from what they represent as evidence to their preferred alternatives for flows and water quality. If this is true, then by the professional standards, the authors have failed to balance the relevant competing uses, including, for example, public trust uses. As a result, they have not reached a reasoned and reasonable conclusion.

    b. Among the questions begged by this series of excerpts is, How exactly does 35 percent flow strike a balance?

    c. For guidance, the authors can look to the Board's own decision in the Mono Lake case for guidance on balancing.[19]

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[19] Broussard, J. 1983. *National Audubon Society et al., Petitioners, v. The Superior Court of Alpine County, Respondent; Department of Water and Power of the City of Los Angeles et al., Real Parties in Interest*. 33 Cal.3d 419. S.F. No. 24368. Supreme Court of California. February 17.; ECONorthwest. 2013. *Bay-Delta Water: Economics of Choice*. p.6-8.

III. Other Critiques

Critique #1: Ignoring groundwater as a substitute for reduced surface flows exaggerates the negative effects

The *SED Report* authors' analysis includes what they describe as a "conservative" assumption that agricultural producers would not replace reduced surface flows by increasing groundwater applications. This assumption, however, ignores how agricultural producers operate. As a result, the authors overestimate—perhaps markedly—the negative effects of the flow alternatives on agricultural producers.

We find the authors' use of this assumption curious given the following well-known, and documented facts:

1. Agricultural producers use groundwater. Agricultural producers in the authors' analysis use groundwater and substitute groundwater for surface water.[20]

2. The SWAP model includes groundwater. The SWAP model includes the capabilities of modeling increased use of groundwater as a substitute for reduced surface flows.[21] Other studies conducted with the SWAP model have routinely included groundwater substitution for surface water supplies.[22] This begs the question: Why were these capabilities not applied in the *SED Report* authors' analysis?

3. The authors calculated the increased groundwater use. Indeed, as described in SED Chapter 9 Groundwater Resources, the authors even calculated the quantities of groundwater that would be needed to offset reduced surface flows (see Table 9-10, page 9-23).
"*Irrigation district and water district service areas may experience reduced surface water supplies as a result of the LSJR alternatives, which could result in increased groundwater pumping. … [T]he magnitude of potential groundwater*

[20] Howitt, R., D. MacEwan, and J. Medellin-Azuara. 2011. "Drought, Jobs, and Controversy: Revisiting 2009," Agricultural and Resource Economics Update. V.14 no.6. Giannini Foundation of Agricultural Economics, University of California. July/August; SED 2012, Chapter 9, page 9-11.

[21] Michael, J. R. Howitt, J. Medellin-Azuara, and D. MacEwan. 2010. A Retrospective Estimate of the Economic Impacts of Reduced Water Supplies to the San Joaquin Valley in 2009. September 28.

[22] Howitt et al. 2011; Michael et al. 2010.

impacts was quantified by assessing the expected increased pumping to replace the reduced surface water supplies."[23]

4. Reviewers pointed out that not including groundwater in the SED analysis would overstate the negative effects on agricultural producers. In his comments on the Draft analysis of agricultural-economic effects of the flow alternatives, Dr. Rich Adams states,
"… *Years of empirical research have documented that irrigators will seek other water sources when confronted with water supply disruptions. By not allowing such an adjustment in modeling of the stream flow effects, the assessment here likely overstates the economic costs of the flow alternatives.*"[24]

   Dr. Rex Chaffey states in his review,
   "*I understand the rational for this assumption* [of no groundwater substitution] *given the potential complexity involved in characterizing the variable quantities (and the range of agricultural impacts) that might result from development of alternative irrigation sources in response to the proposed LSJR flow alternatives. Nevertheless, I find the description of this assumption (as used here) to be a bit misleading—though not necessarily intentionally so. I would suggest that this assumption is more "convenient" than "conservative" because its use (as the Staff points out) ultimately results in higher economic impacts. By incorporating some element of incremental substitution, the economic impacts of the LSJR alternatives could be partially offset. Thus, use of this assumption potentially exaggerates the upper bounds of economic impact produced via the IMPLAN model.*
   … I cannot say how realistic it would be to assume (and account for) any incremental substitution effects, but describing this assumption as 'conservative' seems odd at best and strategic at worse—especially given its acknowledged inflationary effect…."[25]

The facts do not support the *SED Report* authors' assumptions or analysis that generated a "worst case" outcome for agricultural producers. The facts do support a "reasonably foreseeable" or "likely" outcome for agricultural producers of little effects for any of the flow alternatives—including the 60-percent flow alternative. We expect that an analysis that generated "reasonably

[23] SED 2012. Chapter 9, page 9-1.

[24] Adams, R. 2011. Review of "DRAFT Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives." June 11. Submitted to, and at the request of, the State Water Resources Control Board.

[25] Chaffey, R.. 2012. Review of "Draft report: Agricultural Economic Modeling for Phase 1 Update to the 2006 Bay-Delta Plan." June 23. Submitted to, and at the request of, the State Water Resources Control Board.

foreseeable" rather than "worst case" outcomes for agricultural producers would also produce a preferred alternative much closer to, if not, at the 60-percent flow amount.

Critique #2: The SWAP model overestimates the negative effects

The authors' analysis of the agricultural-economic effects of the flow alternatives relies on the predictive capabilities of the SWAP model. This model, however, has questionable capabilities as a predictive tool. For example, a retrospective analysis that compared SWAP results with real-world conditions found that the model's output—and the follow-on economic analysis—overstated job losses from the 2009 drought by approximately 65 percent. Researchers have raised serious questions about the SWAP model's validity.

A recent report by David Sunding and Max Auffhammer[26] describes some of their concerns and recommendations regarding the SWAP model.

> "*…[W]e are concerned that SWAP is built on a very large number of relatively untested assumptions. We also have concerns about the underlying data, and about the calibration procedures used to fit the model to the data.*"[27]
>
> "*The state should conduct a systematic peer review of SWAP, focusing on the large number of assumptions underlying the model …*
>
> *We recommend that the predictions of the SWAP model be tested against real-world changes in land allocation….*
>
> *DWR should work to integrate SWAP with a groundwater model…*
>
> *The UC Davis researchers should consider reconfiguring the SWAP regions to better correspond to actual water rights, project service areas, and groundwater conditions.*
>
> *DWR should develop an econometric model for the agricultural sector in the San Joaquin Valley…. A key advantage of an econometric model is that it would produce standard errors around forecasts, a key omission of the SWAP model.*"[28]

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[26] Sunding, D. and M. Auffhammer. 2012. An Assessment of Models for Measuring the Economic Impact of Changes in Delta Water Supplies. Public Comment, Bay Delta Plan Workshop 3. October 24.

[27] Sunding and Auffhammer, 2012, page 27.

[28] Sunding and Auffhammer, 2012, page 27-28.

Regarding the recommendation to submit the model to peer review, the *SED Report* authors did solicit comments on the model as part of the review of the authors' draft analysis of the LSJR flow alternatives. One reviewer, Dr. Rich Adams, noted, however, that the authors' requested review fell short of an academic-quality peer review. "*I note that the requested review is somewhat circumscribed compared with a peer review for publication in a scientific journal*."[29]

Regarding the recommendation to test the model against real world changes, the evidence of one such comparison found the model substantially overestimated negative effects on agricultural producers. Researchers estimated the economic effects on agricultural producers of the reductions in surface flows attributed to the 2009 drought. The SWAP model, and the resulting economic analysis, overestimated revenue losses by approximately 50 percent, and overestimated job losses by approximately 65 percent, relative to actual outcomes.[30] Unlike the *SED Report*, the SWAP analysis of the 2009 drought accounted for groundwater substitution for surface water and still overestimated losses by a considerable margin. In the case of the 2009 drought, the authors said that the SWAP model overestimated the negative effects on agricultural producers because there were more water transfers than the model predicted.[31]

For illustrative purposes, adjusting the 4.5 percent reduction in crop revenues estimated for LSJR Alternative 4 (60-percent flows) by a 50-percent overestimation factor, yields a reduction in crop revenues of 2.25 percent. Taking this measure of negative agricultural effects into account—which represent a large share of the total negative effects in the *SED Report* authors' analysis—would likely result in a preferred alternative with a flow rate much closer to, if not, at the 60-percent flow.

Critique #3: IMPLAN yields only short-run effects and overestimates the impacts of the alternatives

The authors' IMPLAN analysis contains a number of shortcomings. We focus on two. First, IMPLAN can describe economic changes only over the short-run—of only a few quarters or of a year or two. Second, IMPLAN overestimates the true employment and income impacts of alternatives.

In general, the IMPLAN analysts estimate economic impacts by holding static all economic sectors and relationships among sectors in the economy. It gives a

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[29] Adams, 2011, page 1.

[30] Howitt et al., 2010.

[31] Michael, et al., 2010; Howitt, et. al., 2011.

snapshot, not a video. Thus, IMPLAN produces economic impacts over the short run. Economies, however, are not static. They develop, change, and react to economic forces and trends. For example, agricultural producers will likely continue substituting capital (equipment) for labor over time. If that's the case, how does this affect our interpretation of IMPLAN results, which rely on the assumption of no such substitution?

Missing from the *SED Report* authors' static, short-run IMPLAN analysis is information on:

- The relevant economic forces and trends that will likely affect the stakeholders and economies affected by the authors' decision.
- Revising the static IMPLAN results given these likely economic forces and trends.
- Identifying likely mitigation possibilities that could lessen negative effects that happen over time.

The Board's decision would affect dynamic, changing economies, and these effects would happen not just in the short-run, but for the foreseeable future—decades or generations. As such, IMPLAN, cannot describe these dynamic changes over the time that stakeholders would experience the economic impacts of the Board's decision.

In the context of the *SED Report*, the results from IMPLAN's snapshot overestimate the negative economic impacts of the flow alternatives:

> "*Input-output analysis approach employed by IMPLAN usually overestimates indirect job and income losses. One of the fundamental assumptions in input-output analysis is that trading patterns between industries are fixed. This assumption implies that suppliers always cut production and lay off workers in proportion to the amount of product supplied to farms or other industries reducing production. In reality, businesses are always adapting to changing conditions. When a farm cuts back production, some suppliers would be able to make up part of their losses in business by finding mew markets in other areas. Growth in other parts of the local economy is expected to provide opportunities for these firms. For these and other reasons, job and income losses estimated using input-output analysis should often be treated as upper limits on the actual losses expected* (SWRCB 1999)."[32]

Even though the *SED Report* authors acknowledge that their IMPLAN analysis overstates the true employment and income impacts of the flow alternatives,

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[32] SED 2012, page G-29.

they apparently ignored this fact when selecting their preferred alternative of 35 percent unimpaired flows. The authors compounded or magnified the "worst case" results from their SWAP analysis by using the SWAP results as input into their IMPLAN analysis, which also produced its own "worst case" output.

Critique #4: A 60% unimpaired flow would have a negligible effect on the three counties' economic activity

The *SED Report* authors estimated agricultural-employment impacts of the flow alternatives for the counties of Merced, Madera, and Stanislaus. According to the IMPLAN data upon which the *SED Report* authors' analysis rests, the economic activity of these three counties had total employment of 356,125.[33] Assuming for the sake of argument that the authors' IMPLAN results reflect the economic impacts of the flow alternatives—which we do not assume for the reasons we describe elsewhere in this critique—the employment impacts of even the 60 percent flow alternative represents a negligible portion of total employment in the affected counties. The negative employment impacts of the 60 percent flow alternative of 1,432 represent just 0.4 percent of the total. The authors admit these losses are exaggerated. A more reasonable estimate of economic losses is likely to be less than half the amount estimated in the *SED*, which would represent approximately 0.2 percent of the three counties' economic activity.

If we were to include San Joaquin County,[34] the negative employment impacts of the 60 percent flow alternative represent just 0.23 percent of the four counties' total employment of 625,178. Halved to be more reasonable, this represents approximately 0.1 percent of the counties' economic activity.

These results offer no support of the *SED Report* authors' preferred flow alternative, 35-percent unimpaired flow. The available evidence supports a preferred alternative closer to, if not, at the 60-percent flow alternative.

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[33] Bureau of Economic Analysis, Local Area Personal Income and Employment Data. BEA employment data is the source data for IMPLAN, and its definition of employment is consistent with IMPLAN. The most recent data is for 2011. http://www.bea.gov/iTable/iTable.cfm?reqid=70&step=1&isuri=1&acrdn=5#reqid=70&step=1&isuri=1.

[34] This is a reasonable addition, because economic impacts of a flow alternative would be felt in San Joaquin County, where South San Joaquin Irrigation District and Stockton East Water District are located. In addition to the farms themselves, most of the labor force and input suppliers for farms in these districts will be located in San Joaquin County, primarily Stockton, which also is the primary location of workforce and suppliers for farms within the South Delta Water Agency territory.

Critique #5: The SED Report authors ignore or underestimate the economic benefits of flow alternatives and of current salinity standards

The authors' analysis does not adequately address the full range of economic effects of the flow and salinity alternatives. They emphasize costs of flow alternatives to agricultural producers in the upper San Joaquin, and the extent to which crops currently produced by Delta growers could tolerate higher salinity concentrations. Economic effects missing from the authors' analysis include:

1. Effects of flow alternatives on threatened or endangered species: Comments on the *SED Report* by Thomas Cannon[35] and reports by EPA[36] document the precarious state of existing salmon and steelhead populations in the Delta, and the important role of water flow and quality on these species. But the *SED Report* authors fail to describe how the alternatives would affect these species, and the values that Californian's place on these species. Why couldn't the authors have used an EPA-approved benefits transfer to monetize the values?

   Specifically, the *SED Report* authors should more completely address the following questions: To what extent do flows below 60 percent, and increased salinity concentrations, increase the threat to the salmon and steelhead populations—and to the other aquatic life populations (e.g., striped bass, splittail, zooplankton, phytoplankton, etc.)? What is it worth to California residents and other stakeholders of avoiding extinction of these species?

   The EPA describes the important interactions between restoration efforts in the upper San Joaquin and the quality of aquatic habitats in the lower migratory corridors. "*The measured survival and decreasing populations of salmon in the San Joaquin watershed suggest that fall-run salmon restoration in the San Joaquin River tributaries cannot succeed until the lower migratory corridor is more supportive of salmon migration*."[37] Given this relationship between the San Joaquin and lower migratory corridors, the *SED Report* authors' analysis failed to address the extent to which the flow and salinity alternatives jeopardize the effectiveness and benefits from

[35] Cannon, T. 2013. Flow Requirements and other Recommendations to Protect San Joaquin River Fisheries. Prepared for the California Sportfishing Protection Alliance. March.

[36] EPA. 2011. Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: Unabridged Advanced Notice of Proposed Rulemaking. February;

[37] EPA 2011, page 61.

upstream restoration efforts—and the approximately $890 million[38] expenditures on these restoration efforts—conduced under the San Joaquin River Restoration Settlement Act of 2009.

2. The market benefits of enhanced commercial and recreational fishing: Low salmon populations resulted in the closure of salmon fishing in 2008 and 2009. The California Department of Fish and Game estimated that the salmon fishery closure in 2009 resulted in a loss of $279 million in output and 2,690 jobs. A report by the University of the Pacific estimated the economic impact of the closure at 1,823 jobs when compared to 2004-05 levels, and a report commissioned by the fishing industry estimated the loss at over 23,000 jobs.[39]

3. The benefits of lower salinity concentrations on Delta growers: The *SED Report* authors note that under baseline conditions, current salinity standards in the 2006 Bay-Delta Plan, "*are not always fully met*."[40] The authors' analysis of salinity issues focused on the extent to which crops currently grown by Delta producers could tolerate higher salinity concentrations in Delta waters. The analysis ignored the economic benefits to Delta growers of fully enforcing current salinity concentrations. For example, increasing allowable salinity concentrations may limit the types of crops that Delta growers could produce in the future.

4. The benefits of higher flows and lower salinity concentrations on Delta habitats and species: The *SED Report* authors make no mention of the relationships between flows and salinity, and the Delta habitats and species, including salmon and steelhead. To the extent that higher flows and lower salinity concentrations affects natural resources and related ecosystem services that benefit society, it will also affect the values of these services.

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[38] Kantor, S. 2012. The Economic Benefits of the San Joaquin River Restoration. Fresno Regional Foundation. September.

[39] Business Forecasting Center. 2010. Employment Impacts of California Salmon Fisher Closures in 2008 and 2009. University of the Pacific. April. http://forecast.pacific.edu/BFC%20salmon%20jobs.pdf

[40] SED 2012, page ES-15.

Critique #6: The SED Report authors ignored recent peer-reviewed research on the effects of salinity on Delta agriculture

In 2011, the most comprehensive study of salinity impacts to Delta agriculture was conducted for the Delta Protection Commission's Economic Sustainability Plan (ESP).[41] The ESP econometric model controlled for a variety of physical (e.g., elevation, soil type, temperature, field size, irrigation water salinity) and market variables (e.g., prices) that impact crop choices. The results showed that the salinity of irrigation water had a large and significant effect on planting decisions in the Delta. The ESP model predicts that the degradation in water quality from moving the standard from 0.7 dS/m to 1.0 dS/m could result in agricultural revenue losses of up to $40 million per year in the South Delta. Not incidental, the loss in revenue from this model stems solely from a shift towards lower-value, more salt-tolerant crops and does not include any loss from lower yields.

An independent panel of experts for the Delta Science Program reviewed the ESP and praised the agricultural economics work in the ESP as, "well drafted and used appropriate techniques." Regarding the model for measuring salinity impacts, the reviews commented, "We commend the authors for using this approach," and that it was "state of the art."[42] Finally, the California Department of Water Resources (DWR) chose the ESP model of salinity impacts on Delta agriculture for their analyses of the Bay Delta Conservation Plan.[43] The DWR's adoption of the ESP model shows that DWR recognizes that the ESP model represents the best available science on salinity impacts on Delta agriculture. The *SED Report* authors failed to mention this work.

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[41] Economic Sustainability Plan for the Sacramento-San Joaquin Delta, chapter 7, Agriculture. Retrieved from http://forecast.pacific.edu/DESP/report/Chapter_7.pdf; Caswell, M.F. and D. Zilberman. 1985. The choice of irrigation technologies in California. *American Journal of Agricultural Economics* 67: 224-34; Wu, J. and B. A. Babcock. 1998. The choice of tillage, rotation, and soil testing practices: Economic and environmental implications. *American Journal of Agricultural Economics* 80: 494-511; Wu, J., R.M. Adams, C.L. Kling, and K. Tanaka. 2004. From micro-level decisions to landscape changes: An assessment of agricultural conservation policies. *American Journal of Agricultural Economics* 86: 26-41.

[42] Adams, R., J. Chermak, R. Gilbert, T. Harris, and W. Marcuson III. Independent Panel Review of the Economic Sustainability Plan for the Sacramento-San Joaquin Delta. December 2, 2011. Retrieved from http://forecast.pacific.edu/DESP/other/Review%20of%20Sustainabilty%20Plan_Final.pdf

[43] See page 3 of the scope of work posted at http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/ICF-11_Amend1_finalCombined.sflb.ashx

Critique #7: The SED Report authors ignored evidence of salt damage to crops in the south Delta

Direct observation of salt damage to crops has been reported throughout the south Delta. For example, the draft EIR for the Bay Delta Conservation Plan states,

> "*Areas of the south Delta that grow processing tomatoes, which are particularly salt-sensitive in seedling and blooming growth stages, have been documented to exhibit seedling mortality and bloom loss resulting from salt burning during irrigation that have resulted in reduced yields and crop quality during certain years.*"[44]

The Economic Sustainability Plan also reports focus groups in which Delta farmers described salt damage to crops when salinity levels in the Delta were below 1.0 dS/m, and that Delta farmers reported regularly monitoring salinity levels when planning and managing their farms. We understand that the South Delta Water Agency will provide declarations and further evidence to support crop damage that has occurred under existing conditions.

Critique #8: The SED Report authors relied on the deeply flawed report on salinity by Dr. Hoffman.

The *SED Report* authors state that increases to Delta salinity standard of 1.0 dS/m would have no impact on Delta agriculture. They conclude this based entirely on a report by Dr. Hoffman (2010).[45] Dr. Hoffman used overestimated leaching fractions to estimate the potential loss to Delta farmers from changes to salinity. However, the Hoffman report does not have the data necessary to support the leaching fractions it assumes. In fact, Hoffman states,

> "*The leaching fraction in the South Delta is difficult to estimate because measurements of soil salinity or salt concentration of drainage water are not measured routinely.*"[46]

Dr. Hoffman generally assumes leaching fractions of 0.15 or above, which as we understand, came from soils that differ in soil type and elevation from most of

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[44] Administrative Draft of the EIR for the Bay Delta Conservation Plan. Chapter 14, Agricultural Resources. http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/EIR-EIS_Chapter_14_-_Agricultural_Resources_2-29-12.sflb.ashx

[45] Hoffman, G. 2010. Salt Tolerance of Crops in the Southern Sacramento-San Joaquin Delta, Final Report. Prepared for the California EPA and the State Water Resources Control Board.

[46] Hoffman 2010, page 51.

the area at issue. In contrast, an analysis by Dr. Orlob of leaching fractions in the relevant area found that 40 percent of the soils in the south Delta have leaching fractions as low as .05, and in another 34 percent are approximately .09.[47] Dr. Orlob calculated yield loss for soils with a leaching fraction of .05 and applied water salinity of 1.0 dS/m as beans, -68 percent; corn, -34 percent; alfalfa, -19 percent; tomatoes, -21 percent;, fruit and nuts, -61 percent; and grapes, -29 percent.[48]

Dr. Hoffman's conclusions resemble untested hypotheses about soil conditions in the south Delta. He states his hypotheses unencumbered by current, site-specific evidence. For example, he collects no field data on Delta agriculture to test the prediction of his hypothesis. He admits that his conclusions rest heavily on results of 30-year old studies of potted bean varieties that commercial growers no longer use. It is unbelievable that the *SED Report* author supports a degradation of water quality standards based on an untested hypothesis while ignoring compelling evidence, presented in this critique and elsewhere, that Dr. Hoffman's hypothesis should be rejected.

Dr. Hoffman identified the deficiencies of his analysis regarding the lack of field data.

> "*It is unfortunate that the published results on the salt tolerance of bean are taken from five laboratory experiments conducted more than 30 years ago. In addition, there are not data to indicate how the salt tolerance of bean changes with growth stage. With such an important decision as the water quality standard to protect all crops in the South Delta, it is unfortunate that a definitive answer can not be based on a field trial with modern bean varieties.*"[49]

Dr. Mark Grismer, one of those asked by the Board to review Dr. Hoffman's report, agreed with Dr. Hoffman on this deficiency of his analysis.

> "*I also agree with Hoffman's observations on (p. 21) the limited data available for determination of bean salt tolerance. This data is relatively old, based on greenhouse pot studies and bean varieties unlikely used today commercially. Field studies in typical Delta clay soils (dominant soil type) considering salt tolerance of commercially grown beans in the Delta are needed. …*"[50]

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[47] Orlob, G. 1987. Impact of San Joaquin River Quality on Crop Yields in the South Delta. Page 2-3.

[48] Orlob 1987, page 6.

[49] Hoffman 2010, page 98.

[50] Grismer. M. 2011. Peer Review of Technical Reports on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives. Prepared for the Bay-Delta Unit, State Water Resources Control Board. November 10. Page 4-5.

Of the five scientists asked to review Dr. Hoffman's work, only Dr. Grismer provided comments.

Dr. Hoffman's analysis focuses on the salt tolerance of crops, mostly beans. Missing from his or other analyses is the effects of increases salinity concentrations on species and habitats in the Delta. To the extent that increased salinity negatively affects natural resources and related ecosystem services that benefit society, the higher salinity concentrations will negatively affect the values of these services. One of the scientists asked by the Board to review the scientific basis for the flow and salinity alternatives noted this lack of information on the relationship between proposed increased salinity concentrations and effects on salmon. Dr. Thomas Quinn, from the School of Aquatic and Fishery Sciences at the University of Washington, Seattle commented:

> "*The report has so much effort devoted to salmon and steelhead that the absence of reference to these fishes in the section on salinity is stark. Are there no issues related to estuarine dynamics or salinity related to salmon?*"[51]

Critique #9: Rather than address current salinity problems, the SED Report authors dodge them by increasing allowable salinity concentrations

The record on salinity concentrations in the Delta clearly shows that concentrations regularly exceed current allowable amounts, and have done so for some time.[52] Indeed, the authors acknowledge as much in the *SED Report*, "*Under baseline, these salinity levels* [allowable concentrations] *are not always fully met*."[53]

The record is also clear that salinity concentrations below those proposed by the *SED Report* authors harm Delta agriculture. As we mention elsewhere in our critique, the analyses conducted for the Draft EIR for the Bay Delta Conservation

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[51] Quinn, T. No date. Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives.

[52] California Department of Water Resources. 2011. *Low Head Pump Salinity Control Study - Prepared to meet requirements of the State of California State Water Resources Control Board Water Rights Order WR 2010-0002, Condition A.7*. April.; State of California State Water Resources Control Board. 2006. *In the Matter of Draft Cease and Desist Order Nos. 262.31-16 and 262.31-17 Against the Department of Water Resources and the United States Bureau of Reclamation Under their Water Right Permits and License and In the Matter of Petitions for Reconsideration of the Approval of a Water Quality Response Plan Submitted by the Department of Water Resources and the United States Bureau of Reclamation for their Use of Joint Points of Diversion in the Sacramento-San Joaquin Delta*. Order WR 2006-0006.

[53] SED 2012, p.ES-15.

Plan, and the Delta Protection Commission's Economic Sustainability Plan (ESP) documented this harm, as does the Orlob report.[54] Peer reviewers validated this work and the California Department of Water Resources gave the ESP study its seal of approval by adopting the ESP model of salinity impacts on Delta agriculture.

Instead of solving the problem by dealing with its causes, the *SED Report* authors simply hide it by increasing the amount of salinity allowed, which strongly resembles polluters turning off the monitors. And the authors try to counter all the evidence against this dodge with a 30 year old, severely criticized study of potted beans. We don't see how this can possibly be taken seriously.

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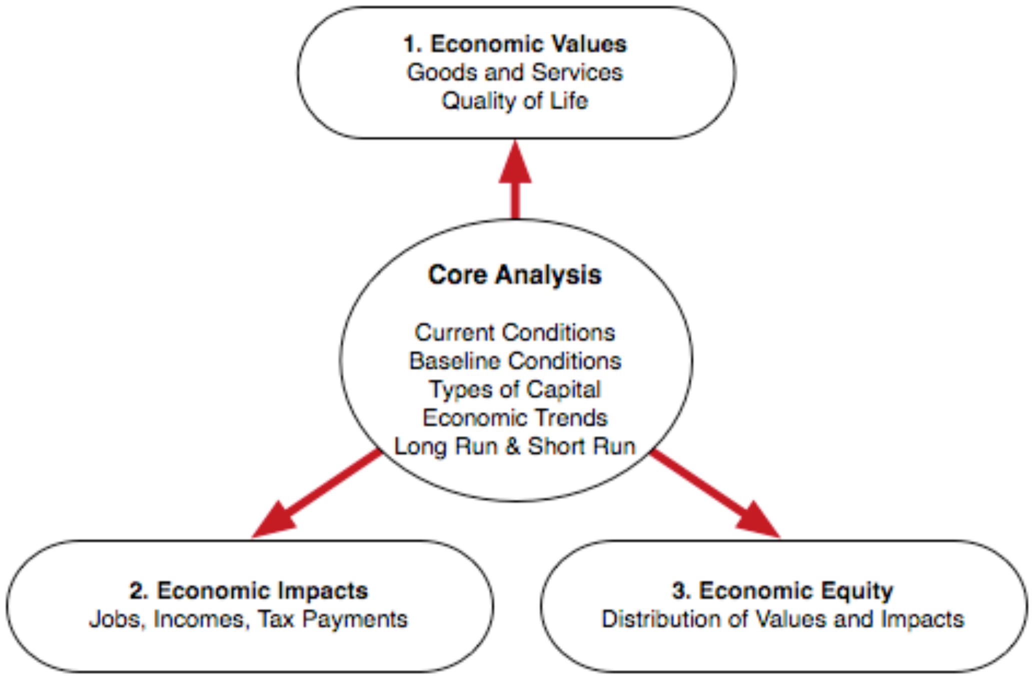
[54] Orlob 1987.

Appendix: Figure 1. Categories of Economic Effects

Figure 1. Categories of Economic Effects[55]



Source: ECONorthwest. 2013. *Bay-Delta Water: Economics of Choice*.

Figure 1 shows the three categories of economic effects each alternative would cause. The first category, Economic Values, represents *changes in the values of goods and services* available to Californians that result from the market and non-market activities associated with each alternative. Such effects include changes in economic benefits, costs or both, as well as changes in the quality of life. The second category, Economic Impacts, represents changes in jobs and incomes for workers, costs or revenues for private firms, and expenditures or tax revenues for governments. These impacts occur directly, as workers are employed on construction, deconstruction, and restoration, for example, and indirectly, as

[55] For a description and explanation of the economic consequences of a shift from abundance to scarcity in an ecological system, e.g., a watershed, see Courant, P., E. Niemi, and E. Whitelaw. 1997. *The Ecosystem-Economy Relationship: Insights from Six Forested LTER Sites*. Grant No. DEB-9416809. National Science Foundation. November.; Hulse, D., G. Gordon, and E. Niemi. 2001. *Establishing Correlations Between Upland Forest Management Practices and the Economic Consequences of Stream Turbidity in Municipal Supply Watersheds*. EPA Grant No. R825822. Environmental Protection Agency. September.

dollars are spent locally on goods and services, dollars which multiply through the local economy, supporting additional jobs and incomes. The third category, Economic Equity, represents the distribution of the other two categories of effects, Economic Values and Economic Impacts, across income brackets of households, across ethnicities, and across geographic areas. These changes are particularly challenging to describe and evaluate when, say, groups of households who enjoy the benefits, jobs, and incomes, differ from those who bear the costs.

The center of Figure 1—the Core Analysis—shows the analyses common to characterizing or calculating all three categories of economic effects.

1. By describing the Current Conditions and Baseline Conditions for each alternative, the analyst can describe the gap between the two. The larger the gap, the larger the problem.

2. By describing the four basic forms of capital (physical capital, human capital, social capital and natural capital)[56] under both Current and Baseline Conditions for each alternative, the analyst can, for example, measure the effects of the alternative on the stocks of economic assets and thereby on the flows of services from those assets.[57]

3. By taking economic trends into account, the analyst can apply a with-versus-without approach, which isolates the economic effects (values, impacts, equity) caused by the alternatives from changes that will likely occur unrelated to the alternatives.

4. By addressing both the short- and long-term effects, the analyst can avoid errors of omission and commission through confusing today and tomorrow. The literal differences in effects between today and tomorrow would be trivial. But since the relevant period of time may stretch to a century, the figurative differences would likely be huge.

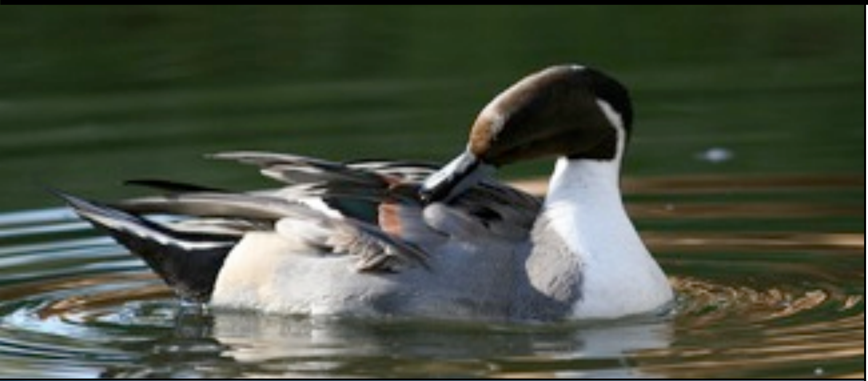
---

[56] These four types of capital affect local economic productivity, which in turn is the source of economic growth in, say, California. Examples of physical capital are private and public machines, buildings, roads, and water and sewage systems. Examples of natural capital are rivers and streams, mountains and valleys, and grasslands and forests. Examples of human capital are workers of all types and their knowledge and skills. Examples of social capital are social networks and the norms, laws, and judicial and political systems.

[57] O'Sullivan, A. 2008. *Urban Economics*, 7th Edition. p.90-91.

Bay-Delta Water

Economics of Choice



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ECONorthwest
ECONOMICS • FINANCE • PLANNING

99 W. 10th Avenue, Suite 400
Eugene, OR 97401
Phone: 541-687-0051
www.econw.com

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Contact Information

This report was prepared by Mark Buckley, Ed MacMullan, Sarah Reich, Bryce Ward, and Ed Whitelaw, with technical support from Philip Taylor, all of ECONorthwest, which is solely responsible for its content.

ECONorthwest specializes in economics, planning, and finance. Founded in 1974, we're one of the oldest independent economic consulting firms in the Pacific Northwest. ECONorthwest has extensive experience applying rigorous analytical methods to examine the benefits, costs, and other economic effects of environmental and natural resource topics for a diverse array of public and private clients throughout the United States and across the globe.

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For more information about this report, please contact:

Ed MacMullan
ECONorthwest
99 W. 10th Ave., Suite 400
Eugene, OR 97401-3040
541-687-0051

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SECTION 1: CONTEXT AND ASSIGNMENT

Water flows from the Sierra Nevada into the Sacramento and San Joaquin Rivers, which in turn flow into the San Francisco Bay-Delta, and from the Delta Bay into the Pacific Ocean. In 2009, the California state legislature enacted the Delta Reform Act. As part of that legislation the California State Water Resources Control Board (State Water Board) was instructed to report to the Delta Stewardship Council (Council) the Board's view of what flows would be necessary to protect the Delta ecosystem. In its August 2010 report, *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem* (*Flow Report*)[1], the State Water Board expressed its concerns about the Bay-Delta flows.[2] It concluded that the Bay-Delta flows are inadequate. They threaten native fish[3], and thereby violate California's obligations under the public-trust doctrine.[4] According to the *Flow Report*, changing flow conditions in ways that would support native fish species requires improving the Bay-Delta flows throughout the year.

If we understand the Council's role correctly, then to allocate the Bay-Delta flows well, the Council would seek to balance its obligations to protect public-trust use of the Bay-Delta flows with its obligations to support the dual coequal goals of i) habitat conservation and management, and ii) improving reliability of water supplies. This balancing task includes:

a. Developing alternatives to increase the efficiency and equity of allocating the Bay-Delta flows among the competing instream and consumptive demands[5]

b. Describing the economic, biophysical[6] and other effects of the alternatives

c. Selecting what it regards as the best of the alternatives and enforcing the efficient allocation of the imputed flow conditions.

Economics, at its core, is the science of choice[7] or, as it is defined frequently in introductory textbooks, the study of the allocation of scarce[8] resources among competing

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[3] These species include Chinook Salmon, Delta Smelt, and Bay Shrimp. *Flow Report*, p. 5 and 8.

[4] *Flow Report*, p.1-7; *Flow Report*, p.12: "The purpose of the public trust is to protect commerce, navigation, fisheries, recreation, ecological values, and fish and wildlife habitat. Under the public trust doctrine, the State of California has sovereign authority to exercise continuous supervision and control over the navigable waters of the state and the lands underlying those waters. [citation omitted] A variant of the public trust doctrine also applies to activities that harm a fishery in non-navigable waters. [citation omitted]"

[5] Instream demands are water uses that can be carried out without removing the water from its source, such as in navigation and recreation. Consumptive demands are water uses which lessen the amount of water available for other uses, such as in manufacturing, agriculture, and food preparation. [U.S. Bureau of Reclammation. *Glossary*. January 5, 2011. Retrieved June 24, 2011, from http://www.usbr.gov/library/glossary/.]

[6] By 'biophysical,' we mean the biological effects (e.g., on plants and animals), ecological effects (e.g., on ecological systems), and physical effects, e.g., on water, land and air). We do not mean the interdisciplinary science of biophysics that, as Wikipedia tells us, 'uses the methods of physics and physical chemistry to study biological systems.' We apologize for any confusion, and plead only expedience for our lack of precision. [2011. *Biophysics*. May 16. Retrieved June 27, 2011, from en.wikipedia.org/wiki/Biophysical].

demands.[9] The State's balancing decision, whether good or bad, would include such an allocation among competing demands. Michael Jackson, an attorney working with Bay-Delta stakeholders, asked ECONorthwest to describe economic issues relevant to the State's balancing of competing demands for Bay-Delta flows. We at ECONorthwest recognize the diverse group of people interested in the Bay-Delta Flows, and have sought to write an accessible yet technically sound report rooted in established economic practices and theory. To that end, we have prepared this report.

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[7] See, for example, <http://www.google.com/search?sclient=psy&hl=en&site=&source=hp&q=economics+science+choice&btnG=Search>

[8] By "scarcity," we mean situations in which the resources available for producing output are insufficient to satisfy wants. This is different to saying that they are insufficient to satisfy demand since demand relates to an expression of want backed by money. This concept of relative scarcity in relation to wants is widely held to define the central conflict of economics since, otherwise, there would be no need to think about the 'best' allocation of resources. [Pearce, D.W. 1992. *The MIT Dictionary of Economics*, 4th edition. Cambridge, MA: The MIT Press.]

[9] See, for example, <http://www.google.com/search?sclient=psy&hl=en&site=&source=hp&q=economics+allocation+scarce+resources+competing+demands&btnG=Search>; Field, B.C. 1997. *Environmental Economics*, Second Edition. San Francisco: McGraw-Hill Company, Inc.; Gramlich, E.M. 1990. *A Guide to Benefit-Cost Analysis*. Englewood Cliffs, New Jersey: Prentice Hall.; Harberger, A. and G. Jenkins, eds. 2002. *Cost-Benefit Analysis*. The International Library of Critical Writings in Economics: 152. Northampton, Massachusetts: Edward Elgar Publishers.; and U.S. Environmental Protection Agency. 2010. *Guidelines for Preparing Economic Analyses*. December.

SECTION 2: ECONOMICS AND THE CHOICES CALIFORNIA FACES

If the waters flowing from the Sierra Nevada to the San Francisco Bay-Delta had conditions of abundance, the State might not have felt compelled to prepare the *Flow Report*. But scarcity rules the waters and causes fierce competition. The consequences of the competition for these scarce waters lies at the heart of the State Water Board's *Flow Report*.[10]

Instream uses of the Bay-Delta flows compete with what the State Water Board describes as "other beneficial uses" of water.[11] These *other beneficial uses* include municipal, industrial, and agricultural uses.[12] If, once again, we understand the State role correctly, then in allocating the Bay-Delta flows the State would seek to balance its obligations to protect public-trust use of the Bay-Delta flows, with its obligations to support the "other uses" of the Bay-Delta flows.

To balance its obligations effectively, the State would, as we state in Section 1, seek to develop alternatives to improve the Bay-Delta flows, describe the economic, biophysical and other effects of these alternatives, and then select the best of the alternatives. To serve these ends, a necessary step for the State would be to describe how each alternative would affect economic well-being, power production, human health and welfare, the sustainability of natural resources, habitats and species, and possibly other factors.[13] Economists have developed tools for describing such effects.

Among the tools economics offers for comparing competing alternatives, the most widely known and frequently used in environmental and natural resource matters is benefit-cost analysis (BCA).[14] As applied in this case by the State, a properly conducted BCA would describe differences in net economic values—economic benefits minus economic costs—across the alternatives. In our experience, stakeholders and decision makers frequently care about other types of economic consequences besides changes in economic values. They want to know how policy alternatives will affect things like jobs and income, which economists describe as economic impacts, and the distribution of changes in economic values and impacts among stakeholders and households, which

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[10] For a description and explanation of the economic consequences of a shift from abundance to scarcity in an ecological system, e.g., a watershed, see Courant, P., E. Niemi, and E. Whitelaw. 1997. *The Ecosystem-Economy Relationship: Insights from Six Forested LTER Sites*. Grant No. DEB-9416809. National Science Foundation. November.; Hulse, D., G. Gordon, and E. Niemi. 2001. *Establishing Correlations Between Upland Forest Management Practices and the Economic Consequences of Stream Turbidity in Municipal Supply Watersheds*. EPA Grant No. R825822. Environmental Protection Agency. September.

[11] In the rest of the report, we will italicize the phrase "other beneficial uses" to signal that these are not all other uses but only those specified by the State Water Board.

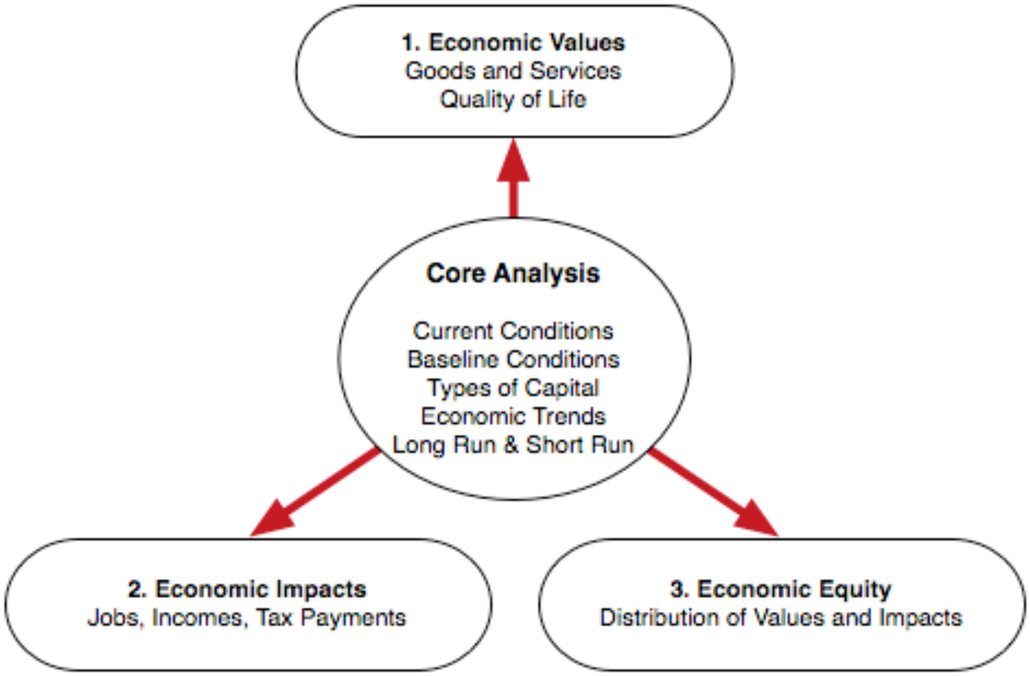
[12] *Flow Report*, p.1-7.

[13] *Flow Report*, p.2-3.

[14] Mishan, E.J. *Elements of Cost-Benefit Analysis*, 3rd Edition. 1972. p.11-13; Turner, R., D. Pearce, and I. Bateman. 1993. *Environmental Economics*, p.93-4; Teitenberg, T. and L. Lewis. *Environmental and Resource Economics*, 8th Edition. 2008. p.28.

economists generally address as economic equity. Thus, a comprehensive economic assessment from alternative Bay-Delta flows would describe economic consequences that include changes in economic values, changes in economic impacts, and the distributional outcomes for each alternative. Figure 1 shows the three categories of economic effects each alternative would cause.

Figure 1. Categories of Economic Effects



Source: ECONorthwest

The first category, Economic Values, represents *changes in the values of goods and services* available to Californians that result from the market and non-market activities associated with each alternative. Such effects include changes in economic benefits, costs or both, as well as changes in the quality of life. The second category, Economic Impacts, represents changes in jobs and incomes for workers, costs or revenues for private firms, and expenditures or tax revenues for governments. These impacts occur directly, as workers are employed on construction, deconstruction, and restoration, for example, and indirectly, as dollars are spent locally on goods and services, dollars which multiply through the local economy, supporting additional jobs and incomes. The third category, Economic Equity, represents the distribution of the other two categories of effects, Economic Values and Economic Impacts, across income brackets of households, across ethnicities, and across geographic areas. These changes are particularly challenging to describe and evaluate when, say, groups of households who enjoy the benefits, jobs, and incomes, differ from those who bear the costs.

The center of Figure 1—the Core Analysis—shows the analyses common to characterizing or calculating all three categories of economic effects.

1. By describing the Current Conditions and Baseline Conditions for each alternative, the analyst can describe the gap between the two. The larger the gap, the larger the problem.
2. By describing the four basic forms of capital (physical capital, human capital, social capital and natural capital)[15] under both Current and Baseline Conditions for each alternative, the analyst can, for example, measure the effects of the alternative on the stocks of economic assets and thereby on the flows of services from those assets.[16]
3. By taking economic trends into account, the analyst can apply a with-versus-without approach, which isolates the economic effects (values, impacts, equity) caused by the alternatives from changes that will likely occur unrelated to the alternatives.
4. By addressing both the short- and long-term effects, the analyst can avoid errors of omission and commission through confusing today and tomorrow. The literal differences in effects between today and tomorrow would be trivial. But since the relevant period of time may stretch to a century, the figurative differences would likely be huge.

In 1983, the California Supreme Court issued its opinion in the case of *National Audubon Society et al. v. The Superior Court of Alpine County, et al*.[17] That ruling, commonly called the "Mono Lake decision," (*Mono Lake*) clarified the extent of the State's public-trust obligation to protect water resources. In general, the Court ruled that protecting water resources takes precedence over consumptive water use. The Court's ruling relied in part on economic analyses of the competing demands for Mono Lake water.

The State's analysis of the economic effects of its balancing decision can benefit from applying the widely accepted professional standards applicable to economic analyses in this type of matter, and the precedents set by the *Mono Lake* decision. In this report we examine the relevant professional standards and the *Mono Lake* decision and describe their implications for the State as it seeks a balance.

In the next section, Section 3, we present an economic perspective of the Supreme Court's decision.

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[15] These four types of capital affect local economic productivity, which in turn is the source of economic growth in, say, California. Examples of physical capital are private and public machines, buildings, roads, and water and sewage systems. Examples of natural capital are rivers and streams, mountains and valleys, and grasslands and forests. Examples of human capital are workers of all types and their knowledge and skills. Examples of social capital are social networks and the norms, laws, and judicial and political systems.

[16] O'Sullivan, A. 2008. *Urban Economics*, 7th Edition. p.90-91.

[17] Broussard, J. 1983. *National Audubon Society et al., Petitioners, v. The Superior Court of Alpine County, Respondent; Department of Water and Power of the City of Los Angeles et al., Real Parties in Interest*. 33 Cal.3d 419. S.F. No. 24368. Supreme Court of California. February 17.

SECTION 3: ECONOMICS AND THE STATE WATER BOARD'S BALANCING DECISION IN *MONO LAKE*

In *Mono Lake*, the State Water Board faced a classic public-policy choice, a choice resembling the choice it faces with Bay-Delta flows: allocating a scarce and valuable natural resource—Mono Lake—among competing demands. The State can therefore look to its own history for guidance on balancing its public-trust obligation to protect Bay-Delta flows with the demands from other beneficial uses, and the role that economic information can play in the deliberations. As it balanced competing interests and reached its decision in *Mono Lake*, the State Water Board described the biological significance of the water at issue, developed economic measures of the relevant costs and benefits of alternative water allocations, and considered measures that could mitigate negative economic outcomes.[18] It should take similar steps as it sets criteria for the Bay-Delta flows.

In *Mono Lake*, the State Water Board considered the consequences of the City of Los Angeles (City)— acting through the Los Angeles Department of Water and Power (LADWP)—exercising its right to draw water from Mono Lake for urban-consumption uses, and the resulting impacts on the lake's ecological habitats and affected species. The State Water Board began by considering the biophysical aspects of its decision. It first identified the ecological uses of trust resources at issue and their biological requirements, e.g., the species that depend on Mono Lake and their water requirements. Next, it studied the relationship between water flows out of Mono Lake and the impacts on ecological uses. It then compared the costs of the City acquiring water from sources other than Mono Lake with the economic benefits of protecting the ecological uses of the lake's affected public-trust resources.[19]

Dr. John Loomis, a natural-resource economist,[20] helped quantify the economic benefits in the State Water Board's analysis. Dr. Loomis surveyed California residents and calculated their willingness to pay to protect Mono Lake's habitats and affected species. Based on this information, Dr. Loomis calculated the economic benefits of protecting the ecological uses of the lake's water at $1.5 billion to $3.5 billion annually. This amount significantly exceeded the estimated cost, $26.5 million per year, of finding alternative sources of water for the City.[21]

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[18] Koehler, C.J. 1995. "Water Rights and the Public Trust Doctrine: Resolution of the Mono Lake Controversey." *Ecology Law Quarterly* 22: 451.; Casey, E. 1984. "Water Law—Public Trust Doctrine," *Natural Resources Journal* 24: 809-825.

[19] Koehler, 1995; Casey, 1984.

[20] Dr. Loomis conducted this research while at the Department of Agricultural Economics at the Davis campus of the University of California.

[21] Loomis, J. 1987. "Balancing Public Trust Resources of Mono Lake and Los Angeles' Water Right: An Economic Approach." *Water Resources Research* 23: 1449-1456. August; Loomis, J. 1997. Use of Non-Market Valuation Studies in Water Resource Management Assessments. Colorado State University; Duffield, J. 2010. *Valuing Ecosystem Services in River and Lake Systems: Methods and Western U.S. Case Studies*. Presentation, Salt Lake City, April 28.

Dr. Loomis conducted his analysis as independent research that was not part of the State Water Board's balancing decision. The State Water Board, however, took notice of Dr. Loomis' work and directed the consultant performing the economic portion of the Environmental Impact Statement for the balancing analysis to adopt and implement Dr. Loomis' approach. The consultant's assessment reached the same conclusion: the economic benefits of protecting the ecological uses of trust resources in Mono Lake significantly exceeded the cost of supplying the City with water from alternative sources. The State Water Board considered other factors along with these economic results and ultimately reduced by half the amount of water that the LADWP could divert from Mono Lake.[22]

The State Water Board's *Mono Lake* experience can help inform current deliberations on the relevant economic aspects of balancing competing uses of Bay-Delta flows. Analytical factors from the *Mono Lake* analysis that have relevance to the Delta Stewardship Council's planning decision include:

- *Conduct economic analyses in the context of the biophysical requirements of the ecological uses of public-trust resources*. The State Water Board identified the ecological uses of public-trust resources at issue in *Mono Lake* and the water requirements that support these uses *before* considering the costs and benefits of allocation scenarios. That is, the State Water Board acknowledged its obligation to protect the ecological uses of public-trust resources, and then considered reasonable methods of satisfying this obligation.[23]

- *Account for all relevant economic, legal, and other forces and trends*. The LADWP proposed that the State Water Board make its decision based on a worst-case scenario of future water supplies for the City. Such an approach ignored current trends in water policy at the local, state and federal level. For example, the worst-case approach ignored the fact that trends in state and federal water law at the time encouraged water transfers between and among entities. Such transfers meant that LADWP could tap sources other than Mono Lake for future demands. On this point the State Water Board noted, "[T]he LADWP analysis assumes that insufficient replacement water will be available thereby causing high water shortage costs to be imposed on water users in Los Angeles. This assumption does not appear to be realistic in light of the evidence…." The State Water Board took the current trends in water transfers into account when making its decision.[24]

- *Consider likely mitigating circumstances*. LADWP also asked that the State Water Board assume that the City would take no actions to mitigate the impacts of reduced flows from Mono Lake. That is, the LADWP asked that the State Water Board base its decision on a *static analysis* that assumed conditions would remain fixed over the foreseeable future. The State Water Board, instead, based its decision on a *dynamic analysis*, which assumed the City and others would take appropriate actions, such as

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[22] Loomis, 1997; Duffield, 2010.

[23] Koehler, 1995; Casey, 1984.

[24] Koehler, 1995; Casey, 1984.

doing more to conserve water, to mitigate the initial effects of a reduction in water supplied from Mono Lake. More broadly, this dynamic analysis took into account relevant economic and other forces and trends, as noted above.

- *Account fully for both values reflected in market prices and values that are not.* In reaching its *Mono Lake* decision, the State Water Board considered estimates of the City's potential costs to acquire water from another source. These estimates derived from data on the prices at which water was bought and sold in the region. No such prices and data existed for the economic value of protecting the ecological uses of public-trust resources. The State Water Board recognized, however, that the absence of prices did not mean that protecting these uses had little or no value, but, instead, that market prices are not an appropriate tool for measuring the value. Hence, the State Water Board looked to the results of research that employed non-market techniques for estimating the value.[25] We address this point in more detail in the next section.

[25] Loomis, 1987; Loomis, 1997; Duffield, 2010.

SECTION 4: THE EVOLUTION OF THE ECOLOGICAL USES OF PUBLIC-TRUST RESOURCES AND ECONOMIC METHODS

Stakeholders in the *Mono Lake* case litigated to clarify the relationship between the City's water rights and the State's public-trust obligation to protect water resources. The Supreme Court of California ultimately ruled that, in general, the State's public-trust obligations have precedence over the City's water rights. This ruling helped inform the State Water Board's balancing decision in that case. The Supreme Court's decision emphasized that stakeholders and decision makers should consider public-trust obligations as dynamic and evolving over time, rather than fixed and based exclusively on historical conditions. What constitutes a protected use of public-trust resources can evolve along with changes in understanding of the natural environment and its relationship to the well being of human society.

Methods of describing the economic effects of public policies on ecological uses of water resources have also evolved. Markets do not exist for many of these uses and so economists calculate their economic significance using non-market valuation methods. Years ago, economists and public-policy analysts could reasonably debate the analytical veracity of these methods. Not so today. Analytical methods continue evolving, and areas of legitimate disagreement still exist, however, detailed descriptions of these analytical methods appear in economic textbooks, articles in academic journals, undergraduate and graduate economics courses, and reports by federal and state natural-resource agencies in the U.S. Economists in Europe, Asia and elsewhere also regularly use these methods.

In this section we describe the evolution of thinking on ecological uses of California's public-trust resources. We then summarize methods of describing the economic significance of ecological uses of trust resources, especially those that provide society with ecosystem-services for which markets do not exist. The information in this section provides a context for the sections that follow, in which we describe in more detail the analytical principles relevant to describing the economic effects of the State's balancing decision regarding the Bay-Delta flows.

A. Ecological Uses of Public-Trust Resources

Implementing the public-trust doctrine in California has evolved over time. Early in the state's history, the doctrine protected the public's access to, and use of, tidelands for navigation, commerce and fisheries. More recent court decisions recognized the changing nature of the use of trust resources and expanded the list of protected uses to include recreational uses and ecological uses that support habitats and species. Litigation related to the State Water Board's *Mono Lake* decision help clarify the responsibilities of the State as administrator of the public-trust resources. The Supreme Court of California ruled that the State Water Board must take impacts of allocation decisions on uses of trust resources into account when administering water rights.[26]

[26] Koehler, 1995; Casey, 1984.

The Court's ruling also emphasized a flexible definition of use, one that responds to changing public needs. The Court also identified ecological resources as one of "the most important" uses of trust resources.[27]

"[W]e stated that '[t]he public uses to which tidelands are subject are sufficiently flexible to encompass changing public needs. In administering the trust the state is not burdened with an outmoded classification favoring one mode of utilization over another. [citation omitted] There is a growing public recognition that one of the most important public uses of the tidelands—a use encompassed within the tidelands trust—is the preservation of those lands in their natural state, so that they may serve as ecological units for scientific study, as open space, and as environments which provide food and habitat for birds and marine life, and which favorable affect the scenery and climate of the area.'"[28]

Preservation of water-based natural resources "in their natural state" can affect a wide range of ecosystem services that trust resources provide. An illustrative, though incomplete, list of these ecosystem services includes flood mitigation and groundwater recharge, water filtration, sediment capture, nutrient cycling, gas regulation, provision of habitat for economically important fish and wildlife, and scenic and amenity values. While the natural resources at issue exist independent of human society, ecosystem services only exist insofar as there is human demand for their supply, at a particular place and time, and their value reflects the specific context within which the demand exists. Ecological uses of trust resources are not traded in markets, however, and so we must look to non-market valuation methods for measures of their values. We describe these methods in the next subsection.

B. Evolution of Economic Methods

Methods of measuring the economic effects of water allocation decisions on what the California Supreme Court described as one of the most important uses of public-trust resources—uses by aquatic resources that provide ecosystem services—have evolved over time. In the remainder of this section, we illustrate the evolution of these economic methods using reports by federal and California state agencies. We picked these sources because they help guide federal and state public policies, and because they often incorporate analytical principles or methods only after they have been subject to peer review and debate in academic and professional forums. We begin with federal guidelines.

1. Federal Guidelines

a. Principles and Guidelines

In 1983, the U.S. Water Resources Council published, *The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (*P&G*).

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[27] Broussard, J. 1983. *National Audubon Society et al., Petitioners, v. The Superior Court of Alpine County, Respondent; Department of Water and Power of the City of Los Angeles et al., Real Parties in Interest*. 33 Cal.3d 419. S.F. No. 24368. Supreme Court of California. February 17.

[28] Broussard, 1983.

This report helps federal agencies, including the Corps of Engineers and Bureau of Reclamation, plan water-related projects. The *P&G* have not been updated since they were introduced. Recently, the National Research Council (NRC) of the National Academies, reviewed proposed changes to the *P&G*. The NRC's review begins by describing some of the significant changes in water-resources planning since the publication of the *P&G* in 1983.

"Since the early 1980s there have been may changes in the national water resources planning landscape. For example, … [s]cientific understanding and appreciation of the natural functions of aquatic ecosystems have increased, and environmental protection and ecosystem restoration have become primary planning objectives for some projects ... Many national water planning challenges involve balancing decisions and resources among a greater number of water resource users and interests."[29]

"For the Corps of Engineers, new missions have been added … especially aquatic ecosystem restoration."[30]

"[Other water-planning issues] such as design of ecosystem restoration projects, reallocating water from traditional users to rapidly growing cities or ecosystem restoration purposes, and controlling nonpoint source pollution reflect more recent changes and needs. Many of today's key national water management issues lie largely outside the missions of the agencies for which the *P&G* was written."[31]

"In light of these developments, many groups—including committees of the National Research Council—have recommended that the P&G be reviewed and modernized.[32]

The NRC concluded, however, that the proposed changes did not adequately address the many deficiencies in the outdated *P&G*. The proposed revisions "lacked clarity and consistency,"[33] which precluded the NRC from offering specific suggested changes. The NRC did comment on a few areas for improvement.

"…[T]he 2007 Water Resources Development Act requires that the P&G revision ensure the use of best available economic principles and analytical techniques. However, the proposed revisions contain concepts, advice, and language that are carryovers from historical practices and documents and are not fully consistent with contemporary best practices in decision science and economics. This relates

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[29] National Research Council of the National Academies. 2010. *A Review of the Proposed Revisions to the Federal Principles and Guidelines Water Resources Planning Document*. Committee on Improving Principles and Guidelines for Federal Water Resources Project Planning, Water Science and Technology Board, Division on Earth and Life Studies. p.1.

[30] National Research Council, 2010, p.5.

[31] National Research Council, 2010, p.6.

[32] National Research Council, 2010, p.1.

[33] National Research Council, 2010, p.2.

to both how analysis is conducted and the role that it plays informing decisions."[34]

For example, the NRC noted that limiting an economic analysis of an environmental policy to costs and benefits would not satisfy current professional standards. An adequate analysis will look beyond costs and benefits to describe all relevant impacts and tradeoffs that affect jobs, income, competitiveness, etc. The *P&G* also separated the analysis of economic effects of environmental changes, which are described qualitatively, from the analysis of economic-development changes, which are described quantitatively. The NRC characterized this approach as a "residue" from the 1983 *P&G* that is inconsistent with current best practices.[35]

The NRC described the *P&G* as outdated and not representative of current best economic practices. This is especially true for analyses of the economic effects of public policies on environmental resources and ecosystem services. Given the significance of public-trust resources that support ecological habitats and ecosystem services that the Bay-Delta flows support, and given the deficiencies in the *P&G*, this report can offer the State Water Board little useful guidance on economic aspects balancing Bay-Delta flows.

b. EPA Guidelines on Economic Analyses

In December of 2010, the Environmental Protection Agency (EPA) released *Guidelines for Preparing Economic Analyses (Guidelines)*. The 2010 edition of the *Guidelines* represents the third update since the first edition was released in 1983. Unlike the *P&G*, which remain unchanged since first introduced in 1983, EPA anticipated periodically revising the *Guidelines* to account for "new literature published since the last revision" and the "growth and development of economic tools and practices."[36] These revisions and updates help keep the *Guidelines* more consistent with current best economic practices than do the *P&G*.

The 2010 edition includes a number of updates that help make the document a useful planning tool in general, and specifically for the State's balancing decision in the Delta. These updates include:[37]

- More detailed recommendations on identifying and describing baseline conditions that would exist without a proposed policy revision or regulation.

- An expanded description of methods of defining and valuing ecological benefits of projects and policies that protect natural resources.

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[34] National Research Council, 2010, p.12.

[35] National Research Council, 2010, p.11-12.

[36] National Center for Environmental Economics. 2010. *Guidelines for Preparing Economic Analyses. U.S. Environmental Protection Agency*. EPA 240-R-10-001. December. p.1-1.

[37] National Center for Environmental Economics, 2010, p.1-1.

- A revised and updated description of methods of discounting costs and benefits that occur at different times in the future.

- Directions on presenting the results of benefit-cost studies, including effects that cannot be quantified or expressed in dollar amounts.

c. EPA Guidelines on Valuing Ecological Services

EPA's Science Advisory Board (SAB) released a report titled, *Valuing the Protection of Ecological Systems and Services* in May of 2009. As the name implies, the report describes methods of identifying and describing the economic significance of natural resources and associated ecosystem services affected by policies or projects. The SAB noted the importance of valuing ecosystem services using up-to-date economic methods, and promoting collaboration among social scientists and biophysical scientists.[38]

"This report describes and illustrates how EPA can use an 'expanded and integrated approach' to ecological valuation. The proposed approach is 'expanded' in seeking to assess and quantify a broader range of values than EPA has historically addressed and through consideration of a larger suite of valuation methods. The proposed approach is 'integrated' in encouraging greater collaboration among a wide range of disciplines, including ecologists, economists, and other social and behavioral scientists, at each step of the valuation process."[39]

The report describes a number of recommendations that facilitate the "expanded and integrated approach." Many of the recommendations have relevance to assessing the economic effects of water allocations in the Delta. These include:[40]

- Identifying and describing the critical relationships between biophysical aspects of affected natural resources and ecosystem services, and analyses of the economic effects of policies that impact resources and services.

- Choosing appropriate valuation methods.

- Identifying and describing sources of uncertainty in analyses of the economic significance of ecosystem services.

2. Guidelines by the California Department of Water Resources

The California Department of Water Resources (Department) recently produced guidelines for economic analyses of public policies that affect water resources. We describe two of these works in this subsection. The first, a four-part study published in 2005, describes the importance of considering the full range of economic costs and

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[38] Environmental Protectation Agency (EPA) Science Advisory Board. 2009. Valuing the Protection of Ecological Systems and Services. EPA-SAB-09-012. May. p.2.

[39] EPA, 2009, p.2.

[40] EPA, 2009, p.1-7.

benefits of public policies that affect aquatic resources. The Department refers to this as a "multi-objective approach" to floodplain management because it takes into account objectives besides flood mitigation (a single objective) to consider consequences on habitats, water quality, society, etc. The second is a guidebook on conducting economic analysis published by the Department in 2008.

a. Multi-Objective Approach to Floodplain Management

1. Ecosystem Valuation Methods

The first of the four reports in the multi-objective approach, *Ecosystem Valuation Methods* (*Methods*), describes a number of up-do-date methods of valuing aquatic-based ecosystem services. [41] The report summarizes ten analytical methods and their advantages and disadvantages. The floodplain focus and the up-to-date descriptions of analytical methods in this and the other three reports, have relevance to, and can help inform, the State's assessment of the economic significance of ecological uses of the Bay-Delta flows.

2. Natural Floodplain Functions and Societal Values

The second report, *Natural Floodplain Functions and Societal Values* (*Functions*), describes biophysical aspects of floodplain habitats and examples of economic values of the ecosystem services that floodplains provide.[42] The report provides background information on floodplain habitats and the biological and human services they provide, and the importance of considering this information when making decisions that affect floodplains. The report describes economic values of ecosystem services including managing flows, maintaining natural channel processes, water supply, water quality, soil quality, and plant and wildlife habitat. The staff conducting the study applied some of the analytical methods described in the *Methods* report.

3. Middle Creek Restoration Project Case Study: Benefit and Cost Analysis

The third report, *Middle Creek Flood Ecosystem Restoration Project Case Study: Benefit and Cost Analysis* (*Case Study*), describes the results of a case study of applying analytical methods and data described in the *Methods* and *Functions* reports to a floodplain restoration project.[43] The Middle Creek Ecosystem Restoration Project restored damaged floodplain structure, habitats and functions in the Clear Lake watershed.

The analysis compared the benefits and costs of a no-action alternative and four restoration alternatives. The five alternatives described land use scenarios including maintaining current agricultural and rural-residential uses and flood protection,

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[41] California Department of Water. 2005A. *Ecosystem Valuation Methods. Revised Draft*. Multi-Objective Approaches to Floodplain Management on a Watershed Basis. May.

[42] California Department of Water Resources. 2005B. *Natural Floodplain Functions and Societal Values Revised Draft*. Multi-Objective Approaches to Floodplain Management on a Watershed Basis. May.

[43] California Department of Water Resources. 2005C. *Middle Creek Flood Ecosystem Restoration Project Case Study: Benefit and Cost Analysis*. Multi-Objective Approaches to Floodplain Management on a Watershed Basis. May.

restoring portions of the floodplain, and providing increased flood protection for existing uses and enhanced agricultural production.

4. Floodplain Management Benefit and Cost Framework

The fourth report, *Floodplain Management Benefit and Cost Analysis Framework* (*Framework*), describes a framework for analyses of ecological, social and economic consequences of policy decisions that affect aquatic resources. [44] It emphasizes the importance of including information on ecological consequences in decision-making. The report cites sources that are somewhat dated, though more current than those referenced in the 1983 *P&G*. In spite of this drawback, the document describes analytical concepts relevant to the State's balancing decision on the Bay-Delta flows. These concepts include the following.

- Incorporate environmental and social consequences into management decisions.[45]
- Measure the economic effects of policies on ecosystem services that have value to humans using non-market valuation techniques. The report references the *Methods* report for information on valuation techniques.[46]
- Not all economic effects of management decisions will occur over the same geography and time. Take these differences into account.[47]
- Select the appropriate discount rate for economic effects that will occur in the future.[48]
- Account for analytical uncertainty and risk. The report describes four methods of doing so.[49]
- Consider ecological, social and economic effects of policy decisions on a broad watershed scale. Do not limit economic analyses to the geographic boundaries of an individual project.[50]

State water projects that have a federal nexus must conduct economic analyses using the 1983 *P&G*. The *Framework* notes some of the limitations of the *P&G* and describes analytical principles that will produce more comprehensive assessments of ecological, social and economic effects of management decisions.

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[44] California Department of Water Resources. 2005D. *Floodplain Management Benefits and Cost Analysis Framework. Revised Draft*. Multi-Objective Approaches to Floodplain Management on a Watershed Basis. June.

[45] California Department of Water, 2005D, p.2.

[46] California Department of Water, 2005D, p.11-12.

[47] California Department of Water, 2005D, p.12.

[48] California Department of Water, 2005D, p.14.

[49] California Department of Water, 2005D, p.15-17.

[50] California Department of Water, 2005D, p.22-24.

"Local agencies seeking federal cost-sharing assistance for multi-objective projects with the [Army] Corps [of Engineers] will still be subject to the [P&G] However, if the local agencies are able to perform an economic analysis following the framework presented [in this report], they will not only have generated the information necessary to do the Corp's analysis, but more importantly, they will also have developed the information necessary to make a more informed decision about proposed floodplain management projects."[51]

b. Economic Analysis Guidebook

Economic analyses conducted by the Department must conform to the Federal *P&G* because of the significant amount of interactions and partnerships between the Department and Federal agencies. The Department recognized, however, that the outdated *P&G* could not adequately address the complex nature of water-management challenges that the Department faces. Department staff, therefore, developed the *Economic Analysis Guidebook* (*Guidebook)* in 2008, to address deficiencies in the *P&G*, help Department economists conduct economic analyses using up-to-date methods, and describe economic concepts and analyses to non-economists Department staff. [52]

"It is … DWR [Department] policy to adopt, maintain, and periodically update its own *Economics Analysis Guidebook*, which is consistent with the *P&G* but can also incorporate innovative methods and tools when appropriate. This policy is necessary because (a) the *P&G* has not been updated for more than 20 years, (b) federal and State economic analyses sometimes have different regional analysis perspectives, and (c) water management projects and programs have become more complex."[53]

"Water resource projects are increasingly becoming more complex, requiring more difficult economic analyses. Projects now tend to have multiple purposes and affect many diverse stakeholders. … [T]raditional methods of performing economic analysis often do not provide reliable means for quantifying important categories of benefits that these projects may provide (such as, ecosystem restoration)."[54]

The *Guidebook* describes economics as "critical" to describing the environmental consequences, social effects, and costs and benefits of water-management alternatives. Environmental issues include the tradeoffs between "natural" and "human" demands on water resources and should take into account the economic effects of water uses that benefit the natural environment, even if this use adversely impacts agricultural and urban water users. Economics can also help describe effects on social equity or

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[51] California Department of Water, 2005D, p.35-36.

[52] California Department of Water Resources (CDWR). 2008. *Economic Analysis Guidebook*. The State of California. January.

[53] CDWR (2008), p.vii.

[54] CDWR (2008), p.1.

environmental justice. Economic costs and benefits include monetary and non-monetary effects.[55]

Methods of economic analysis described in the *Guidebook* include cost-effectiveness, benefit-cost, and socioeconomic-impact analysis. As the name implies, cost-effectiveness analyses identify the least-cost option of achieving a given goal. A benefit-cost analysis compares changes in costs to society with changes in benefit and calculates the net change, or net benefits of a proposal or proposals. A socioeconomic-impact analysis describes how a policy change affects factors such as population, employment, income, etc.

[55] CDWR (2008), p.viii.

Section 5: The Principles of Benefit-Cost Analysis

In Section 1 of this report, we summarize our understanding of the State's objective to find a balance between the public-trust use of the Bay-Delta flows and, namely, the other beneficial uses of the Bay-Delta flows. In Section 2, we identify benefit-cost analysis (BCA) as the most widely used tool for evaluating alternative approaches to such a balance. In this section, Section 5, we focus on the principles by which the State should calculate and report the benefits and costs of these alternative approaches.[56]

A. Identify the Alternatives

At its most basic level, BCA is simply a tool for comparing alternatives. Whether one is already using one of the alternatives—in which case that alternative serves as the gauge or standard—or not, applying the principles remains the same. One begins by identifying all the alternatives and describing all the elements of each alternative.[57]

Today, the State does not seem to suffer too few alternatives. Rather, its challenge lies in identifying and clarifying the elements of each alternative. That said, prudence dictates ensuring the list of alternatives avoids errors of omission, because the alternatives selected for the BCA could affect the outcome of the analysis. By the same token, elements omitted from the description of an alternative could affect its ranking among the alternatives State evaluates.

B. Identify the Relevant Scope

At the beginning of any BCA, the State should identify the relevant scope of the analysis. That is, the analyst should specify which benefits and costs matter, to whom, over what geography and over what period of time.

> "Before you conduct an economic analysis, it is necessary to define its scope (i.e., identify who and what should be included in the analysis and who and what should be excluded)."[58]

Once the State has identified the relevant scope, it then should maintain each of the scope's dimensions throughout the BCA.

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[56] For portions of this Section 5, we relied on material Ed Whitelaw and others at ECONorthwest prepared in a matter involving Methanex Corporation, Claimant/Investor, and the United States of America, Respondent/Party; *In the Arbitration Under Chapter 11 of the North American Free Trade Agreement and the UNCITRAL Arbitration Rules Between Methanex Corporation and United States of America*. The arbitration occurred in 2004.

[57] Field, B.C. 1997. *Environmental Economics*, 2nd Edition. San Francisco: McGraw-Hill Company, Inc. p.116-117; U.S. Environmental Protection Agency (EPA). 2010. *Guidelines for Preparing Economic Analyses*. Report No. EPA-240-R-10-001. December. p.A-8.

[58] U.S. Environmental Protection Agency (EPA). 1993. *Guide for Cost-Effectiveness and Cost-Benefit Analysis of State and Local Ground Water Protection Programs*. U.S. Environmental Protection Agency, Office of Water, and Office of Ground Water and Drinking Water. April. p.11.

C. Assemble Information and Account for Risk and Uncertainty

Given the relevant scope, the analyst should assemble information on the full range of costs and benefits. Even on topics for which extensive research exists, the published findings would still reflect different levels of understanding. Researchers have grouped these different levels into risk, uncertainty, and ignorance. Risk refers to conditions under which the range of possible outcomes and their probabilities are known. Uncertainty refers to conditions under which the range of possible outcomes is known, but their probabilities are not.[59] Ignorance applies when we do not know the possible outcomes.

The more that analysts differ on estimates or ranges of important categories of costs and benefits, the more the State should account for the uncertainty clearly and consistently.[60]

> "Estimates of costs, benefits and other economic impacts should be accompanied by indications of the most important sources of uncertainty embodied in the estimates, and, if possible, a quantitative assessment of their importance… Ideally, an economic analysis would present results in the form of probability distributions that reflect the cumulative impact of all underlying sources of uncertainty. When this is impossible, due to time or resource constraints, results should be qualified with descriptions of major sources of uncertainty."[61]

In interpreting the benefits and costs associated with those elements of the various alternatives that affect environmental assets and ecosystem services, the State should not assume Californians would perceive numerically equal upside and downside risks neutrally. That is, when it comes to environmental matters, individuals tend to exhibit risk aversion.

> "…it seems reasonable to advocate that environmental policymakers approach their decisions in a risk-averse manner."[62]

> "If people are risk averse, then we should expect them to give extra weight to measures that avoid environmental disasters … It seems sensible to many people to take measures today to avoid the possibility of catastrophe in the future, even if the worst-case scenario has a relatively low probability."[63]

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[59] Knight, F.H. 1921. *Risk, Uncertainty and Profit*. New York, NY: Sentry Press.; Integrated Risk Information System. 2011. *IRIS Glossary*. U.S. Environmental Protection Agency. May 16. Retrieved July 27, 2011, from http://www.epa.gov/risk_assessment/glossary.htm#u.; Camerer, C. and M. Weber. 1992. "Recent Developments in Modeling Preferences: Uncertainty and Ambiguity." *Journal of Risk and Uncertainty* 5: 325-370.

[60] U.S. Environmental Protection Agency (EPA). 2000. *Guidelines for Preparing Economic Analyses*. September. p.27.

[61] EPA, 2010, p.11-12.

[62] Lesser, J.A., D.E. Dodds, and R.O. Zerbe, Jr.. 1997. *Environmental Economics and Policy*. p.406.

[63] Goodstein, 1999. E.S. *Economics and the Environment*. p.150.

> "There are many cases in environmental pollution control where risk-aversion is undoubtedly the best policy …"[64]

For the State to consider such risk aversion makes economic sense. It should request that in the displays of the usual ranges and probability distributions of the elements of the alternatives, the analysts present not only the expected values or, in the jargon, the central tendencies, but also the downside and upside risks.

> "[An evaluation of benefits and costs should] reflect the full probability distribution of potential consequences. Where possible, present probability distributions of benefits and costs and include the upper and lower bound estimates as complements to central tendency and other estimates."[65]

Often, sufficient data simply are not available for fully quantifying certain categories of the costs and benefits of the alternatives. Accepted principles of benefit-cost analysis also prescribe that analysts take into account non-monetized costs and benefits.[66] In such cases, the analyst should identify the likely sign and size of the effect. For natural assets for which the professional literature offers no direct calculations of value, economics offers the benefit-transfer technique.[67] With benefit-transfer, the analyst, with appropriate adjustments, imputes to the subject asset values calculable for other assets.

If the information on which the calculation of costs and benefits depends is faulty, then, of course, the calculation itself is faulty. In the best cases, the academic and professional communities reach consensus on the direction and magnitude of a policy's impacts. In the worst cases, they do not, because the information available and the analyst's interpretations of it are faulty or still evolving. Under these conditions, high uncertainty persists. In such cases, the value of BCA is limited, and the analyst has an obligation to report this limitation prominently and the uncertainty causing it.

> "When important benefits and costs cannot be expressed in monetary units, BCA is less useful, and it can even be misleading, because the calculation of net benefits in such cases does not provide a full evaluation of all relevant benefits and costs. You should exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of the alternatives based on your estimated net benefits. If the non-quantified benefits and costs are likely to be important, you should recommend which of the non-quantified factors are of sufficient importance to justify consideration in the regulatory decision. This discussion should also include a clear explanation that support[s] designating these non-quantified factors as important. In this case, you should also consider conducting a threshold analysis to help decision makers and

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[64] Field, B.C. 1994. *Environmental Economics*. p.129.

[65] Office of Management and Budget (OMB). 2003. *Regulatory Analysis*. Circular No. A-4. October. p.18.

[66] See, Moore, J.L. 1995. *Cost-Benefit Analysis: Issues in Its Use in Regulation.* CRS Report for Congress 95-760 ENR. June 28. Retrieved July 22, 2011, from http://www.cnie.org/nle/crsreports/risk/rsk-4.cfm.; EPA, 2010, p.7-57.

[67] EPA, 2010. p.7-51.

other users of the analysis to understand the potential significance of these factors to the overall analysis."[68]

D. Best Practices for BCA

In preparing this Section 5 on the principles of BCA, we found we had accumulated various techniques or practices that, while perhaps not qualifying as general principles, have proved useful over the years. We view this list as illustrative, not exhaustive.

1. Compare conditions with the alternative to conditions without the alternative: A good BCA avoids comparing conditions before the alternative to conditions after the alternative.

   "Calculation of net present value should be based on incremental benefits and costs. Sunk costs and realized benefits should be ignored. Past experience is relevant only in helping to estimate what the value of future benefits and costs might be."[69]

   By comparing the conditions with each of the State's alternatives to the conditions without that alternative, the analyst can isolate the effects of the alternative alone and thereby increase the accuracy of the comparison among all the State Water Board's alternatives.

2. Report and Document Methods, Information, and Assumptions: A good BCA should rely on transparent assumptions and allow for straightforward replication by a third-party analyst.[70]

3. Apply Methods and Assumptions Consistently: the analyst should remain consistent throughout the analysis.[71] For example, the analyst should not account for the possibility of uncertainty in underlying assumptions in one aspect of the BCA and ignore it in another.

4. Economic Impacts and Economic Equity Are Complements to BCA: In Section 2, regarding Figure 1, we describe the three categories of economic effects each of the State's alternatives would cause, economic values (for which the primary tool of analysis is BCA), economic impacts and economic equity. The State should keep in mind that the second and third categories can serve as complements to BCA, but not as substitutes for it. Consider, for example, EPA's guidance.

[68] Office of Management and Budget (OMB). 2003. *Informing Regulatory Decisions: 2003 Report to Congress on the Costs and Benfits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities*. Office of Information and Regulatory Affairs. February. p127

[69] Office of Management and Budget (OMB). 1992. *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. Circular A-94. October. p.6.

[70] OMB, *Informing Regulatory Decisions*, 2003, p.134.

[71] Rossi, P. and H. Freeman. 1982. *Economics*, 13th Edition. New York: McGraw-Hill Book Company. p.275.

"Counting the number of jobs lost (or gained) as a result of a regulation generally has no meaning in the context of benefit-cost analysis."[72]

Each of the three categories of economic effects plays a distinct role in a comprehensive economic description and evaluation of the alternatives for improving the Bay-Delta flows. These roles should remain distinct.

5. Address externalities explicitly: In a market transaction, consider the buyer as the first party and the seller as the second party. A good BCA accounts the effects of the transaction on third parties, i.e., those who did not agree to experience the costs or benefits of the transaction.

> "Identify the expected undesirable side-effects and ancillary benefits of the proposed regulatory action and the alternatives. These should be added to the direct benefits and costs as appropriate[73]."

[72] EPA, 2010, p.8-8. See also, OMB, 1994, p.6-7.

[73] OMB, *Regulatory Analysis*, 2003, p.3.

SECTION 6: OBSERVATIONS ON THE BURGEONING LITERATURE ON BAY-DELTA FLOWS

In preparing this report, we reviewed roughly 100 studies that address the economic issues associated with managing Bay-Delta flows. There are plenty more studies out there and the number is increasing. In this Section 6, we have chosen to draw the State's attention to some of the salient points raised in or illustrated by 12 of the studies.

We do not claim that the studies we have not yet reviewed are any worse or better than the ones we managed to acquire and review. Furthermore, we do not claim that the 12 studies on which we have based our observations represent the entire 100 studies. We do claim, however, that our observations help illustrate, though not exhaust, the challenges the State will face as it seeks a balance between the public-trust uses and the *other beneficial uses* and must choose among the proffered alternative approaches to managing the Bay-Delta flows.

A. BCA without Adequate Data Would Suffer Fatal Flaws

A widespread lack of basic data on California's water resources constrains the extent to which scientists, stakeholders and decision makers can develop fact-based water plans. Specific to the Board's benefit-cost analysis, describing the economic consequences of changing Bay-Delta flows would be much more challenging without baseline data on the Bay-Delta flows. The less adequate the data, the greater the uncertainty of benefit-cost analyses of the management alternatives.

The Delta Stewardship Council staff (Council Staff) propose achieving the Delta Plan's coequal goals of improving the quantity and quality of the water resources using the best available science.

> "Coequal goals means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem."[74]

> "The Council is required by law to use the best available science … as the basis for the Delta Plan. The Delta Plan must include 'a science-based, transparent, and formal adaptive management strategy for ongoing ecosystem restoration and water management decisions.' [citation omitted]"[75]

The Council Staff acknowledge, however, that the body of scientific information on the Bay Delta lacks adequate data on water resources. Council Staff, and others, also acknowledge that this lack hampers water-planning efforts for the Bay Delta Plan.

[74] Delta Stewardship Council Staff (Council Staff). 2011. *Fourth Staff Draft Delta Plan*. Delta Stewardship Council. June 13. p.3.

[75] Council Staff, 2011, p.19.

"The Delta plan requires the development and submission of water use data and other data that are currently unavailable or inaccessible."[76]

The Public Policy Institute of California (PPIC) recently concluded the same.

"Beyond an almost entirely non-technical California Water Plan Update developed by the Department of Water Resources every five years or so, there is little to no statewide organization, prioritization, and synthesis of technical and scientific activity applied to water problems."[77]

"The state's fragmented water rights system has contributed to serious gaps in water measurement and accounting. Most groundwater users have not been required to report water use to the state. Although riparian and pre-1914 appropriative rights holders are required to report their diversions, there was no legal sanction for failure to file an annual statement of diversion and use until the legislature amended the Water Code in 2009 … Many did not report, and those who did tended to substantially overstate their diversions and use. These gaps have led to difficulties in tracking water use trends, and they impede more effective management of water resources for economic and environmental purposes [citation omitted]."

"As water becomes increasingly scarce, it will become ever more important to measure and keep track of physical stocks and flows and their uses."[78]

"California is almost unique among western states in not collecting information on such diversions. California also lacks water quality information on many of its aquifers and waterways."

"To aid analysis and enforcement, greater and more systematic state efforts are essential to assemble data from local, state, and federal agencies within a coherent framework."[79]

"[W]ithout better reporting, California's water accounting and water rights enforcement will remain approximate at best—an increasingly difficult handicap for policy discussions and water management in a water-scarce state."[80]

Other stakeholders in the Bay Delta agree. For example, the California Roundtable on Water and Food Supply recently reported,

"A clear picture of the factors affecting water distribution and use in California is important to decision-making at the policy and farm levels, but is currently lacking.

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[76] Council Staff, 2011, p.19.

[77] Hanak, E., et al. (PPIC). 2011. *Managing California's Water from Conflict to Reconciliation*. Public Policy Insistute of California. p.128.

[78] PPIC, 2011, p.330.

[79] PPIC, 2011, p.353-54.

[80] PPIC, 2011, p.87.

There is a need for better data collection and demonstration of water supply and distribution at basin scale, and better baseline data on water use to guide decision-making."[81]

Developing science-based water-management plans in the Bay Delta without the missing data on water resources would be challenging. The recent review of the scientific support for the Draft Bay Delta Conservation Plan (BDCP) by the National Research Council of the National Academies (Research Council) illustrates this point. The Research Council criticized the Draft BDCP for lacking basic information on affected water volumes. The Research Council described this as a "major shortcoming" of the Draft BDCP.

"The lack of clarity concerning the volumes of water to be diverted is a major shortcoming of the BDCP. In addition, the BDCP provides little or no information about the reliability of supply for such a diversion or the different reliabilities associated with diversions of different volumes. There is no indication of how the amount of water to be diverted and its associated reliability are to be determined. It is nearly impossible to evaluate the BDCP without a clear specification of the volume(s) of water to be diverted, whose negative impacts the BDCP is intended to mitigate."[82]

The missing information impedes well-informed planning and management decisions, and scientists and policy makers would have difficulty developing a science-based Delta Plan without the missing data. This lack of fundamental data on water resources would also likely increase the uncertainty of analytical results from benefit-cost analyses of water-management alternatives.

B. Assessing the Analytical Veracity of Past Studies of Conveyance Structures

The literature on economic analyses of management alternatives for the Bay Delta includes a number of assessments of conveyance structures, such as a peripheral canal or tunnel. Among the most widely cited works in this literature are those by the PPIC. This literature, however, does not include a full benefit-cost analysis of conveyance structures or their alternatives. Most studies focus on certain costs and do not include many of the relevant benefits. In spite of these conditions, these studies illustrate the challenge the Board would face should they conduct a benefit-cost analysis of conveyance structures. We give two examples.

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[81] The California Roundtable on Water and Food Supply. 2011. *Agricultural Water Stewardship: Recommendations to Optimize Outcomes for Specialty Crop Growers and the Public in California*. June. p.3.

[82] National Research Council of the National Academies (Research Council). 2011. *A Review of the Use of Science and Adaptive Management in California's Draft Bay Delta Conservation Plan*. The National. In the PPIC report, *Comparing Futures*, the authors concluded that a peripheral canal would be the least-cost option for maintaining water exports out of the Delta, and that ending exports would have the highest probability of saving threatened or endangered fish in the Bay Delta.[82] Academies Press: Washington, D.C. May 5, page 4.

In the PPIC report, *Comparing Futures*, the authors concluded that a peripheral canal would be the least-cost option for maintaining water exports from the Bay Delta, and that ending exports would have the highest probability of saving threatened and endangered fish.[83] They estimated that the peripheral canal had an average annual cost of between $0.25billion and $0.85billion. The three other alternatives—1) continuing through-Delta exports; 2) dual conveyance of peripheral canal and through-Delta exports; or, 3) no exports—all had higher economic costs. The no-export option had the highest likelihood of achieving viable populations of delta smelt and fall-run Chinook.[84]

Dr. Jeffrey Michael of the University of the Pacific, critiqued some of the major assumptions, data and conclusions described in *Comparing Futures*.[85]

- Regarding the use of discount rates, PPIC did not "… utilize the conventional, scientifically accepted present discounted value approach …"[86]
- PPIC ignored the market and non-market values of affected fishery species. (In a later report, the PPIC described the importance of including non-market values—or as they describe, the values of ecosystem benefits—in benefit-cost analyses.[87])
- PPIC relied on out-dated and second-best estimates of population growth, which overestimated population growth and water demand over the time of the analysis (through 2050).
- PPIC also overestimated the costs of water recycling and ignored recent trends in water conservation.
- PPIC did not conduct their analysis in the context of water scarcity. They assumed no advances in water-conservation or desalination technology over the next 40 years. That is, the PPIC assumed a static analysis of an economy with fixed technology rather than a dynamic analysis of an economy that responds to price signals.
- The PPIC results are highly sensitive to analytical assumptions, and thus are not robust.

In another critique, the Research Council had harsh criticism for the quality of the biophysical information in the Draft BDCP in support of a peripheral canal. The Research Council concluded that the analysis underlying the Draft BDCP relied on incomplete or unsupported data, unrealistic assumptions, ignored relevant trends, and, like the PPIC's analysis, the underlying analysis ignored the concept of water scarcity.

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[83] Lund, Jay, aet al. 2008 (PPIC 2008). *Comparing Futures for the Sacramento-San Joaquin Delta*. Public Policy Institute of California. Chapter 6 and p.ix.

[84] PPIC, 2008, Table S.1, p.ix.

[85] Michael, Jeffrey. 2011. *First Administrative Draft Economic Sustainability Plan for the Sacramento-San Joaquin Delta*. Submitted to the Delta Protection Commission. June 16; Michael, Jeffrey. 2008. *The Economics of Ending Delta Water Exports Versus the Peripheral Canal: Checking the Data of the PPIC*. University of the Pacific. December 15.

[86] Michael, 2011, p.65.

[87] Hanak, Ellen, et al. (PPIC). 2011. *Managing California's Water From Conflict to Reconciliation*. Public Policy Institute of California. Pages 99 and 207.

"The BDCP cannot be properly evaluated if is does not clearly specify the volume of water deliveries whose negative impacts are to be mitigated. The draft BDCP suggests that the water requirements are based on the amount of acreage and crops that contractors have grown, or on the maximum deliveries specified by the SWP [State Water Project] contracts … There is no mention that quantities diverted may be constrained by various provisions of California water law, by possible changes in the extent of irrigated agriculture south of the Delta, and by potential changes in cropping patterns fueled by globalizing forces of supply and demand for food. The draft BDCP also fails to identify and integrate demand management actions with other proposed mitigation actions. A conservation plan should address issues of water use efficiency and should account for future trends in other variables that drive the demand for agricultural and urban water supplied. … The BDCP's lack of attention to these issues constitutes a significant omission, given the intensifying scarcity of water in California."[88]

"The lack of an appropriate structure creates the impression that the entire effort is little more than a post-hoc rationalization of a previously selected group of facilities, including an isolated conveyance facility [peripheral canal] …"[89]

A peripheral canal or tunnel has proponents and detractors. Some of the critiques to date, however, raise serious concerns regarding the veracity of analyses that support a canal or tunnel as the preferred management alternative. Any new analyses of a conveyance structure's benefit and costs would likely be considered incomplete if they do not address the analytical deficiencies raised by these analyses.

C. Addressing Environmental Justice Consequences of Water-Management Alternatives

Past planning efforts in the Bay Delta have not effectively dealt with environmental justice (EJ) aspects of water use and distribution in California's Central Valley. The Delta Plan is an opportunity to change this. Informational resources exist that can help analysts address EJ issues in benefit-cost analyses in meaningful ways so that they go beyond the typically superficial treatment of EJ issues in past analyses.

The Bay Delta Conservation Plan describes EJ as,

"The fair treatment and meaningful involvement of all people regardless of race, color, national origin, educational level, or income with respect to the development, implementation, and enforcement of environmental laws. EJ seeks to ensure that minority and low-income communities have access to public information relating to human health and environmental planning, regulations, and enforcement. EJ ensures that no population, especially the elderly and children, are forced to shoulder a disproportionate burden of the negative human health and environmental impacts of pollution or other environmental hazard."[90]

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[88] Research Council, 2011, p.31-32.

[89] Research Council, 2011, p.43.

[90] California Natural Resources Agency. 2010. *Highlights of the Bay Delta Conservation Plan*. December. p.84.

As described by the California Natural Resources Agency, EJ communities in the Central Valley share a number of characteristics and conditions including:[91]

- Mostly minority and low-income households
- Excluded from environmental policy setting
- Subject to disproportionate impacts from environmental hazards
- Residents experience disparate implementation of environmental regulations, requirements, practices and attributes.

A study published in July of 2008, by OxFam America and the Rockefeller Foundation, reported that the 20th U.S. Congressional District, which encompasses Westlands and the southwestern side of the San Joaquin Valley, was the poorest congressional district in U.S.[92] EJ communities in the San Joaquin Valley face challenges including unsafe drinking water, poor air quality and high incidence of childhood asthma.[93] The *Fourth Staff Draft Delta Plan* reported that nitrates and other pollutants contaminate drinking water supplies from groundwater for many low-income communities in the San Joaquin Valley.

> "The high cost of accessing water from alternative sources, coupled with the low earnings of these households, often makes safe drinking water in these communities unaffordable [citation omitted]."[94]

A recent report by the Pacific Institute concluded the same.

> "Despite the acute health effects of nitrate contamination, some communities in the state have been waiting for more than a decade for measures to restore the safety of their drinking water. … These communities … tend to be low-income and have a high percentage of Latino households. Although costs to community water systems and the households they serve are significant and directly tied to nitrate contamination of groundwater, public policy and regulatory programs have to-date failed to incorporate those costs in their policy and regulatory programs."[95]

As described in the Pacific Institute report, the high costs of addressing nitrate contamination and limited available funds means a significant backlog of unfunded

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91 California Natural Resources Agency. 2003. *Environmental Justice Policy*. www.resources.ca.gov/environmental_justice_policy_20031030.pdf.

92 Burd-Sharps, S., K. Lewis, and E. Borgess Martins. 2008. *The Measure of America: American Human Development Report 2008-2009*. OxFam America and the Rockefeller Foundation.

93 Pacific Institute. 2011. *The Human Costs of Nitrate-Contaminated Drinking Water in the San Joaquin Valley*; Carger, Lloyd. 2010. *Reaping Riches in a Wretched Region: Subsidized Industrial Farming and Its Link to Perpetual Poverty*, 3 Golden Gate U. Envtl L.J., http://digitalcommons.law.ggu.edu/cgi/viewcontent.cgi?article=1033$context=ggueli.

94 Delta Stewardship Council Staff. 2011. *Fourth Staff Drat Delta Plan*. June 13. p.111.

95 Moore, E. and E. Matalon. 2011. *The Human Costs of Nitrate-contaminated Drinking Water in the San Joaquin Valley*. Pacific Institute. March. p.7.

projects. The California Department of Public Health currently has a waiting list of 100 community water projects, with a total cost of $150 million.[96]

A number of benefit-cost experts describe methods of combining EJ objectives including equity considerations with the economic-efficiency objectives of a benefit-cost analysis.[97] Such an approach in the Bay Delta could help avoid negative EJ impacts of water-management decisions and promote more equitable distribution of environmental benefits to communities that currently suffer from inequitable distribution of contaminated water resources.

D. Describing the Relevant Economies as Dynamic, Not Static

Economies are dynamic. They grow, develop, change and react over time in response to local, regional, national and international forces and trends. Consumers, workers and business owners make decisions based on how these forces and trends affect them. For example, as gas prices increase, consumers change their driving habits, purchases more fuel-efficient cars, or take mass transit. As the price of apples increases, some consumers will switch to other, less expensive fruits.

The dynamic nature of economies is important to the State Water Board's benefit-cost analysis of their balancing decision for two reasons. The first is because the affected economies will change for reasons unrelated to the new management alternatives. Attributing economic consequences from outside forces to the Bay Delta management alternatives would yield inaccurate results and mask the true consequences of the alternatives.

Recent reports on the Bay Delta describe some of the relevant outside forces likely to affect the region's economy. The PPIC report, *Managing California's Water*, lists what the authors describe as "drivers of change," which will affect future water supply and demand. These drivers include environmental, economic and demographic changes.[98]

- Rising sea levels will cause seawater intrusions into coastal aquifers.
- Climate-change induced warming will reduce snowpacks, increase winter runoff, decrease spring and summer runoff, and increase stream temperatures.[99]
- New urban developments will likely use less water per capita than existing homes.
- Urbanization will increase discharges of urban runoff.[100]

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[96] Moore and Matalon 2011, p.8.

[97] See for example, Banzhaf, H. S. 2010. *Regulatory Impact Analyses of Environmental Justice Effects*. National Center for Environmental Economics. Working Paper # 10-08. U.S. Environmental Protection Agency. August; Haveman, Robert. 1965. *Water Resources Investment and the Public Interest*. Nashville: Vanderbilt University Press; and Johansson-Stenman, Olof. 2005. "Distributional Weights in Cost-Benefit Analysis—Should we Forget About Them?," *Land Economics*, Vol. 81.

[98] PPIC, 2011, p.135-136.

[99] PPIC, 2011, p.135-136.

- Urbanization of agricultural lands will reduce agricultural water use.[101]
- Population growth has been, and is expected to continue as, the most important demographic driver of water demand.[102]
- Continued reduction in agriculture's share of the state's economy.[103]
- California's agricultural producers will continue shifting to more permanent and higher-valued tree and vine crops in response to global market forces.[104]

Anticipated changes in local and state regulations will also affect future water supply and demand. For example, a recent report by the California Department of Water Resources describes an upcoming change that will affect urban water use. Beginning in 2016, water suppliers must comply with water conservation requirements established by the Water Conservation Bill of 2009 to be eligible for State water grants or loans.[105]

One of the challenges of conducting a benefit-cost analysis of Bay Delta management alternatives will be controlling for the economic consequences attributed to the types of biophysical, economic and other forces and trends described above that are unrelated to the management alternatives.

The second reason why the dynamic nature of economies is important to a benefit-cost analysis of Bay-Delta alternatives is that the affected economies will likely respond to the management alternatives. That is, the analysts should not assume a static economy, frozen in time and technology. The management alternatives will affect different sectors of the state's economy differently. Some sectors may experience higher costs, others may have increased employment or revenues. Consumers, workers and business owners will respond to these first-round changes. For example, in response to an alternative that reduces irrigation flows, some growers may idle their land. Others, however, will likely continue producing by switching to less water-intensive crops, increasing irrigation efficiency, engaging in water trades, or all three.

Authors of a recent retrospective analysis of the economic impacts of reduced flows to the San Joaquin Valley describe such reactive behavior.[106] The analysis focused on the changes in agricultural production in response to reduced water supplies from the Bay Delta caused by drought and restrictions on pumping due to environmental concerns.

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[100] PPIC, 2011, p.164.

[101] PPIC, 2011, p.137.

[102] PPIC, 2011, p.164.

[103] PPIC, 2011, p.137.

[104] PPIC, 2011, p.166.

[105] Pezzetti, Tonianne. 2011. *Guidebook to Assist Urban Water Supplirs to Prepare A 2010 Urban Water Management Plan*. State of California, Natural Resources Agency, Department of Water Resources. March. p.xiii.

[106] Michael, J., et al. 2010. *A Retrospective Estimate of the Economic Impacts of Reduced Water Supplis to the San Joaquin Valley in 2009*. September 28. p.1-3.

The authors report that growers reacted to the water reductions by engaging in water trades and changing their growing practices.

> "[A] significant increase in the amount of water transfers was critically important to reducing the negative impacts of water scarcity. … Building on these successful transfers will be important in minimizing the losses from future water shortages."[107]

> "Across the entire San Joaquin Valley, virtually the entire decline in net harvested acreage was in lower-value field and seed crops as farmers rationally directed more of their scarce water resources to protecting high value fruit and nut orchards."[108]

Water scarcity in California is not a new phenomenon. Water users react to this scarcity by adjusting their use and adopting new technologies and practices. This trend is expected to continue. A benefit-cost analysis that assumes a static economy, frozen in time and fixed in technology would not reflect the reality of how local and regional economies in the Bay Delta function.

E. Describing the Complex Competition for Bay Delta Water Resources

Much of the debate over Bay-Delta water resources pits in-stream or habitat use against agricultural or municipal use. Some describe this as the "jobs vs. fish" argument. Implicit in this characterization is the assumption that consumptive use of water—water use that supports "jobs"—is more important or has greater economic value than in-stream use—water for "fish." As the PPIC describe in their recent report, *Myths of California Water—Implications and Reality*, the competition for Bay-Delta water resources is much more complex.[109]

> "Healthy ecosystems provide significant value to California's economy, partially and sometimes fully offsetting their costs to traditional economic sectors. Direct benefits include improvements in recreation, commercial fishing, and drinking and agricultural water quality, and indirect benefits include improvement in the quality of life in California."[110]

In most times and places there are insufficient resources to satisfy all the demands for all of the goods and services provided by Bay-Delta water resources. Hence, there is competition for the water and, when it is used to produce one set of goods and services, the demands for others go unmet. The characteristics of this competition provide useful insights into the economic consequences of current and future decision-making for Bay-Delta water resources.

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[107] Michael et al., 2010, p.1-2.

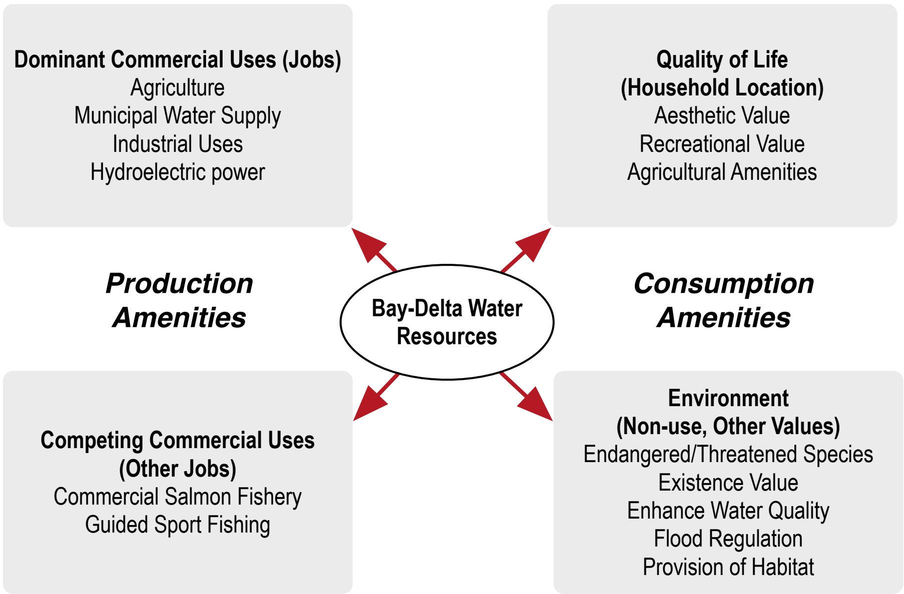
[108] Michael et al., 2010, p.3.

[109] Hanak, Ellen et al. 2010 (PPIC 2010). "Myths of California Water—Implications and Reality." *West-Northwest*, Vol. 16, No. 1, Winter. p.20-22.

[110] PPIC, 2010, p.21.

One could categorize the competition any number of ways, but we employ a taxonomy that distinguishes among four types of demand, as illustrated in Figure 2. Two of these are called demands for production amenities, i.e., those goods and services that are, or could be, inputs to processes that produce other goods and services. The other two represent demands for consumption amenities, i.e., those goods and services that directly enhance the well being of consumers.

Figure 2. The Competing Demands for Bay-Delta Water Resources



Source: ECONorthwest

Competition for Production Amenities. Demand for Bay-Delta agricultural, municipal, industrial, and hydroelectric production, represented on the left side of Figure 2, comes from private and public enterprises, as well as households, that rely on water resources to conduct commercial activities. We separate the demands for production amenities into two groups—dominant and competing demands—to show that, sometimes, negative effects on other commercial sectors, which are represented in the bottom left of Figure 2, can offset the positive consequences arising from others. Using water for commercial production of crops may, for example, prevent it from being used to support guided sport fishing.

Competition Directly from Consumers. On the left side of Figure 2, water resources are economically important because they are inputs in the production of other things, notably crops and livestock, that consumers want to have. On the right side, the connection to consumers is more direct. Here, consumers consider Bay-Delta water resources economically important for how they directly contribute to their well-being. In economic parlance, these are known as consumption amenities.

Some ecosystem goods and services, such as recreational opportunities and scenic vistas, contribute directly to the well-being of people who have access to them. Their contribution to consumers' well-being makes them economically important in their own right, but they have additional economic importance when they also influence the location decisions of households and firms. We show the demands for consumption amenities that influence location decisions of households sensitive to spatial variation in the quality of life, in the upper right portion of Figure 2. In general, the nearer people live to amenities, the lower their cost of using them. Thus, consumers can increase their economic well-being by living in a place that offers recreational opportunities, pleasant scenery, wildlife viewing, and other amenities they consider important.

Quality-of-life values can be powerful. All else equal, if the Bay-Delta's consumption amenities improve, some people already here would tend to stay and additional people would tend to move in. Degradation would have the reverse impacts. One consequence is that the amenities lead to higher demand for housing and consumer-oriented commercial products. The higher demand raises land value for these uses higher than otherwise would exist.[111] Differences in quality of life also explain about half the interstate variation in job growth during periods of economic growth.[112] This relationship also has been found at sub-national perspectives.[113] Some in the Bay-Delta undoubtedly could enjoy higher earnings living elsewhere, but choose not to do so because their overall economic welfare—the sum of their earnings plus quality of life—is higher here. Some aspects of this quality of life—the strength of communities, schools, and churches, for example—are not directly related to water resources, but others are: scenic views, ways of life, and opportunities for fishing and boating, to mention a few.

The lower right portion of Figure 2 represents demands associated with economic values that do not necessarily entail a conscious, explicit use of ecosystem goods and services. We call these environmental values. There are two general categories: non-use values and values of goods and services that generally go unrecognized. Non-use values arise whenever people place a value on maintaining some aspect of the environment, even though they do not use it and have no intention to do so. Research has documented non-use values for maintaining salmon populations, for example, whose survival in the Bay-Delta depends on adequate water flows. Studies have shown that regardless of direct interaction with salmon populations, many Californians hold a positive willingness to pay to ensure the long-term survival of salmon.[114]

Environmental values also can be important when water resources provide valuable services that people generally consume without being aware of them. Some of these are part of the so-called web of life. Others, such as the ability of wetlands to purify water

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[111] Roback, J. 1982. "Wages, Rents, and the Quality of Life." *Journal of Political Economy* 90: 1257-1278; 1988. "Wages, Rents, and Amenities: Differences among Workers and Regions." *Economic Inquiry* 26: 23-41.

[112] Partridge, M. and D. Rickman. 2003. "The Waxing and Waning of Regional Economies: The Chicken-Egg Question of Jobs Versus People." *Journal of Urban Economics* 53: 76-97.

[113] For a more thorough discussion of relevant research, *see,* for example, Power, T.M. and R.N. Barrett. 2001. *Post-Cowboy Economics: Pay and Prosperity in the New American West*. Island Press, and Kim, K.-K., D.W. Marcouiller, and S.C. Deller. 2005. "Natural Amenities and Rural Development: Understanding Spatial and Distributional Attributes." *Growth and Change* 36 (2): 273-297.

[114] Loomis, J., T. Brown, and J. Bergstrom. 2007. "Defining, Valuing, and Providing Ecosystem Goods and Services," *Natural Resources Journal* 47: 329-376.

and mitigate flood damage, have a more direct link to the well-being of California's residents. For example, San Francisco, which receives its water from the pristine Hetch Hetchy watershed, saves tens of millions of dollars per year in avoided water treatment costs.[115] Some scientists and economists believe many services have great economic value, even though people generally are unaware of their importance.[116] Environmental values typically increase as people learn more about the environment, the services it provides, and environmental degradation.[117] Many people today, for example, consciously consider the economic values associated with the services produced by the global climate in ways that were unknown, even to scientists, just a few years ago.

The demands associated with the consumer amenities represented on the right side of Figure 2 are typically harder to measure, or even to observe, than the commercial demands shown on the left side of the diagram. This difficulty does not diminish their value or impact on jobs and incomes, however. Instead, it merely reflects the lack of tools for measuring them.

As described in the PPIC Report, one of the goals and challenges of the Board's benefit-cost analysis of its balancing decision will be identifying and describing the full range of benefits and costs of the competing demands for Bay-Delta water resources.

> "California must find ways to manage water jointly for environmental and commercial benefits. Better accounting of water use and its economic and environmental benefits and costs can help guide policies for watershed management."[118]

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115 Null, S. and J. R. Lund. 2006. "Re-assembling Hetch Hetchy: Water Supply Implications of Removing O'Shaughnessy Dam," *Journal of the American Water Resources Association* 42 (4): 395-408.

116 Daily, G.C. (ed). 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington, D.C.: Island Press.

117 Blomquist, G.C. and D.R. Johnson. 1998. "Resource Quality Information and Validity of Willingness to Pay in Contingent Valuation." *Resource and Energy Economics* 20:179-196.

118 PPIC, 2010, p.21.