

AQUALLIANCE

DEFENDING NORTHERN CALIFORNIA WATERS

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Subject: Comments on the Draft Environmental Assessment and Findings of No Significant Impact for the 2013 Water Transfer Program and the 2010-2011 Water Transfer Program

Dear Messrs. Hubbard and Messer:

AquAlliance submits the following comments and questions for the Draft Environmental Assessment (“EA”) and Findings of No Significant Impact (“FONSI”), for the *2013 Water Transfer Program* (“Project”). We also provide comments about the purpose and need for the 2013 state and federal water transfer programs that are mirror images of the *2009 Drought Water Bank* and the *2010/2011 Water Transfer Program*.

The Bureau of Reclamation’s draft environmental review of the Project does not comply with the requirements of National Environmental Policy Act (“NEPA”), 42 U.S.C. §4321 *et seq.* First, we believe that the Bureau needs to prepare an environmental impact statement (“EIS”) on this proposal, as we believed for the *2009 Drought Water Bank* (“DWB”) that allowed up to 600,000 acre-feet (AF) of surface water transfers, up to 340,000 AF of groundwater substitution, and significant crop idling. It also mirrors the *2010-2011 Water Transfer Program* that sought approval for 200,000 AF of CVP related water and assumed NEPA coverage for additional non-CVP transfer water up to 195,910 AF.

Bureau reliance on the EA itself violates NEPA requirements because, among other things, the EA fails to provide a reasoned analysis and explanation to support the Bureau’s proposed finding of no significant impact. The EA contains a fundamentally flawed alternatives analysis, and treatment of the chain of cause and effect extending from project implementation leading to inadequate analyses of nearly every resource, growth inducing impacts, and cumulative impacts. An EIS would afford the Bureau, DWR, the State Water Resources Control Board, and the California public far clearer insight into how, where, and why the Project might or might not be needed. Litigation by AquAlliance and partners challenged the *2010-2011 Water Transfer Program* and appeared to prod the Bureau toward the necessary environmental review for their

multi-year, serial, so-called “temporary” water transfers with the scoping meetings that were held in January 2011 for the *Long-Term North to South Water Transfer Program* (“10-Year Plan”) (<http://www.usbr.gov/mp/cvp/ltwt/>). The 10-Year Plan’s proposal to transfer up to 600,000 AF of river water has stalled despite Bureau optimism that an EIS would be available in the fall of 2011 and again in the fall of 2012. Absent serious and comprehensive NEPA and California Environmental Quality Act (“CEQA”) review, the Bureau offers another EA/FONSI here, which again fails to provide adequate disclosure of impacts.

Second, CEQA analysis of the 2013 Water Transfer Program is completely absent at the programmatic level. The Project’s actual environmental effects—which are similar to the 2009 DWB, the Sacramento Valley Water Management Agreement, and the proposed 1994 Drought Water Bank (for which a final Program Environmental Impact Report was completed in November 1993) – are not presented in any document. The Bureau and DWR have known for over a decade that programmatic environmental review was and is necessary. The following examples highlight the Bureau and DWR’s (“Agencies”) deficiencies in complying with NEPA and CEQA.

- The Sacramento Valley Water Management Agreement was signed in 2002 and the need for a programmatic EIS/EIR was clear at that time it was initiated, but never completed.
- In 2000, the Governor’s Advisory Drought Planning Panel report, *Critical Water Shortage Contingency Plan* promised a program EIR on a drought-response water transfer program, but was never undertaken.
- Twice in recent history, the state readily acknowledged that CEQA review for a major drought water banking program was appropriate.
- Last, but not least, is the attempt of the Bureau and San Luis Delta Mendota Water Authority to analyze the 10-Year Plan, which also has failed to materialize.

The Bureau’s failure to conduct scientifically supported environmental review in an EIS and DWR’s negligence to provide *any* form of CEQA review reflects an end-run around established law through the use of so-called “temporary” water transfers, in multiple years and is therefore vulnerable to legal challenge under NEPA and CEQA.

Finally, we also question the merits of and need for the Project itself. The existence of very dry conditions in California should not surprise the Agencies or require an urgent and “temporary” response once again. The existence of this water transfer program reflects the Agencies’ abandonment of a sensible water policy framework. Our organizations believe the Bureau’s EA/FONSI and the absence of programmatic CEQA review go too far to help a few junior water right holders at the expense of agriculture, communities, and the environment in and north of the Delta. The *2013 Water Transfer Program* will directly benefit the areas of California whose water supplies are the least reliable by operation of state water law and climate. Though their unreliable supplies have long been public knowledge, local, state, and federal agencies in these areas have failed to stop blatantly wasteful and irrational uses and diversions of water and to pursue aggressive planning for regional water self-sufficiency.

The proposed Project will have significant effects on the environment—both standing alone, as serial, so-called “temporary” water transfers, and when reviewed in conjunction with the multitude of other plans and programs (including the non-CVP water that is mentioned in the EA cumulative impacts section) that incorporate and are dependent on Sacramento Valley water. Ironically, the Bureau appears to recognize in its cumulative impacts discussion that there is potential for significant adverse impacts associated with the Project, but instead of conducting an EIS as required, attempts to assure the public that the *2013 Water Transfer Program* will be deferred to the “willing sellers” through individual “monitoring and mitigation programs” as well as through constraining actions taken by both DWR and Bureau professional staff whose criteria ought instead be incorporated into the Proposed Action Alternative (EA at p. 6, FONSI at pp. 1-4). It is impossible to evaluate whether or not the mitigation and monitoring plans will be adequate to relieve the Bureau and DWR of responsibility for impacts from the Project (including the non-CVP water transfers). The language used in the EA (pp.12-14, 25-27) and the *Draft Technical Information for Water Transfers in 2013* (February 2013) (pp. 39-45) fails to pass the blush test (details below). Of course, this is not a permissible approach under NEPA; significant adverse impacts should be mitigated—or avoided altogether as CEQA normally requires.¹ Moreover, in light of the wholly inadequate monitoring and mitigation planned for the 2013 Water Transfer Program’s extensive water sales, the suggestion that the public should be required to depend on the insufficient monitoring to provide the necessary advance notice of “significant adverse impacts” is an unacceptable position.

We incorporate by reference the following documents:

- AquAlliance, California Sportfishing Protection Alliance, and California Water Impact Network *Testimony on Water Availability Analysis for Trinity, Sacramento, and San Joaquin River Basins Tributary to the Bay--Delta Estuary*. 2012.
- AquAlliance comments on the *Draft Environmental Assessment/Initial Study and Finding of No Significant Impact/Mitigated Negative Declaration for the Anderson-Cottonwood Irrigation District Integrated Regional Water Management Program – Groundwater Production Element Project*. 2011.
- AquAlliance scoping comments for the 10-Year Plan. 2011.
- AquAlliance et. al comments on the *2010/2011 Water Transfer Program*. 2010.
- Jim Brobeck’s comment letter for Butte Environmental Council on the Supplemental Environmental Water Account EIR/EIR, 2007.

¹ Perhaps even more telling, the Bureau actually began its own Programmatic EIS to facilitate water transfers from the Sacramento Valley, and the interconnected actions that are integrally related to it, but never completed that EIS and now has impermissibly broken out this current segment of the overall Program for piecemeal review in the present draft EA. See 68 Federal Register 46218 (Aug 5, 2003) (promising a Programmatic EIS on these related activities, “includ[ing] groundwater substitution in lieu of surface water supplies, conjunctive use of groundwater and surface water, refurbish existing groundwater extraction wells, install groundwater monitoring stations, install new groundwater extraction wells...” *Id.* At 46219. See also http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=788 (current Bureau website on “Short-term Sacramento Valley Water Management Program EIS/EIR”).

- Lippe Gaffney Wagner LLP letter for Butte Environmental Council to DWR regarding the Drought Water Bank Addendum, 2009.
- Barbara Vlamis' letter for Butte Environmental Council to DWR regarding the 2009 Drought Water Bank Addendum.
- Multi-Signatories letter regarding the Drought Water Bank, 2008.
- Professor Kyran Mish's White Paper, 2008.
- Professor Karin Hoover's Declaration, 2008.

I. The Bureau and DWR Must Prepare an Environmental Impact Statement/ Environmental Impact Report on the Proposed 2013 Water Transfer Program

We strongly urge the Bureau to withdraw this inadequate environmental document and instead prepare a joint EIS/R on the *2013 Water Transfer Program*, before approaching the State Water Resources Control Board (SWRCB) for a change in place of use, in order to comply with both NEPA and CEQA requirements for full disclosure of human and natural environmental effects. NEPA requires federal agencies to prepare a detailed environmental impact statement on all “major Federal actions significantly affecting the quality of the human environment” 42 U.S.C. §4332(2)(C). This requirement is to ensure that detailed information concerning potential environmental impacts is made available to agency decision makers and the public before the agency makes a decision. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989). CEQA has similar requirements and criteria.

Under NEPA's procedures, an agency may prepare an EA in order to decide whether the environmental impacts of a proposed agency action are significant enough to warrant preparation of an EIS. 40 C.F.R. §1508.9. An EA must “provide sufficient evidence and analysis for determining whether to prepare an [EIS]” (*id.*), and must demonstrate that it has taken a “hard look” at the potential environmental impact of a project.” *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1212 (9th Cir. 1998) (internal quotation marks omitted). However, the U.S. Court of Appeals for the Ninth Circuit has cautioned that “[i]f an agency decides not to prepare an EIS, it must supply a convincing statement of reasons to explain why a project's impacts are insignificant.” *Id.* (internal quotation marks omitted). The Bureau has not provided a convincing statement of reasons that would explain why the Projects's impacts are not significant. So long as there are “substantial questions whether a project *may* have a significant effect on the environment,” an EIS must be prepared. *Id.* (emphasis added and internal quotation marks omitted). Thus, “the threshold for requiring an EIS is quite low.” *NRDC v. Duvall*, 777 F. Supp. 1533, 1538 (E.D. Cal. 1991). Put another way, as will be shown through our comments, the bar for sustaining an EA/FONSI under NEPA procedures is set quite high, and the Bureau fails to surmount it in the *2013 Water Transfer Program*.

NEPA regulations promulgated by the Council on Environmental Quality identify factors that the Bureau must consider in assessing whether a project may have significant environmental effects, including:

- (1) “The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.” 40 C.F.R. §1508.27(b)(5).
- (2) “The degree to which the effects on the quality of the human environment are likely to be highly controversial.” *Id.* §1508.27(b)(4).
- (3) “Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate on a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.” *Id.* §1508.27(b)(7).
- (4) “The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.” *Id.* §1508.27(b)(6).
- (5) “The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.” *Id.* §1508.27(b)(9).

Here, the Bureau has failed to take a hard look at the environmental impacts of the Project. As detailed below, there are substantial questions about whether the *2013 Water Transfer Program’s* proposed water transfers will have significant effects on the region’s environmental and hydrological conditions, especially groundwater; the interactions between groundwater and surface streams of interest in the Sacramento Valley region; and the species dependent on aquatic and terrestrial habitat. There are also substantial questions about whether the *2013 Water Transfer Program* will have significant adverse environmental impacts when considered in conjunction with the other related water projects that have occurred in the last dozen years and that are underway and proposed in the region. The Bureau simply cannot rely on the EA/FONSI for the foreseeable environmental impacts of the proposed *2013 Water Transfer Program* and still comply with NEPA’s requirements.

A. The Proposed Action Alternative is poorly specified, making it difficult to identify chains of cause and effect necessary to analyze adequately the alternative’s environmental effects.

The Proposed Action Alternative is poorly specified and needs additional clarity before decision makers and the public can understand the human and environmental consequences of the *2013 Water Transfer Program*. The EA describes the Proposed Action Alternative as one reflecting the Bureau’s intention to approve transfers of Central Valley Project water from willing sellers who contract with the Bureau ordinarily to use surface water on their croplands. Up to 37,505 AF of CVP water are offered from these sellers, according to Table 2-1 (EA p. 9). In contrast to the EA/FONSI for the 2009 Drought Water Bank (p. 3-88), the Project EA contains no “priority criteria” to determine water deliveries and simply acknowledges that CVP river water will be transferred to San Luis & Delta Mendota Water Authority agricultural districts. The EA fails to indicate how much water has been requested by the buyers of CVP or non-CVP water, which is also in contrast to the EA/FONSI and DWR’s addendum for the 2009 Drought Water Bank.

Potential buyers of non-CVP water are also not disclosed. These significant omissions eliminate the public's ability to consider, assess, and comment on possible impacts in the receiving areas. This denial of information further obfuscates the need for the Project.

The EA/FONSI's Background section (p. 3) states specifically that, "To facilitate the transfer of water within the State of California, Reclamation is considering whether to approve individual water transfers between willing sellers and buyers when Base Supply, Project Water or Project facilities are involved in the transfer." This paragraph omits mentioning DWR's role as an approving agency for SWP water sales while acknowledging its role in potentially wheeling both CVP and SWP river water. This failure to elucidate DWR's authority adds further confusion to a poorly defined project.

Another serious omission is that the EA/FONSI lacks a section that names and explains the purpose of the Project. AquAlliance agrees with the Bureau's *Reclamation's NEPA Handbook* (2012) that states, "The need for an accurate (and adequate) purpose and need statement early in the NEPA process cannot be overstated. This statement gives direction to the entire process and ensures alternatives are designed to address project goals." (p.11-1) While "need" is disclosed in section 1.2 (p. 4), there is no coherent discussion of the need. Merely stating that, "The hydrologic condition for 2013 is dry, and because the CVP and SWP are providing 20% and 35% of contract amounts, respectively, to contractors south of the Delta, there is a need for water to supplement local and imported supplies to meet demands," lacks context, specificity, and rigor. The purpose and need should also state that this transfer program would be subject to specific criteria for prioritizing transfers. The absence of a statement of purpose and the inadequate need statement renders the EA/FONSI wholly deficient.

The EA's description of the proposed action alternative needs to make clear what would occur if sale criteria are in fact applied and if exceptions will be allowed, and, if so, by what criteria would exceptions be made.. Do both Project Agencies, the Bureau and DWR, lack criteria to prioritize water transfers? What is the legal or policy basis to act without providing priority criteria? Without foundational criteria, the public is not provided with even a basic understanding of the need for the Project.

There is considerable ambiguity over just how many potential sellers there are and how much water they would make available. The EA states that, "Entities that are not listed in this table [2-1] may decide that they are interested in selling water, but those transfers would require supplemental NEPA analysis," (p. 9). Allowing a roving Project location is not permissible and avoids accurate analysis of all impacts including growth inducing and cumulative impacts.

Absent the names of buyers, buyers' request numbers, and the potential for the participation of unknown additional sellers, the EA signals that neither the Bureau nor DWR have a clear idea what the *2013 Water Transfer Program* is intended to be. This problem contributes greatly to and helps explain the poorly rendered treatment of causes and effects that permeate the Bureau's EA. The Project Agencies present decision-makers and the public with an ill-defined Project,

purpose, and need: they are moving targets. Such chaos and blunders reflect hasty consideration and poor planning by project proponents. Nor can the Agencies reasonably attribute their inadequate or absent environmental reviews on lack of warning. The Agencies know better than anyone that California has a Mediterranean climate with major fluctuations in precipitation and has long periods of drought (Anderson, 2009).

From data available in the EA/FONSI, it is not possible to determine with confidence just how much water is requested by potential urban and agricultural buyers. There is no attempt to describe how firmly tendered are offers of water to sell or requests to purchase. Left to guess at the possible requests for water, we look at the 2009 DWB where there were between 400,000 and 500,000 AF of presumably urban buyer requests alone (which had priority over agricultural purchases, according to the 2009 DWB priorities) and a cumulative total of less than 400,000 AF from willing sellers. It is highly possible, based on the example during the 2009 DWB, that many buyers are not likely to have their needs addressed by the *2013 Water Transfer Program*. If so, the Bureau and DWR should state the likelihood that many requests will not be fulfilled in order to achieve a full and correct environmental compliance treatment of the proposed action. Such an estimate is necessary for accurate explication of the chains of cause and effect associated with the *2013 Water Transfer Program*—and which must propagate throughout a NEPA document for it to be adequate as an analysis of potential natural and human environmental effects of the proposed project. We have additional specific questions:

- Are the San Luis and Delta Mendota Water Authority (SLDMWA) requests for agricultural or urban use of Project water?
- What are the specific urban requests for water nested within the SLDMWA request?
- Who are the buyers and what are their requests for the non-CVP river water?
- Will sale criteria be premised on full compliance with all applicable environmental and water rights laws? If so, how will cumulative impacts be analyzed under CEQA?

If priority criteria were actually revealed in the EA/FONSI, how would intervening economic factors beyond the control of the Project be analyzed? Given the added uncertainty, an EIS should be prepared to provide the Agencies with advance information and insight into what the sensitivity of the program's sellers and buyers are to the influences of prices—prices for water as well as crops such as rice, orchard and vineyard commodities, and other field crops. It is plausible that crop idling occurs more in field crops, while groundwater substitution would be more likely for orchard and vineyard crops. However, high prices for rice—the Sacramento Valley's largest field crop—undermines this logic and have lead to substantial groundwater substitution. These potential issues and impacts should be recognized as part of the *2013 Water Transfer Program* description and should directly apply to the Agriculture and Land Use, and Socioeconomic sections of the EA, because crop prices are key factors in choices potential water sellers would weigh in deciding whether to idle crops, substitute groundwater, or decline to participate in the Project altogether. The EA is inadequate because it fails to identify and analyze the market context for crops as well as water that would ultimately influence the size and scope of the *2013 Water Transfer Program*.

Rice prices are high because of conditions for the grain in the world market. Drought elsewhere is a factor in reduced yields, but growing populations in south and east Asia demand more rice; the rice industry has gladly tried to meet that demand.²

This is very important. The Bureau tacitly admits that the Bureau—and by logical extension, DWR—has no idea how many sales of what type (public health, urban, agricultural) can be expected to occur. Put another way, there is a range of potential outcomes for the *2013 Water Transfer Program*, and yet the Bureau has failed utterly to use the EA to examine a reasonable and representative range of alternatives as it concerns how the priority criteria would be established and affect Project transfers. And DWR has not bothered to conduct an appropriate level of review under CEQA.

Nor does the *2013 Water Transfer Program* prevent rice growers (or other farmers) from “double-dipping,” but actually encourages it. Districts and their growers have opted to turn back their surface supplies from the CVP and the State Water Project and substitute groundwater to cultivate their rice crop—thereby receiving premiums on both their CVP contract surface water as well as their rice crop this fall when it goes to market. There appear to be no caps on water sale prices to prevent windfall profits to sellers of Sacramento Valley water — especially for crops with high market prices, such as in rice.

As stated, neither the Bureau nor DWR disclose what quantity of water from the transfers would go to public health, urban, or agricultural buyers. The EA must also (but fails to) address the ability and willingness of potential buyers to pay for Project water given the supplies that may be available. Complaints from agricultural water districts were registered in the comments on the Draft EWA EIS/R and reported in the Final EIS/R in January 2004 indicating that they could not compete on price with urban areas buying water from the EWA. Given the absence of priority criteria, will agricultural water buyers identified in Table 2-2 of the EA be able to buy water when competing with urban districts? Since buyers are not disclosed in the EA for non-CVP river water (as they also were not, for example, in the Negative Declaration for Butte Water District’s 2013 non-CVP river water sales), not only is there a significant lack of disclosure, but the failure to access ramifications on economic policy and competition between and agricultural sectors is a serious omission? What factors other than price should be considered in allocating water among our state’s regions? This fails dramatically to encourage regions to develop their own water supplies more efficiently and cost-effectively without damage to resources of other regions.

Full disclosure of each offer of and request for *2013 Water Transfer Program* water should be provided as part of the EA including non-CVP river water. This is necessary so the public can understand and have confidence in the efficacy of the Project’s need, although the Project

² “Panic over rice prices hits California,” *AZCentral.com*, April 24, 2008; UN News Service, “Bumper rice harvests could bring down prices but poor may not benefit, warns UN,” 25 February 2009; “Era of cheap rice at an end in Taiwan: COA,” *The China Post*, March 5, 2009; Jim Downing, “Sacramento Valley growers see rice prices soar,” *Sacramento Bee*, 18 January 2009.

purpose, as discussed above, is completely absent. The public benefits from full disclosure of who requests what quantity of water, and for what uses, so that the public may easily verify chains of cause and effect. Agricultural and urban application of transferred surface water is not examined in the EA/FONSI, as though the ways potential buyers would use their purchased water had no environmental effects. Agriculture hardens demand by expansion and crop type and urban users harden demand by expansion. Both sectors may fail to pursue aggressive conservation and grapple with long-term hydrologic constraints with the delivery of more northern California river water that has been made available by groundwater mining. Since California has high variability in precipitation year-to-year (<http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST>), how will purchased water be used and conserved? What growth inducing impacts will such transferred water facilitate and how will hardening of demand be evaluated?

Nor is a hierarchy of priority uses among agricultural or urban users for purchasing CVP and non-CVP water presented. Could purchased water be used for any kind of crop or landscaping, rather than clearly domestic purposes or strictly for drought-tolerant landscaping? We cannot tell from the EA/FONSI narrative. How can the citizens of California be assured that water purchased through the *2013 Water Transfer Program* will not be used wastefully, in violation of the California Constitution, Article X, Section 2?

If urban buyers are participating in the CVP and/or non-CVP river water sales, and the public has not been presented with any information in this regard except that, “[u]rban water users would face shortages in the absence of water transfers” in the No Action discussion, (pp. 6 and 27), will they need their Project purchased water only in July through September, or is that the delivery period preferred in the Project because of ecological and fishery impact constraints on conveyance of purchased water?

Should agricultural water users be able to buy Project water, how will DWR and the Bureau assure that transferred water for irrigation is used efficiently? Many questions are embedded within these concerns that DWR and the Bureau should address, especially when they approach the State Water Resources Control Board to justify consolidating their places of use in their respective water rights permits:

- How much can be expected to be purchased by agricultural water users, given the absence of any criteria, let alone priority criteria, in the *2013 Water Transfer Program*?
- How much can be expected to be consumptively used by agricultural water buyers?
- How much can be expected to result in tailwater and ag drainage?
- How much can be expected to add to the already high water table in the western San Joaquin Valley?
- What selenium and boron loads in Mud Slough and other tributaries to the San Joaquin River may be expected from application of this water to WSJ lands?
- What mitigation measures are needed to limit such impacts consistent with the public trust doctrine, Article X, Section 2 of the California Constitution, the Porter-Cologne Water Quality Control Act, and California Fish and Game Code Section 5937?

In other words, the most important chains of cause and effect— from the potential for groundwater resource impacts in the Sacramento Valley to the potential for contaminated drainage water from farm lands in the western San Joaquin Valley where many of the agricultural buyers are located—are ignored in the Bureau’s EA/FONSI and completely missing due to DWR’s failure to comply with CEQA.

Will more of river water transfers go to urban users than to ag users or not? The EA’s silence on this is disturbing, and it highlights the absence of priority criteria. What assurances will the Bureau and DWR provide that criteria exist or will be developed and how will these criteria be presented to the public and closely followed?

- The more transfers to urban water agencies, the less environmental impacts there would be on drainage-impaired lands of the San Joaquin Valley, a neutral to beneficial impact of the Project’s operation on high groundwater and drainage to the SJR.
- However, the more Project water goes to agricultural users than to urban users, the higher would be groundwater levels, the more contaminated the groundwater would be in the western San Joaquin Valley and the more the San Joaquin River would be negatively affected from contaminated seepage and tailwater by operation of the Project.

We are pleased that the EA provides a map indicating where the CVP sellers and buyers are located, but the cumulative buyers and sellers in 2013, which includes non-CVP river water and groundwater substitution, are omitted. This is a major error.

Two issues concerning water rights are raised by this EA/FONSI:

- **Consolidated Place of Use.** The EA should fully disclose the consolidated places of use for DWR and the Bureau. Why is the flexibility claimed for the consolidated place of use necessary for this year's water transfer program? Could the transfers be facilitated through transfer provisions of the Central Valley Project Improvement Act? Will the consolidation be a permanent or temporary request, and will the consolidation be limited to the duration of just the *2013 Water Transfer Program*? Is there an actual sunset date to this Project, since it continues serially in multiple years and plans a 10-Year Program? How do the consolidated places of use permit amendments to the SWP and CVP permits relate to their joint point of diversion? Why doesn’t simply having the joint point of diversion in place under D-1641 suffice for the purpose of the Project?
- **Description of the water right claims of sellers, buyers, the Bureau, and DWR.** Informing the public about water rights claims would necessarily show that buyers and the Agencies clearly possess junior water rights as compared with those of many willing sellers. Full disclosure of these disparate water right claims and their priority is needed to help explain the actions and motivations of buyers and sellers in the *2013 Water Transfer Program*. Otherwise the public and decision makers have insufficient information on which to support and make informed choices. We notice that a modicum of discussion is found in the *Draft Technical Information for Water Transfers in 2013*, but the EA/FONSI fails to take the opportunity to point the reader to it.

To establish a proper legal context for these water rights, the Project’s Action Alternative section of the EA/FONSI should also describe more extensively the applicable California Water Code sections about the treatment of water rights involved in water transfers.

Thus, in many ways, the *2013 Water Transfer Program* is a poorly specified program for NEPA and CEQA purposes, leaving assessment of its environmental effects at best murky, and at worst, risky to all involved, especially users of Sacramento Valley groundwater resources. “Clearly, it is pointless to ‘consider’ environmental costs without also seriously considering action to avoid them.” *Calvert Cliffs’ Coordinating Comm., Inc. v. U.S. Atomic Energy Commn.*, 449 F.2d 1109, 1128 (D.C. Cir. 1971). It is thus the Bureau’s duty to consider “alternatives to the proposed action” and to “study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources.” 42 U.S.C. §§ 4332(2)(C)(iii), 4332(2)(E); 40 C.F.R. § 1502.14(a).

B. Correcting the EA’s poorly specified chains of cause and effect forces consideration of an expanded range of alternatives.

Bureau and DWR water transfers are not just one- or two-year transfers, but rather many serial actions in multiple years by the Agencies, sellers, and buyers without the benefit of comprehensive planning or environmental analysis under NEPA and CEQA. The Agencies have been implementing so called “temporary” or “short term” water transfers over a dozen years and has had those same years to adequately consider the ramifications of these serial actions in multiple years in an EIS/EIR, yet the Agencies have chosen not to complete the task. See table below³.

Past Water Transfers from the Sacramento Valley Through the Delta TAF Annually												
Program	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Potential 2012
DWR Drought Water Bank/Dry yr. Programs	138	22	11	0.5	0	0	0	0	74	0	0	0
Environ. Water Acct	80	145	70	120	5	0	147	60	60	60	0	60
Others (CVP, SWP, Yuba, inter alia)	160	5	125	0	0	0	0	173	140	243	0	190
Totals	378	172	206	120.5	5	0	147	233	274	303	0	250

*Table reflects gross AF purchased prior to 2percent Delta carriage loss (i.e., actual amounts pumped at Delta are 20 percent less)

³ This table is derived from the Western Canal Water District’s Negative Declaration for a 2012 water transfer.

Adequate treatment of alternatives should have been examined in the EA with several reasonable scenarios beyond simply the Proposed Action and a “no action” alternative. Three reasonable permutations would have considered relative proportions of crop idling versus groundwater substitution (e.g., high/low, low/high, and equal proportions of crop-idled water and groundwater substitution). Other reasonable dry-year response alternatives that can meet operational and physical concerns merit consideration and analysis by the Bureau includes:

- Planned permanent retirement of upslope lands in the western San Joaquin Valley where CVP-delivered irrigation water is applied to lands contaminated with high concentrations of selenium, boron and mercury, and which contribute to high water table and drainage problems for lowland farmers, wetlands and tributaries of the San Joaquin River. Retirement of these lands would permanently free up an estimated 3.9 MAF⁴ of state and federal water during non-critical water years. Ending irrigation of these lands would also result in substantial human environmental benefits for the San Joaquin River, the Bay-Delta Estuary, and the Suisun Marsh from removal of selenium, boron, and salt contamination. Having such reasonable and pragmatic practices in place would go a long way to eliminate the need for drought water banks in the foreseeable future.
- More aggressive investment in agricultural and urban water conservation and demand management among CVP and SWP contractors even on good agricultural lands, including metering of all water supply hook-ups by all municipal contractors, statewide investment in low-flush toilets and other household and other buildings’ plumbing fixtures, and increased capture and reuse of recycled water. Jobs created from such savings and investments would represent an economic stimulus that would have lasting employment and community stability benefits as well as lasting benefits for water supply reliability and environmental stabilization.

C. The 2013 Water Transfer Program EA fails to specify adequate environmental baselines, or existing conditions, against which impacts would be assessed and mitigation measures designed to reduce or avoid impacts.

The Project’s EA/FONSI incorporates by reference the *2010/2011 Water Transfer Program* (pp. 11-13). The Project EA narrative discloses that no water was transferred under the *2010/2011 Water Transfer Program* (p. 13), but fails to mention that litigation was filed in 2010 by AquAlliance, CSPA, and C-WIN challenging the adequacy of the NEPA review.

The Bureau’s *2010/2011 Water Transfer Program* environmental review incorporated by reference, for specific facets of the review, the 2003/2004 and 2007/2008 Environmental Water Account EIS/R documents. In both cases, these environmental reviews were conducted on a program whose essential purpose is to “provide protection to at-risk native fish species of the Bay-Delta estuary through environmental beneficial changes in State Water Project/Central Valley Project operations at no uncompensated water cost to the Projects’ water users. This

⁴ Pacific Institute, http://www.pacinst.org/reports/more_with_less_delta/index.htm.

approach to fish protection involves changing Project operations to benefit fish and the acquisition of alternative sources of project water supply, called the ‘EWA assets,’ which the EWA agencies use to replace the regular Project water supply lost by pumping reductions.”

The two basic sets of actions of the EWA were to:

- Implement fish actions that protect species of concern (e.g., reduction of export pumping at the CVP and SWP pumps in the Delta); and
- Increase water supply reliability by acquiring and managing assets to compensate for the effects of the fish actions (such as by purchasing water from willing sellers for instream flows that compensates the sellers for forgone consumptive use of water).

Without going into further detail on the EWA program, there was no attempt by the EWA agencies to characterize its environmental review as reflective of water transfer programs generally; the EWA was a specific set of strategies whose purpose was protection of fish species of concern in the Delta, not dry-year aid for junior water right-holding areas of California. Is the Bureau still relying on the EWA analysis from 2003/2004 and 2007/2008 since it continues to point backward in each successive attempt to analyze water transfers? If so, one consequence of this attempt to rely on the EWA EIS/R is that it makes the public understanding of the environmental baseline of the *2013 Water Transfer Program* impossible, because environmental baselines, differing purpose and need for the project, and many relevant mitigation measures are not readily available to the public. Merely referring to the EWA documents in the *2010/2011 Water Transfer Program* (e.g.) p. 3-47) and then referring to the *2010/2011 Water Transfer Program* in the Project EA mocks the missions of NEPA and CEQA to inform the public adequately about the environmental setting and potential impacts of the proposed project’s actions. Moreover, a Water Transfer Program for urban and agricultural sectors is plainly not the same thing as an Environmental Water Account.

Another consequence is that the chains of cause and effect of an EWA versus the *2010/2011 Water Transfer Program* or the *2013 Water Transfer Program* are entirely different because of their different purposes. While the presence of water purchases, willing sellers, and requesting buyers is similar, the timing of EWA water flows are geared to enhancing and protecting fish populations; the water was to flow in Delta channels to San Francisco Bay and the Pacific Ocean. In stark contrast, the *2010/2011 Water Transfer Program* and the *2013 Water Transfer Program* water flows focus water releases from the SWP and CVP reservoirs to exports for deliveries in the July through September period, whereas EWA assets would be “spent” year-round depending on the specific need to protect fish. EWA was about purchasing water to provide instream flows in the Delta, while the *2010/2011 Water Transfer Program* and the *2013 Water Transfer Program* facilitate water sales to serve consumptive uses outside of the Delta.

Furthermore, DWR and the Bureau do not even attempt to tease out the various ways in which the EWA review—itsself a two-binder document consisting of well over 1,000 pages—could be used to provide appropriate environmental compliance for river water transfers with myriad potential for impacts in the areas of origin, despite at least having staff resources that could have

undertaken such task. It is therefore well beyond the reach of non-expert decision-makers and the public, and the use of the EWA EIS/R as part of the environmental review for the *2010/2011 Water Transfer Program* or the *2013 Water Transfer Program* therefore violates both NEPA and CEQA.

Nor is any attempt made in the EWA EIS/Rs to characterize the EWA as a “program level” environmental review, off of which a Water Transfer Program-like project could perhaps legitimately tier. In our view, this reliance on the EWA EIS/R obscures the environmental baselines of the Project from public view, inappropriately conflates the purposes of two (or maybe three) distinct environmental reviews, and flagrantly violates NEPA and CEQA. This could only be redressed by preparation of an EIS/R on the *2013 Water Transfer Program*.

Finally, the most significant baseline condition omitted in the Bureau’s inadequate and DWR’s negligent reporting relates to Sacramento Valley groundwater resources, discussed in the next section.

D. Scientific uncertainties and controversy about Sacramento Valley groundwater resources merit consideration that only an EIS can provide.

There is substantial evidence that the *2013 Water Transfer Program* may have significant impacts on the aquifer system underlying the project and the adjacent region that overlies the Tuscan Formation. This alone warrants the preparation of an EIS.

Additionally, an EIS is necessary where “[a] project[’s] ... effects are ‘highly uncertain or involve unique or unknown risks.’” *Blue Mountains Biodiversity Project*, 161 F.3d at 1213 (quoting 40 C.F.R. §1508.27(b)(5)). Here, the draft EA/FONSI fails to adequately address gaps in existing scientific research on the hydrology of the aquifer system and the extent to which these gaps affect the Bureau’s ability—and by logical extension, DWR’s ability—to assess accurately the Project’s environmental impacts.

1. Existing research on groundwater conditions indicates that the 2013 Water Transfer Program may have significant impacts on the aquifer system.

The EA fails to describe significant characteristics of the aquifers that the *2013 Water Transfer Program* proposes to exploit. These characteristics are relevant to an understanding of the potential environmental effects associated with the *2013 Water Transfer Program*’s potential direct extraction of up to 37,505 AF of groundwater (pp. 8, 9, 11, 28,29, 35) and the indirect extraction of 92,806 AF of groundwater (p. 31). First, the draft EA/FONSI fails to describe a significant saline portion of the aquifer stratigraphy of the *2013 Water Transfer Program* area, which includes the non-CVP regions. According to Toccoy Dudley, former Groundwater Geologist with the Department of Water Resources and former director of the Butte County Water and Resources Department, saline groundwater aquifer systems of marine origin underlie

the various freshwater strata in the northern counties of Butte, Colusa, Glenn, and Tehama (“northern counties”). The approximate contact between fresh and saline groundwater occurs at a depth ranging from 1500 to 3000 feet. (Dudley 2005)

Second, the EA fails to discuss the pressurized condition of the down-gradient portion of the Tuscan formation, which underlies the northern counties. Dudley finds that the lower Tuscan aquifer located in the Butte Basin is under pressure. “It is interesting to note that groundwater elevations up gradient of the Butte Basin, in the lower Tuscan aquifer system, are higher than the ground surface elevations in the south-central portion of Butte Basin. This creates an artesian flow condition when wells in the central Butte Basin are drilled into the lower Tuscan aquifer.” (Dudley 2005). The artesian pressure indicates recharge is occurring in the up-gradient portions of the aquifer located along the eastern margin of the Sacramento Valley.

Third, the EA fails to describe the direction of movement of water through the subbasins in the Sacramento Valley. To consider the Lower Tuscan Formation as an example, according to Dudley: “From Tehama County south to the city of Chico, the groundwater flow direction in the lower Tuscan is westerly toward the Sacramento River. South of Chico, the groundwater flow changes to a southwesterly direction along the eastern margin of the valley and to a southerly direction in the central portion of the Butte Basin.” (2005) Adequate NEPA review would describe in detail all the subbasins where groundwater substitution transfers (or “mining” to be more direct) is planned to facilitate the Project.

Fourth, the draft EA fails to disclose that the majority of wells used in the Sacramento Valley are individual wells that pump from varying strata in the aquifers. The thousands of domestic wells in the target export areas of the Sacramento Valley are vulnerable to groundwater manipulation and lack historic monitoring. The Bureau’s 2009 DWB EA elaborated on this point regarding Natomas Central MWC (p. 39) stating that, “Shallow domestic wells would be most susceptible to adverse effects. Fifty percent of the domestic wells are 150 feet deep or less. Increased groundwater pumping could cause localized declines of groundwater levels, or cones of depression, near pumping wells, possibly causing effects to wells within the cone of depression. As previously described, the well review data, mitigation and monitoring plans that will be required from sellers during the transfer approval process will reduce the potential for this effect.”

As the latter statement made clear (even though the information from the 2009 DWB was excluded from the Project EA), the Bureau hoped that individual mitigation and monitoring plans created by the sellers would reduce the potential for impacts, but there wasn’t in 2009 (and there certainly isn’t in 2013) any assurance in the EA that it will reduce it to a level of insignificance for the thousands of well owners in the Sacramento Valley. AquAlliance questions the adequacy of individual mitigation and monitoring plans and suggests that an independent third party, such as USGS, oversee the mitigation and monitoring program, not the Bureau and DWR. After the fiasco in Butte County during the 1994 Drought Water Bank and with the flimsy, imprecise

proposal for mitigation and monitoring in the *2013 Water Transfer Program* (see details below), the agencies lack credibility as oversight agencies.

In addition, even the Sacramento Valley Integrated Water Management Plan (2006) proposed a Framework for Sacramento Valley regional water resource monitoring that would also benefit shallow domestic-well owners. The Framework acknowledged that, “The lowering of groundwater levels due to the interception of groundwater underflow to surface water systems due to the increased groundwater extraction associated with conjunctive water management programs, have the potential to impact the native habitat areas,” and that, “In order to identify potential habitat impacts associated with implementation of conjunctive water management alternatives, a program-specific network of shallow monitor monitoring wells should be developed to detect changes in water levels over the shallowest portion of the aquifer. The groundwater monitoring network should contain shallow monitoring wells that will record changes to the water table elevation in the vicinity of these sensitive habitat areas.” Unfortunately, the Framework was shelved, and the shallow monitoring network never got off the ground.

Fifth, the draft EA fails to provide recharge data for the aquifers. Professor Karin Hoover, Assistant Professor of hydrology, hydrogeology, and surficial processes from CSU Chico, found in 2008 that, “Although regional measured groundwater levels are purported to ‘recover’ during the winter months (Technical Memorandum 3), data from Spangler (2002) indicate that recovery levels are somewhat less than levels of drawdown, suggesting that, in general, water levels are declining.” According to Dudley, “Test results indicate that the ‘age’ of the groundwater samples ranges from less than 100 years to tens of thousands of years. In general, the more shallow wells in the Lower Tuscan Formation along the eastern margin of the valley have the ‘youngest’ water and the deeper wells in the western and southern portions of the valley have the ‘oldest’ water,” adding that “the youngest groundwater in the Lower Tuscan Formation is probably nearest to recharge areas.” (2005). “This implies that there is currently no active recharge to the Lower Tuscan aquifer system (M.D. Sullivan, personal communication, 2004),” explains Dr. Hoover. “If this is the case, then water in the Lower Tuscan system may constitute fossil water with no known modern recharge mechanism, and, once it is extracted, it is gone as a resource,” (Hoover 2008). In another sub-basin, Yuba County Water Agency has encountered troubling trends that, according to the Draft EWA EIS/EIR, are mitigated by deepening domestic wells (2003 p. 6-81). While digging deeper wells is at least a response to an impact, it hardly serves as a proactive measure to avoid impacts.

All aquifer characteristics are important to a full understanding of the environmental impacts of the *2013 Water Transfer Program*. In the Tuscan Aquifer, for instance, there are numerous indications that other aquifer strata are being operated near the limit of overdraft and could be affected by the *2013 Water Transfer Program* (Butte County 2007). The Bureau has not considered this important historic information in the draft EA/FONSI. According to Dudley, the Chico area has a “*long term average decline in the static groundwater level of about 0.35 feet-per-year.*” (Letter to Lester Snow as presented to the Butte County Board of Supervisors as part

of agenda item 4.05, 2007) (emphasis added.) Declining aquifer levels are not limited to the Chico Municipal area. This trend of declining aquifer levels in Chico, Durham and the Cherokee Strip is illustrated in a map submitted with these comments (CH2M Hill 2006).

Declining groundwater elevations in Butte County are relevant to the Tuscan Aquifer, but also are emblematic of a valley-wide trend affecting other aquifers that illustrates serious overuse of groundwater. It is disturbing that neither the specifics of overuse conditions nor summaries of the groundwater basins and sub-basins are disclosed in the Project EA/FONSI. Below are some examples:

1. The Butte Basin Groundwater Status Report describes the “historical trend” in the Esquon Ranch area as showing “seasonal fluctuation (spring to fall) in groundwater levels of about 10 to 15 feet during years of normal precipitation and less than 5 feet during years of drought.” The report further notes: “Long-term comparison of spring-to-spring groundwater levels shows a decline of approximately 15 feet associated with the 1976-77 and 1986-94 droughts (Butte Basin Water Users Association, 2007). The 2008 report indicates that, “The spring 2008 groundwater level measurement was approximately three feet higher than the 2007 measurement, however it was still four feet lower than the average of the previous ten spring measurements. Fall groundwater levels are approximately nine feet lower than the averages of those measured during either of the previous drought periods on the hydrograph. At this time it appears that there may be a downward trend in groundwater levels in this well,” (Butte Basin Water Users Association, 2008). Thus, “*it appears that there may be a downward trend in groundwater levels in this well.*” *Id.* (emphasis added). The 2012 Esquon Subinventory Unit report confirms this downward trend:

Water elevations have been monitored since 1953 at this location [20N02E09L001M] and the historical averages, including 2011 data, are; Spring=128 feet and Fall=121 feet. The spring 2011 groundwater level measurement was approximately six feet lower than the average during the previous drought periods. Recent fall groundwater levels are approximately eleven feet lower than the averages of those measured during either of the previous drought periods on the hydrograph. At this time it appears that there may be a downward trend in groundwater levels in this well.

This Esquon well is also one that was hammered during the 1994 DWB when water sales with groundwater substitution by Western Canal Water District and others in southern Butte County cause significant impacts. *Id.* (p. 6)

2. Groundwater elevations in the Pentz sub-area in Butte County also reveal significant historical declines. The historical trend for this sub-area “...shows that the average seasonal fluctuation (spring to fall) in groundwater levels averages about 3 to 10 feet during years of normal precipitation and approximately 3 to 5 feet during years of drought. Long-term comparison of spring-to-spring groundwater levels shows a decline in groundwater levels during the period of 1971-1981, perhaps associated with the 1976-77 drought. Since a groundwater elevation high of approximately 145 feet in 1985 the

measured groundwater levels in this well have continued to decline. Recent groundwater level measurements indicate that the groundwater elevation in this well is approximately 15-25 feet lower than the historical high in 1985. (*Butte Basin Water Users Association, 2007* and 2012 Pentz Subinventory Unit report, p. 5). Water elevations at the Pentz sub-area well have been monitored since 1967. “Since 1985 spring groundwater levels in this well have been declining and the spring 2008 measurement remained ten feet below historical high levels and continues the downward trend on the hydrograph.” *Id.* p. 6 The Pentz and Esquon Ranch areas are located on the east and west sides of U.S. 99 respectively, in the eastern portion of the Tuscan aquifer.

3. Further evidence of changing groundwater levels appear in the Vina sub-region of Butte County, where water elevations have been monitored since 1947 at well 23N01W09E001M. The historical averages, including 2012 data, are; Spring=156 feet and Fall=150 feet (Butte County, Vina BMO report, p. 19). Unfortunately, the groundwater level measurement at this well in 2008 was the lowest recorded since 1994 *Id* Rock Creek, which is also in the Vina sub-unit once held water all year, and salmon fishing was robust prior to the 1930s (Hennigan 2010). Declining groundwater levels have caused the valley portion of Rock Creek to run completely dry each year and have also been noticed with Hennigan Farms’ wells since the 1960s. For example, a 1968 well had to be lowered 40 feet in 1974, another well constructed in 1978 had to be lowered 20 feet in 2009, and an old 1940s flood pump was lowered in the early 1960s, lowered again in 1976 when it was converted to a pressure pump, and lowered again in 1997 (Hennigan 2010).

The Natural Heritage Institute and Glenn Colusa Irrigation District acknowledge the declines in the Northstate aquifers, “Based on the most recent (Fall 2011) data collected by DWR, there appear to be some areas in the northern Sacramento Valley with persistent groundwater level declines, primarily in Glenn and Tehama Counties.” (*Feasibility Investigation of Re-Operation of Shasta and Oroville Reservoirs in Conjunction with Sacramento Valley Groundwater Systems to Augment Water Supply and Environmental Flows in the Sacramento and Feather Rivers* p. v) Although the Bureau and DWR provided funds for the NHI/GCID report, the general knowledge of groundwater declines in Glenn and Tehama counties is neither presented nor referenced in the Project’s EA.

In light of this downward trend in regional groundwater levels, the Bureau’s EA should closely analyze replenishment of the aquifers affected by the proposed *2013 Water Transfer Program*. The draft EA fails to provide any in-depth assessment of these issues. For example, the EA fails to discuss the best available estimates of where groundwater replenishment occurs. Lawrence Livermore National Laboratory analyzed the age of the groundwater in the northern counties to shed light on this process: “Utilizing the Tritium (H3) Helium-3 (He3) ratio, the age of each sample was estimated. Test results indicate that the “age” of the groundwater samples ranges from less than 100 years to tens of thousands of years,; (Dudley et al. 2005). As mentioned above, Dudley opines that the youngest groundwater in the Lower Tuscan Formation is probably nearest to recharge areas. (2005).

Are isotopic groundwater data available for other regions in the Sacramento Valley? If so, they would be crucial for all concerned to understand the potential impacts from the proposed *2013 Water Transfer Program*. Where does the EA identify areas most vulnerable to groundwater impacts? Does the Bureau identify how the Project conflicts with attempts at local management, particularly in areas where there are existing groundwater problems? Just consider that the City of Sacramento proposes to transfer surface water into the state water market and substitute 3,800 AF of groundwater (EA p.31), but the Sacramento County Water Agency *Water Management Plan* indicates that intensive use of this groundwater basin has resulted in a general lowering of groundwater elevations that will require extensive conservation measures to remediate. The Sacramento County Water Agency has devised a plan to help lead the city to a sustainable groundwater use to avoid problems associated with unrestrained overuse (2011). The most reliable strategy is to reduce demand, particularly from outside a groundwater basin. Integrating the City's water supply into the state water supply would obviously increase demand and make the SCWA goals impossible to achieve.

The Bureau should prepare an EIS that discloses the fallacies inherent in its policies and actions. The need for almost 400,000 AF per year of water south of the Delta (*2010/2011 Water Transfer Plan*), 190,000 AF with the 2013 Project, and 600,000 AF per year in the 10-Year Plan springs from failed business planning. The Bureau and DWR must acknowledge this and further disclose that their agencies are willing to socialize the risks taken by corporate agribusiness and developers while facilitating private profit. Instead of asking northern California water districts and municipal water purveyors to place at risk their own water (as well as the water of their neighboring communities and thousands of residential well owners), water quality, fisheries, recreation, stream flow, terrestrial habitat, and geologic stability, the Bureau and DWR must disclose all the uncertainty in the *2013 Water Transfer Program* and then evaluate the risks with scientific methodology. This has clearly not been done.

2. The 2013 Water Transfer Program proposes to rely on inadequate monitoring and mitigation to avoid the acknowledged possibility of significant adverse environmental impacts.

The draft EA and the *Draft Technical Information for Water Transfer Proposals in 2013* (<http://www.water.ca.gov/watertransfers/>) referenced in the EA require "willing sellers" to prepare individual monitoring and mitigation plans and to conduct the monitoring with oversight provided by the Bureau and DWR (p. 12 - 14, 32). This fails to provide the most basic framework for governmental authority to enforce the state's role as trustee of the public's water in California, let alone a comprehensive and coordinated structure, for a very significant program that could transfer up to 190,906 AF of water from the Sacramento Valley. The draft EA further defers responsibility to "willing sellers" for compliance with local groundwater management plans and ordinances to determine when the effects of the proposed extraction become "adverse," (EA at p. 12). "Each district will be required to confirm that the proposed groundwater pumping will be compatible with state and local regulations and groundwater management plans," (EA at

p. 25). It is not acceptable that the draft EA/FONSI and the *Draft Technical Information for Water Transfers in 2013* merely provide monitoring direction to “willing sellers” without identifying rigorous standards for the risks at hand, specific actions, acceptable monitoring and reporting entities, funding that will be necessary for this oversight, or resources with which to handle possible impacts.

AquAlliance proposes instead that the Bureau and DWR require, at a minimum, that local governments select independent third-party monitors, who are funded by surcharges on Project transfers paid by the buyers, to oversee the monitoring that is proposed in lieu of Bureau and DWR staff, and that peer-reviewed methods for monitoring be required. If this is not done, the Project’s proposed monitoring and mitigation outline is insufficient and cannot justify the significant risk of adverse environmental impacts.

To be clear, the EA/FONSI and the *Draft Technical Information for Preparing Water Transfer Proposals in 2013* fail to identify standards that would be used to monitor the *2013 Water Transfer Program’s* impacts. The documents fail to identify any specific monitoring protocols, locations (particularly in up-gradient recharge portions of the groundwater basins), and why chosen locations should be deemed effective for monitoring the effects of the proposed groundwater extraction. The EA/FONSI and the *Draft Technical Information for Preparing Water Transfer Proposals in 2013* points to the “seller” as the responsible party to meet the objectives in the *Draft Technical Information for Preparing Water Transfer Proposals in 2013*, but the Bureau and DWR are the responsible agencies that approve and move the water (EA at p.24-26). The EA asserts that, “If monitoring indicated that adverse effects related to the degradation of groundwater quality from the transfer occurred, willing sellers in the region will be responsible for monitoring this degradation and mitigating any adverse effects in accordance with all applicable regulations.” (p. 24). There is no explanation as to how the Bureau will hold the “willing sellers” responsible to meet the Bureau’s obligations under NEPA.

Moreover, the EA/FONSI fails to provide a mitigation strategy for review and comment by the public. Instead it defers this vital mitigation planning effort to future documents created by the “willing sellers,” (EA at p.25-27) despite the fact that the EA acknowledges the potential for significant impacts, however weakly. For example:

Groundwater substitution transfers could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. The well reviews and plans were required from sellers for review by Reclamation. Reclamation would not approve transfers without adequate mitigation and monitoring plans. The well review and required monitoring and mitigation plans described would minimize or avoid potential adverse effects to groundwater resources, to water quality and to wildlife habitat. (EA at p. 12)

If the Bureau and DWR’s approvals are so rigorous and protective of the communities, economy, and environment in the Sacramento Valley, where are the standards for review and approval? With the expectation that groundwater levels will decrease (EA at p. 12) where is the explanation that reveals the amount by which the groundwater is expected to decrease and what level of

decrease is considered to be acceptable? Where is an explanation as to why the amount of water to be extracted is not considered significant? Without thresholds and standards, there is no logical link that leads to the Bureau's conclusion that, "The well review and required monitoring and mitigation plans described would minimize or avoid potential adverse effects to groundwater resources, to water quality and to wildlife habitat." (EA at p.12)

The EA discloses that, "Emissions from the operation of diesel engines could exceed emissions thresholds for each air district and de minimis thresholds for General Conformity," and that , Emissions as a result of the Proposed Action were within thresholds for Glenn, Colusa, Sacramento, and Sutter counties." (EA at p. 12) Where are the support data to reach these conclusory statements? In addition, it is confusing is that the same paragraph assumes that, "Idling rice fields would reduce the use of farm equipment and associated pollutant emissions, resulting in a beneficial impact on air quality." This flies in the face of the Proposed Action that assumes groundwater substitution to replace river water that will be sold, so crop cultivation may continue, which could easily be rice. (EA at pp.6, 9) This incongruity must be explained or changed.

Coupled with the possible impacts that the Bureau is willing to disclose in the EA/FONSI are bold assertions that with Bureau oversight the "sellers" will acknowledge and mitigate impacts. Unfortunately, there is no factual grounding for this grand assumption, and there is no disclosure to demonstrate how a business or individual would demonstrate harm. Such was the problem in 1994, when DWR and the sellers told people without irrigation and residential well water that they couldn't prove it was the water sales or existing conditions. The environment also needs a voice in this water marketing scheme, but there isn't a method or plan to provide it. The EA rightly acknowledges that, "It is recognized that an increase in groundwater pumping will affect the rate of groundwater recharge during balanced conditions, which will affect stream flow," (p.11) but fails to suggest how this could be avoided, monitored, or mitigated. Also missing in this regard in the EA/FONSI are:

1. What is the definition of "balanced conditions" in the numerous regions where both CVP and non-CVP groundwater substitution is proposed and who will define it?
2. What are the existing conditions in the areas of origin in 2013 (let alone at the baseline), which must start no sooner that when the CalFed Record of Decision was approved in August 2000?
3. Because the Bureau , DWR, buyers, and sellers continue these multi-year, serial water transfers from the Sacramento Valley, without the benefit of comprehensive environmental review, how has climate change and local use already affected streams, fish, terrestrial species, and groundwater, to name just a few critical areas with significant impacts from the Project?

The EA noticeably omits painfully obvious and significant impacts in the current Project EA/FONSI that were previously disclosed by the Bureau in the *2010/2011 Water Transfer Program* EA/FONSI. For example:

- Surface water and groundwater interact on a regional basis, and, as such, gains and losses to groundwater vary significantly geographically and temporally. In areas where groundwater levels have declined, such as in Sacramento County, streams that formerly gained water from groundwater now lose water to the groundwater system through seepage (2010/2011 *Water Transfer Program EA* at p. 3-12).
- *Groundwater substitution transfers would alter ground water levels and potentially affect natural and managed seasonal wetlands and riparian communities, upland habitats and wildlife species depending on these habitats.* As a part of groundwater substitution transfers, the willing sellers would use groundwater to irrigate crops and decrease use of surface water. Pumping additional groundwater would decrease groundwater levels in the vicinity of the sellers' pumps. Natural and managed seasonal wetlands and riparian communities often depend on surface water/groundwater interactions for part or all of their water supply. Under the Proposed Action, subsurface drawdown related to groundwater substitution transfers could result in hydrologic changes to nearby streams and marshes, potentially affecting these habitats. Reduced groundwater elevations could also affect trees that access groundwater as a source of water through taproots in addition to extensive horizontal roots that use soil moisture as a water source. Decreasing groundwater levels could reduce part of the water base for species within these habitats (EA at p. 3-53 and 3-54).

Have these impacts dissipated, or were they not disclosed in the Project EA/FONSI?

The reader is directed to the Bureau and DWR's *Draft Technical Information for Water Transfers* in 2013 to discover the *minimal* objectives and required elements of the monitoring and mitigation component of the Project. "Water transfer proponents transferring water via groundwater substitution transfers must establish a monitoring program capable of identifying any adverse transfer related effects before they become significant." However, the reader (and possibly the sellers) are left wondering what exactly is "a monitoring program capable of identifying any adverse transfer related effects before they become significant," since there are no standards or particular guidance to manage and analyze the very complex hydrologic relationships internal to groundwater and its connection to surface waters.

Certainly the public has no idea or ability to comment, which fails the full disclosure mandate in NEPA and CEQA. Page 38 of the *Draft Technical Information for Water Transfers* in 2013 briefly lists, "Potentially significant impacts identified in a water transfer proposals [that] must be avoided or mitigated for a proposed water transfer to continue, including:"

- Contribution to long-term conditions of overdraft;
- Dewatering or substantially reducing water levels in nonparticipating wells;
- Measurable contribution to land subsidence;
- Degradation of groundwater quality that substantially impairs beneficial uses or violates water quality standards; and
- Affecting the hydrologic regime of wetlands and/or streams to the extent that ecological integrity is impaired.

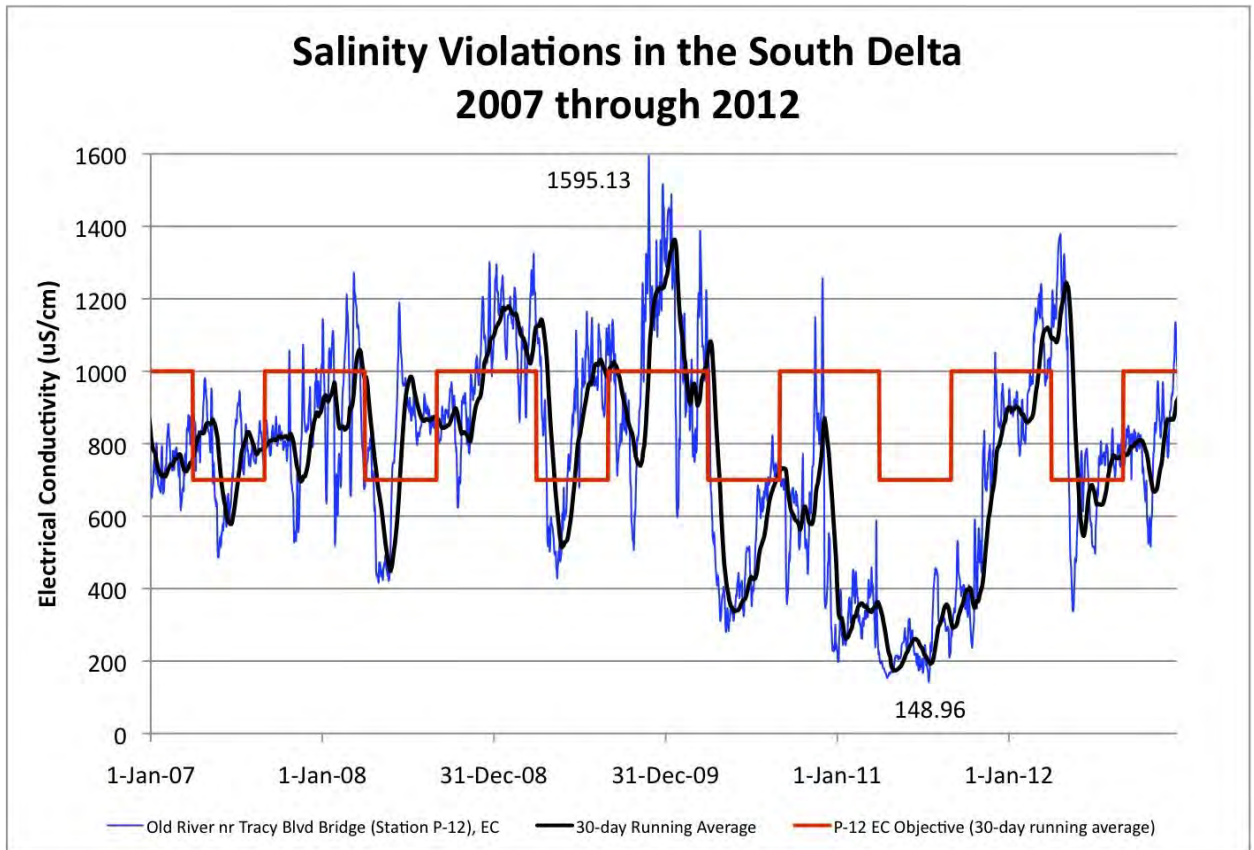
The *Draft Technical Information for Water Transfers* in 2013 continues with suggestions to curtail pumping from lower bowls, and pay higher energy costs to ease the impacts to third party wells owners (p. 38-39). While this bone thrown at mitigation is appreciated, the glaring omissions are notable. The *Draft Technical Information for Water Transfers* in 2013 completely fails to mention, even at a very general level, how individual well owners who may be harmed by the Project, will determine and prove where the impacts to their wells are coming from, that water quality and health could become a significant impact for impacted wells, users, and streams. The onus for coping with and disclosing potential impacts is deflected onto the nonparticipating public, species, and environment. How does this meet the requirements of NEPA and CEQA? Since wetlands and streams would require human observation or adequate monitoring to report an impact, how will, “Affecting the hydrologic regime of wetlands or streams to the extent that ecological health is impaired,” be avoided or mitigated without standards and requirements from the Bureau and DWR? (*Draft Technical Information for Water Transfers* p. 38) There also appears to be no consideration for species monitoring, just “practices” or “conservation measures” to “minimize impacts to terrestrial wildlife and waterfowl,” (*Draft Technical Information for Water Transfers* pp. 16, 20, 22-24).

The EA/FONSI and the *Draft Technical Information for Water Transfers* in 2013 don't appear to weigh the significance of avoidance of impacts, pre-Project mitigation, during Project mitigation, or post-Project mitigation. This fails to create objective standards and merely differs responsibility to the “willing sellers,” a broadly unsuspecting public, and a voiceless environment.

Another example of the inadequacy of the proposed monitoring is that the draft EA fails to include any coordinated, programmatic plan to monitor stream flow of creeks and rivers located in proximity to the “willing sellers” that will evacuate more groundwater than has been used historically. The potential for immediate impacts would be very close to water sellers' wells, but the long term impacts could be more subtle and geographically diverse. What precautions has the Bureau and DWR made for the cumulative impacts that come not only from this one-year Project, but in combination with the water sales from the last dozen years and those that are planned by the Bureau into the future (see lists in Sections G, 4 & 5 below)? Bureau and DWR water transfers are not just one- or two-year transfers, but many serial actions in multiple years by the agencies, sellers, and buyers without the benefit of comprehensive environmental analysis under NEPA and CEQA.

As discussed above, adequate monitoring is vital to limit the significant risks posed by the Project to the health of the region's groundwater, streams, and fisheries (more discussion below). Moreover, to the extent this Project is conceived as an ongoing hardship program that will provide knowledge for future groundwater extraction and fallowing, its failure to include adequate monitoring protocols is even more disturbing and creates the risk of significant long-term, perhaps irreversible impacts from the Project.

a. The Bureau’s assertion that the Project may be modified or halted in the event of significant adverse impacts to hydrologic resources is an empty promise in light of the wholly inadequate EA disclosure, and proposed monitoring for the *2013 Water Transfer Program*. Knowing that the Bureau and DWR deliberately and repeatedly violate the a major requirement like the X2 standard in the Delta does little to instill confidence from AquAlliance in the vague, non-specific monitoring program and mitigation criteria proposed in the EA/FONSI and associated documents..



Source: Tim Strohane, May 2013

The *2010/2011 Water Transfer Program* has been incorporated by reference in the Project EA. AquAlliance found repeated illustrations of potential for significant injury to other groundwater users, water quality, streams, flora and fauna, and the soil profile in the *2010/2011 Water Transfer Program* (p. 3-12, 3-23, 3-24, 3-53, 3-54). Chapter Three contained numerous examples that illustrated the need for an EIS since there is insufficient, comprehensive planning for, let alone preparation to mitigate, adverse environmental impacts:

- *Acquisition of water via groundwater substitution or cropland idling would change the rate and timing of flows in the Sacramento River compared to the No Action Alternative.*
- *In Figure 3.2-2, groundwater substitution pumping results in a change in the groundwater/surface water interaction characteristics. In this case, the water pumped*

from a groundwater well may have two impacts that reduce the amount of surface water compared to pre-pumping conditions. These mechanisms are:

- *Induced leakage. The lowering of the groundwater table causes a condition where the groundwater table is lower than that the water level in the surface water. This conditions causes leakage out of the surface water.*
- *Interception of groundwater. The placement of groundwater substitution pumping may intercept groundwater that may normally have discharged to the surface water (i.e., water that has already percolated into the ground may be pumped out prior the water reaching the surface water and being allowed to enter the “gaining” stream).*
- *The changes in groundwater flow patterns (e.g., direction, gradient) due to increased groundwater substitution pumping may result in changes in groundwater quality from the migration of reduced quality water.*
- *Groundwater substitution transfers would alter ground water levels and potentially affect natural and managed seasonal wetlands and riparian communities, upland habitats and wildlife species depending on these habitats.*
- *Rice land idling transfers would reduce habitat and forage for resident and migratory wildlife populations.*
- *Water transfers could change reservoir releases and river flows and potentially affect special status fish species and essential fish habitat.*
- *Water transfers could affect fisheries and aquatic ecosystems in water bodies, including Sacramento and American River systems, the Sacramento-San Joaquin Delta, San Luis Reservoir, and DWR and Metropolitan WD reservoirs in southern California.*
- *Increased groundwater pumping for groundwater substitution transfers would increase emissions of air pollutants.*

The Bureau thus recognizes the potential for significant decline in groundwater levels in the Project's EA as it did in the proposed *2010/2011 Water Transfer Program* (EA at p. 3-23, 3-24, 3-53, 3-54). The acknowledgements alone are sufficient to require a full EIS, but, regrettably, the Bureau has returned with the Project EA in 2013, instead of the EIS for which it ostensibly held scoping meetings in January 2011. Moreover, as detailed below, the monitoring proposed by the *2013 Water Transfer Program* remains inadequate leaving the public and environment with no guarantee that adverse impacts will be discovered at all (or be discovered in time to avoid significant environmental impacts).

Glenn County will experience groundwater substitution if the Project moves forward. Glenn County realized that its management plan and ordinances were not sufficient for the challenges presented by the *2010/2011 Water Transfer Program* and cautioned that “[s]ince the groundwater management plan is relatively new and not fully implemented, the enforcement and conflict resolution process has not been vigorously tested,” (2010) Subsequently, Glenn County updated their Ordinance 1237 and amended their *Groundwater Management to Groundwater Coordinated Resource Management Plan* (Glenn County Plan) in 2012, so it remains new and untested.. AquAlliance finds the Glenn County inadequate to protect humans and the

environment, since it states that, “The County does not hereby intend to regulate, in any manner, the use of groundwater; unless safe yield is exceeded or there is a threat to public health, welfare, or safety, but intends to adopt monitoring programs that will allow for the effective management of groundwater availability (groundwater level), groundwater quality, and indications of land subsidence.” Moreover, the Glenn County Groundwater Management Plan does not have any provisions to monitor or protect the environment, will in no way protect the common Tuscan aquifer that is beyond Glenn County’s border, and will protect no one or the environment that that is outside its jurisdictional boundary. The *2013 Water Transfer Program EA* fails to disclose the inadequacies of this and other local ordinances and plans.

Ordinance 1237, which updated the *Groundwater Management to Groundwater Coordinated Resource Management Plan* does not contain a definition of “safe yield,” but defers it to the BMO method (Glenn County Plan at p.5) The BMO method is found on Glenn County’s web site and was written by Toccoy Dudley in 2000 while he still worked for DWR. This method was created in an attempt to provide a fig leaf for a massive obstacle: safe yield is extremely difficult to determine. “In early 1999 the GCWAC began to focus on a countywide ordinance that did not attempt to control groundwater use, including export, as long as the aquifer system was not harmed and safe yield was not exceeded. But estimating safe yield appeared to be nearly impossible to accomplish given the inherent difficulties in determining safe yield and that no funding was available to do the required studies.”
(http://www.glenncountywater.org/management_plan.aspx)

Monitoring based on the Glenn County Plan is clearly inadequate to the task because enforcement remains cumbersome and voluntary. “In the Glenn County structure, if a BMO threshold is exceeded, the process sets into motion a series of events. First the TAC reports on the regional extent and magnitude of the non-compliance to the WAC. The TAC then starts a fact-finding process to identify the cause(s) of the non-compliance and makes recommendations to the WAC on how to resolve the situation. The WAC then tries to resolve the problem in the affected area by negotiations with the locals if at all possible. Some of the possible actions that may be taken by the WAC might be to coordinate the following voluntary actions in the affected area.” (Dudley, Basin Management Objective (BMO) Method Of Groundwater Basin Management, 2000 p.8)

The Bureau omitted discussion of the adequacy of the Glenn County Plan or any other county’s plan, in the *2013 Water Transfer Program*, but we are pleased that at a minimum the *Draft Technical Information for Water Transfers in 2013* identifies local ordinances in Table 3-1 (p. 27). We believe that this is appropriate juncture to refer to some of the commitments that the Bureau is making for itself and the sellers in the EA. A review of county-of-origin ordinances reveals that they are inadequate to the task because of the absence of enforceable measures that could protect human and environmental health within each county:

- “The objectives of this process are: to mitigate adverse environmental effects that occur; to minimize potential effects to other legal users of water; to provide a process for review and response to reported third party effects; and to assure that a local mitigation strategy

is in place prior to the groundwater transfer. The seller will be responsible for assessing and minimizing or avoiding adverse effects resulting from the transfer within the source area of the transfer.” (EA at p. 25)

- “Each district will be required to confirm that the proposed groundwater pumping will be compatible with state and local regulations and groundwater management plans. “ (EA at p.25) What consideration is made for the inadequacy of a local ordinance that could lead to a serious impact to the human environment and the environment overall?
- “For purposes of this EA, Reclamation assumes that stream flow losses due to groundwater pumping to make water available for transfer are 12 percent of the amount pumped.” (EA at p. 25) Where are the supporting data? How will this be mitigated?

Since the Project’s EA fails to disclose limitations or inadequacies with local ordinances (also see AquAlliance’s Attachments A & B), it is helpful that Butte County’s Department of Water and Resource Conservation explains that local plans are simply not up to the task of managing a regional resource:

Each of the four counties that overlie the Lower Tuscan aquifer system has their own and separate regulatory structure relating to groundwater management. Tehama County, Colusa, and Butte Counties each have their own version of an export ordinance to protect the citizens from transfer-related third party impacts. Glenn County does not have an export ordinance because it relies on Basin Management Objectives (BMOs) to manage the groundwater resource, and subsequently to protect third parties from transfer related impacts. Recently, Butte County also adopted a BMO type of groundwater management ordinance. Butte County, Tehama County and several irrigation districts in each of the four counties have adopted AB3030 groundwater management plans. All of these groundwater management activities were initiated prior to recognizing that a regional aquifer system exists that extends over more than one county and that certain activities in one county could adversely impact another. Clearly the current ordinances, AB3030 plans, and local BMO activities, which were intended for localized groundwater management, are not well suited for management of a regional groundwater resource like that theorized of the Lower Tuscan aquifer system.⁵

c. The EA asserts that, “The potential for subsidence is small if the groundwater substitution pumping is small compared to overall pumping in a region.” (p. 24) This is misleading at best, and incorrect at worst. The potential for subsidence in a given clay and slit deposit is small only when groundwater levels can be guaranteed to remain above the lowest water levels caused by past droughts. As more water is pumped from an aquifer because of increased usage of groundwater supplies, the potential for subsidence is increased, not decreased, and if existing pumping brings water levels near to their lowest historical lows, then substitution pumping indeed has the potential to induce subsidence.

⁵ Butte County Department of Water and Resource Conservation, *Needs Assessment Tuscan Aquifer Monitoring, Recharge, and Data Management Project*, 2007.

The EA goes on stating, “The minimization measures in Section 3.2.2.3 require all groundwater substitution transfers to monitor for subsidence or provide a credible analysis why it would be unlikely.” (p. 24) Subsidence is difficult (if not impossible) to detect in the short term. Elastic deformations that are recoverable upon aquifer recharge are readily detected by proper measurement techniques, but these reversible motions are not subsidence. Subsidence is by definition an irreversible mechanical response that permanently lowers the ground surface and that permanently decreases aquifer capacity. Because of the low permeability of soil deposits that are susceptible to subsidence, these permanent effects are commonly widely separated in time from the actual pumping that causes them to begin, and thus only long-term monitoring can accurately identify subsidence.

Or in simple terms, the absence of evidence of subsidence when pumping is initiated provides little or no evidence of whether subsidence is actually occurring. Only when irreversible damage is done over the long-term is the effect of groundwater extraction obvious.

Determining a credible basis for subsidence potential can be extremely difficult and expensive. Such an analysis would commonly require determination of historical low groundwater levels, the likelihood of future increases in groundwater extraction, and the composition of the subsurface layers that comprise the aquifer. If these tasks were easy, they would have been performed already, and the fact that the Bureau cannot provide credible evidence to rule out subsidence is an implicit admission that such credibility is difficult or impossible to obtain in practice.

The EA has responded to AquAlliance’s proposal for real-time monitoring for land subsidence (AquAlliance, et. al, 2010). (EA at p. 24) We believed at the time that this would be a step forward that could reveal immediate subsidence problems. We have subsequently learned is that real-time subsidence monitoring is a misnomer. While it is possible to monitor ground surface elevation, performing this with due degree of precision is not easy or inexpensive in practice. And since such ground-surface monitoring often only provides real-time estimates of elastic (i.e., reversible) surface elevation changes, at best it yields only a hint of the potential damage that can occur in the long term.

Third-party independent verification, perhaps by scientists from the U.S. Geological Survey, should be incorporated by DWR and the Bureau into the Project description of the *2013 Water Transfer Program*. We applaud the initiation of a regional GPS network in the Sacramento Valley but remain concerned about the existing extensometers in the Sacramento Valley that measure land subsidence, and a Global Positioning System land subsidence network established by one county (*2010/2011 Water Transfer Program EA* at p. 13). The remaining responsibility is again deferred to the “willing sellers.” Unfortunately, voluntary monitoring by pumpers does not strike us as a responsible assurance given the substantial uncertainties involved in regional aquifer responses to extensive groundwater pumping in the Sacramento Valley. Admonishing sellers not to cause problems is a deferral of responsibility by the Bureau and DWR.

There is a noticeable absence of discussion regarding delayed subsidence, which we broach above, that should also be monitored according to the findings of Dr. Kyran Mish, Presidential Professor, School of Civil Engineering and Environmental Science at the University of Oklahoma. Dr. Mish notes: “It is important to understand that *all* pumping operations have the potential to produce such settlement, and when it occurs with a settlement magnitude sufficient enough for us to notice at the surface, we call it *subsidence*, and we recognize that it is a serious problem (since such settlements can wreak havoc on roads, rivers, canals, pipelines, and other critical infrastructure).” (Mish 2008) Dr. Mish further explains that “[b]ecause the clay soils that tend to contribute the most to ground settlement are highly impermeable, their subsidence behavior can continue well into the future, as the rate at which they settle is governed by their low permeability.” *Id.* “Thus simple real-time monitoring of ground settlement can be viewed as an *unconservative* measure of the potential for subsidence, as it will generally tend to underestimate the long-term settlement of the ground surface.” *Id.* (emphasis added).

The *2010/2011 Water Transfer Program EA* acknowledged the existence and cause of serious subsidence in one area of the valley. “The area between Zamora, Knights Landing, and Woodland has been most affected (Yolo County 2009). Subsidence in this region is generally related to groundwater pumping and subsequent consolidation of aquifer sediments,” (EA p. 3-13). This fact alone illustrates the need for more extensive analysis throughout the export areas in an EIS.

d. The *2013 Water Transfer Program EA* fails to require streamflow monitoring. The 2009 DWB EA/FONSI deferred the monitoring and mitigation planning to “willing sellers,” but even that requirement has been completely eliminated. We can’t emphasize enough the importance of frequent and regular streamflow monitoring by either staff of the project agencies or a third, independent party such as the USGS, paid for by Project transfer surcharges mentioned above. It is clear from existing scientific studies and the EA that the Project may have significant impacts on the aquifers replenishment and recharging of the aquifers (EA at pp. 10 – 12, 27), so the *2013 Water Transfer Program* should therefore require extensive monitoring of regional streams. The radius for monitoring should be large, not the typical two to three miles as usually used by DWR and the Bureau. Though not presented for the Project’s EA or the *2010-2011 Water Transfers Program*, the *Stony Creek Fan Aquifer Performance Testing Plan*, which is a much smaller project, recognized that there may be a drawdown effect on the aquifer by considering results from a DWR Northern District spring 2007 production well test (Water Transfer Program EA/FONSI p. 28). However, it did not assess the anticipated scope of that effect—or even what level of effect would be considered acceptable. Moreover, the results from that test well indicate that the recharge source for the solitary production well “is most likely from the foothills and mountains, to the east and north”—which at a minimum is more than fifteen miles away. (Stanton, Glenn-Colusa Irrigation District Aquifer Performance Testing Glenn County, California).

The Butte County Department of Water and Resource Conservation has identified streams that must be monitored to determine impacts to stream flows that would be associated with pumping the Lower Tuscan Aquifer. These “[s]treams of interest” are located on the eastern edge of the Sacramento Valley and include: Mill Creek, Deer Creek, Big Chico Creek, Butte Creek, and Little Dry Creek (The Butte County DWRC 2007). The department described the need and methodology for stream flow gauging:

The objective of the stream flow gaging is to determine the volume of surface water entering into or exiting the Lower Tuscan Aquifer along perennial streams that transect the aquifer formation outcropping for characterization of stream-aquifer interactions and monitoring of riparian habitat. Measurement of water movement into or out of the aquifer will allow for testing of the accuracy of the Integrated Water Flow Model, an integrated surface water-groundwater finite differential model developed for the eastern extent of the Lower Tuscan aquifer.

Two stream gages will be installed on each of five perennial streams crossing the Lower Tuscan Formation to establish baseline stream flow and infiltration information. The differences between stream flow measurements taking upstream and downstream of the Lower Tuscan Formation are indications of the stream-aquifer behavior. Losses or gains in stream volume can indicate aquifer recharge or discharge to or from the surface waters.
Id.

As is evident in the following conclusory assertions, the draft EA/FONSI fails to define the radius of influence associated with the aquifer testing and thus entirely fails to identify potential significant impacts to salmon:

An objective in planning a groundwater substitution transfer is to ensure that groundwater levels recover to their typical spring high levels under average hydrologic conditions. Because groundwater levels generally recover at the expense of stream flow, the wells used in a transfer should be sited and pumped in such a manner that the stream flow losses resulting from pumping peak during the wet season, when losses to stream flow minimally affect other legal users of water. (EA at p. 11.)

As mentioned above, streamflow monitoring is not a requirement of the Project, which is unfathomable. Monitoring of flow on streams associated with the Lower Tuscan Formation is particularly important to the survival of Chinook salmon which use these “streams of interest” to spawn and where salmon fry rear. Intensive groundwater pumping would likely lower water table elevations near these streams of interest, decreasing surface flows, and therefore reducing salmon spawning and rearing habitat through dewatering of stream channels in these northern counties. This would be a significant adverse impact of the Project and is ignored by the Project’s EA/FONSI.

A similar effect has been observed in the Cosumnes River, where “[d]eclining fall flows are limiting the ability of the Cosumnes River to support large fall runs of Chinook salmon,”

(Fleckenstein, et al 2004). This is a river that historically supported a large fall run of Chinook Salmon. *Id.* Indeed, “[a]n early study by the California Department of Fish and Game . . . estimated that the river could support up to 17,000 returning salmon under suitable flow conditions.” *Id.*, citing CDFG 1957 & USFWS 1995. But “[o]ver the past 40 years fall runs ranged from 0 to 5,000 fish according to fish counts by the CDFG (USFWS 1995),” and “[i]n recent years, estimated fall runs have consistently been below 600 fish, according to Keith Whitener,” (Fleckenstein, *et al.* 2004). Indeed, “[f]all flows in the Cosumnes have been so low in recent years that the entire lower river has frequently been completely dry throughout most of the salmon migration period (October to December).” *Id.*

Research indicates that “groundwater overdraft in the basin has converted the [Cosumnes River] to a predominantly losing stream, practically eliminating base flows....” (Fleckenstein, *et al.* 2004). And “investigations of stream-aquifer interactions along the lower Cosumnes River suggest that loss of base flow support as a result of groundwater overdraft is at least partly responsible for the decline in fall flows.” *Id.* Increased groundwater withdrawals in the Sacramento basin since the 1950s have substantially lowered groundwater levels throughout the county.” *Id.*

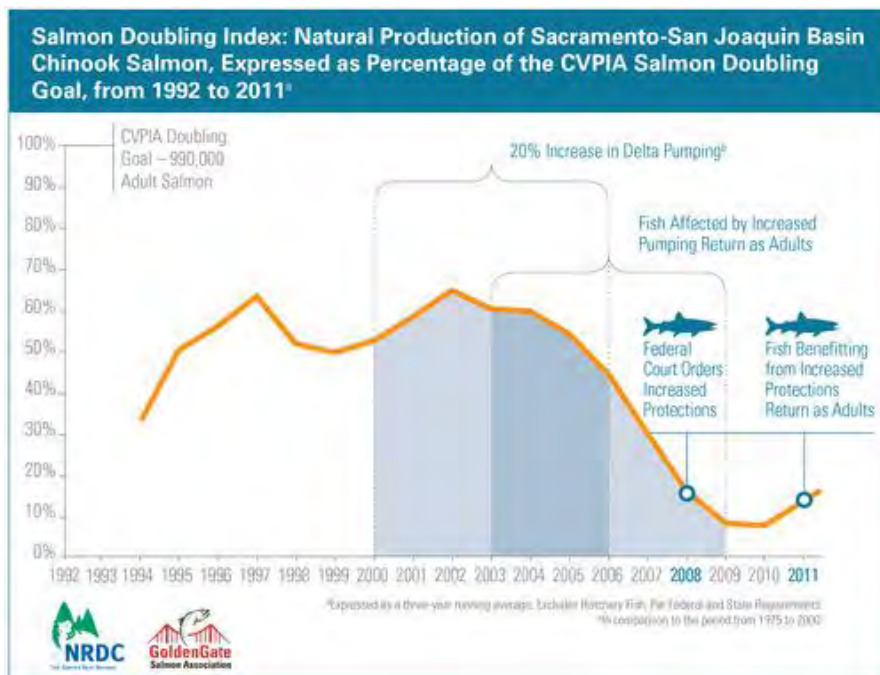
The draft EA acknowledges the potential for impacts to special status fish species from altered river flows and commits to maintaining flow and temperature requirements already in place (p. 12). AquAlliance would like to have greater assurance of a commitment considering, as noted above, that the Bureau and DWR fail to meet the X2 standard in the Delta regularly and repeatedly. The Bureau and DWR should make X2 compliance and streams of interest monitoring in real time part of their permit amendment applications to the SWRCB in June 2013. If stream levels are affected by groundwater pumping, then pumping would cease.

Unfortunately, the draft EA fails to anticipate possible stream flow declines in important salmon rearing habitat in the 2013 Water Transfer Program area. Many important streams, such as Mud Creek, are located within the 2013 Water Transfer Program and flows through probable Tuscan recharge zones, yet are not mentioned in the EA (also see comments above regarding Rock Creek). While a charged aquifer is likely to add to base flow of this stream, a de-watered aquifer would pull water from the stream. According to research conducted by Dr. Paul Maslin, Mud Creek provides advantageous rearing habitat for out-migrating Chinook salmon (1996). Salmon fry feeding in Mud Creek grew at over twice the rate by length as did fry feeding in the main stem of the Sacramento River. *Id.*

Another tributary to the Sacramento River, Butte Creek, also hosts spring-run Chinook salmon, a threatened species under the Endangered Species Act. 64 Fed. Reg. 50,394 (Sept. 16, 1999). Butte Creek contains the largest remaining population of the spring-run Chinook and is designated as critical habitat for the species. *Id.* at 50,399; 70 Fed. Reg. 52,488, 52,590-91 (Sept. 2, 2005). Additionally, Butte Creek provides habitat for the threatened Central Valley steelhead. See 63 Fed. Reg. 13,347 (Mar. 19, 1998); 70 Fed. Reg. at 52,518. While Butte Creek was mentioned in the 2010/2011 Water Transfer Program’s EA (p. 2-11, 3-4, 3-49, 3-57), it is only

mentioned for identification purposes in the Project's EA. In the *2010/2011 Water Transfer Program's EA*, the only protection afforded this vital tributary are statements that cropland idling will not occur adjacent to it, yet that was contradicted on page 3-19. The Bureau should not overlook the importance of rearing streams, and should not proceed with this Project unless and until adequate monitoring and mitigation protocols are established.

Existing mismanagement of water in California's rivers, creeks, and groundwater has already caused a precipitous decline in salmon abundance. There is no mention of the fall-run salmon numbers in the main stem Sacramento River or its essential tributaries despite the fact that their numbers dropped precipitously in 2007, 2008, and 2009 and have not come close to the numbers found over a decade ago. The graph below illustrates natural production of Sacramento-San Joaquin Basin Chinook salmon and is expressed as a percentage of the CVPIA Salmon Doubling Goal, from 1992 to 2011 as a three-year running average. The numbers exclude hatchery fish, which complies with federal and state requirements.



Graph courtesy of NRDC and Golden Gate Salmon

A May 15, 2013 article underscores the past and present impacts from Bureau and DWR mismanagement of the CVP and SWP.

After two closed salmon fishing seasons in 2008 and 2009, and a token season in 2010, fishermen are fishing again, but we remain far below the abundant runs required by law," said Zeke Grader, executive director of Pacific Coast Federation of Fishermen's Association and GGSA board member. "Stronger Delta pumping restrictions are paying off but we have to finish the job and get these salmon runs rebuilt." The groups say these results are only "marginally

better" than the 12 percent of salmon produced in 2011, when NRDC and GGSA released the first analysis of the Central Valley Chinook salmon population goals. The CPVIA specifically directs the U.S. Department of the Interior to protect, restore, and enhance fish in the Central Valley of California. That means rebuilding salmon populations from 495,000 to 990,000 wild adult fish by 2002, according to Grader. "This year our industry will only get a fraction of what our state and federal governments are supposed to be producing," said John McManus, executive director of GGSA. "We're having a hard time living on 22 percent of the legally required salmon population. Balance could be restored by reallocating a fairly small amount of water which would give us healthy salmon runs, healthy local food, healthy communities and a healthy economy." Central Valley Chinook salmon declined drastically from 2003 through 2010, reaching a record low of 7 percent of the required population level, according to McManus. This decline in the fishery corresponded with a 20 percent increase in water diversions from salmon habitat over levels from the preceding quarter century. The largest water exports from the Delta in California history took place from 2003 to 2006 and in 2011. Although the Central Valley salmon numbers have increased since the unprecedented collapse of 2008-2009, forecasts suggest 2013's salmon returns will again fall far below what the law requires. (Bacher)

The following chart provides a valuable summary that compliments the article and graph immediately above and demonstrates how the Bureau and DWR failure to meet required standards.

Year (Y)	Three-Year* Running Average as a Percentage of CVPIA Production Goal	Year (Y)	Three-Year* Running Average as a Percentage of CVPIA Production Goal
1994	32.05%	2004	59.26%
1995	49.82%	2005	53.80%
1996	55.57%	2006	44.15%
1997	62.85%	2007	29.85%
1998	51.38%	2008	15.90%
1999	49.29%	2009	8.04%
2000	52.13%	2010	7.41%
2001	57.88%	2011	13.25%
2002	64.33%		

* $(Y + Y_{Y+1} + Y_{Y+2})/3$

As noted above, the EA casually asserts that maintaining flow and temperature requirements in the main stem will be sufficient to protect aquatic species. (EA at pp. 12, 13, 20) We question that assurance and present factual data compiled by The Bay Institute in 2012 that contradicts the Bureau's conclusory statement. (TBI at pp. 7-12) The EA/FONSI also fails to consider the impacts of 190,906 AF of water transfers and groundwater substitution on the tributaries. How much additional pumping does the Project represent, given CVP and SWP contractual commitments, available reservoir supplies, and other environmental restrictions south of the Delta? The EA and DWR's missing environmental review are silent on this.

Unsupported assertions, that impacts to aquatic species will be below a level of significance, are arbitrary and capricious and lack foundational data. (EA at pp. 10, 12, 17) Habitat values are also essential to many other special status species that utilize the aquatic and/or riparian landscape including, but not limited to, giant garter snake, bank swallow, greater sandhill crane, American shad, etc. Where is the documentation of the potential impacts to these species?

In addition to the direct decline in the salmon populations is the reverberating indirect influence on the food chain that may significantly impact species such as killer whales.

3. The EA fails to address the significant unknown risks raised by the 2013 Water Transfer Program's proposed groundwater extraction.

The EA fails to identify and address the significant unknown risks associated with this Project. There are substantial gaps in scientists' understanding of how the aquifer system recharges.

The EA fails to reveal the scientifically known and unknown characteristics of the Lower Tuscan aquifer. Expert opinion and experience is offered by Professor Karin Hoover from CSU Chico who asserts that: "[T]o date there exists no detailed hydrostratigraphic analysis capable of distinguishing the permeable (water-bearing) units from the less permeable units within the subsurface of the Northern Sacramento Valley. In essence, the thickness and extent of the water-bearing units has not been adequately characterized." (2008 p. 1)

Though the Project fails to disclose the limitations in knowledge of the geology and hydrology of the northern counties, it was disclosed in 2008 in the EA for the *Stony Creek Fan Aquifer Performance Testing Plan* (Testing Plan EA). It revealed that there is also limited understanding of the interaction between the affected aquifers, and how that interaction will affect the ability of the aquifers to recharge. The Testing Plan EA provides:

The Pliocene Tuscan Formation lies beneath the Tehama Formation in places in the eastern portion of the SCF Program Study Area, although its extent is not well defined. Based on best available information, it is believed to occur at depths ranging between approximately 300 and 1,000 feet below ground surface. It is thought to extend and slope upward toward the east and north, and to outcrop in the Sierra Nevada foothills. The Tuscan Formation is comprised of four distinct units: A, B, C and D (although Unit D is

not present within the general project area). Unit A, or Upper Tuscan Formation, is composed of mudflow deposits with very low permeability and therefore is not important as a water source. Units B and C together are referred to as the Lower Tuscan Formation. Very few wells penetrate the Lower Tuscan Formation within the SCF Program study area.

(The Testing Plan EA/FONSI at p. 23). The Tehama Formation, however, generally behaves as a semi-confined aquifer system and the EA contains no discussion of its relationship with the adjoining formations. Nor is there any discussion of the role of the Pliocene Tehama Formation as “the primary source of groundwater produced in the area,” (DWR 2003).

The EA/FONSI fails to offer any in-depth analysis of the groundwater basins for both CVP and non-CVP groundwater substitution transfers, of the aquifers within the basins, and which strata in the aquifers in the basins will be most likely affected by the *2013 Water Transfer Program’s* proposed extraction of groundwater. This detailed information is also not found in the *Draft Technical Information for Water Transfers in 2013*. The *2010/2011 Water Transfer Program’s* EA did disclose information about the Sacramento Valley Groundwater Basin, but there is no direct reference to this in the Project’s EA. It must be emphasized that neither the Project nor the *2010/2011 Water Transfer Program’s* EAs revealed any understanding of aquifer strata or hydrostratigraphy.

In addition, the Project’s EA added the Anderson Cottonwood Irrigation District (ACID) to the CVP groundwater substitution transfers, which resides in a different groundwater basin. The Redding Basin is mentioned on page 21 of the EA, but nowhere is there a description of the basin, its potential sub-basins, strata, or hydrostratigraphy. What is presented are numerous conclusory statement attributed to ACID that assert that their part of the Project will not create impacts, but these are without demonstrable data and analysis. (EA at p. 23) The draft Project EA/FONSI fails to define the radius of influence associated with ACID’s groundwater extraction and thus entirely fails to identify potential significant impacts to tributaries, domestic and agricultural wells, as well as possible special status species. The *Redding Basin Water Resources Management Plan Environmental Impact Report* determined that there was an existing deficit of water need with Shasta County in 2005 and a greater deficit would exist by 2030. (p. 1-6) This begs the questions, why is ACID transferring river water out of the Sacramento Valley and substituting groundwater that could be used for local needs, and why didn’t the Bureau consider and present this information in the Project’s EA? Liability is a crucial component of potential third party impacts. As noted in this paragraph, the Project’s deficient EA does not reveal any information about the current status of the ground water basin, which indicates that there is not enough known about the aquifer to judge liability for damage from pumping. How will the Bureau and ACID rectify this for other ground water dependent users and the environment?

AquAlliance incorporates by reference the comments we submitted September 28, 2011 for the *Draft Environmental Assessment/Initial Study and Finding of No Significant Impact/Mitigated Negative Declaration for the Anderson-Cottonwood Irrigation District Integrated Regional Water Management Program – Groundwater Production Element Project*.

Thousands of domestic wells are in the upper layers of the target area-of-origin aquifers, but they are not even considered in the EA. In addition, the EA provides no assessment of the interrelationship of varying basins, sub-basins, or strata in the target aquifers in the Sacramento Valley.

The EA fails to provide basic background information regarding the recharge of groundwater in the different basins and sub-basins. The Project's EA excludes disclosure of this crucial information, but the *2010/2011 Water Transfer Program's EA* states, "Groundwater is recharged by deep percolation of applied water and rainfall infiltration from streambeds and lateral inflow along the basin boundaries," (*2010/2011 Water Transfer Program's EA* p. 3-10). We asked in 2010 and ask again here, how did the Bureau conclude that applied water leads to recharge of the aquifer? Where are the supporting data? This claim is unsubstantiated by any of the work that has been performed to date. For example, the RootZone water balance model used by a consultant with Glenn Colusa Irrigation District, Davids Engineering, was designed to simulate root zone soil moisture. It balances incoming precipitation and irrigation against crop water usage and evaporation, and whatever is left over is assigned to "deep percolation." Deep percolation in this case means below the root zone, which is anywhere from a few inches to several feet below the surface, depending on the crop. There is absolutely no analysis that has been performed to ensure that applied water does, indeed, recharge the aquifer. For example, if the surface soils were to dry out, water that had previously migrated below the root zone might be pulled back up to the surface by capillary forces. In any case, the most likely target of the "deep percolation" water in the Sacramento Valley is the unconfined, upper strata of the aquifer and possibly the Sacramento River. The Project's EA has not demonstrated otherwise.

A public hearing concerning the Monterey Agreement was held in Quincy on November 29, 2007, hosted by DWR. At the hearing Barbara Hennigan presented the following testimony: "So for the issues of protecting the water quality, protecting the stream flow in the Sacramento, one of the things that we have learned is that the Sacramento River becomes a permanently losing stream at the Sutter Buttes. When I first started looking at the water issues that point was at Grimes south of the [Sutter] buttes, now it is at Princeton, moving north of the buttes. As the Sacramento becomes a losing stream farther and farther north because of loss of the Lower Tuscan Aquifer, that means that it [sic], there will be less water that the rest of the State relies on," (http://www.water.ca.gov/environmentalservices/docs/mntry_plus/comments/Quincy.txt). How and when will the Bureau and DWR address this enormously important condition and amplify the risk to not only to the Northstate, but the entire State of California?

4. The EA contains numerous errors and omissions regarding groundwater resources.

There are numerous errors, omissions, and negligence in addressing existing conditions before and with the Project in Section 3, Affected Environmental and Environmental Consequences.

The failure to address stated problematic conditions and the lack of accuracy in this section of so many elemental issues and facts raises questions about the content of the entire EA and FOSI. A partial list of statements and questions follows.

- On pages 15 and 21 of the EA, the Sierra Nevada [mountain range] and “Pacific Coast Range” are identified, but there is no mention of the southern Cascade Range that is a prominent geologic feature of the northern Sacramento Valley, the genesis of the Sacramento River, and a significant contributor to the hydrology of the region.
- We are so pleased that the Bureau added the McCloud and the Pit rivers as “major tributaries” to the Sacramento River, as we requested in comments for the *2010/2011 Water Transfer Program*, but we note that the Project’s EA still fails to mention Battle, Mill, Big Chico, and Butte creeks, but now also excludes mention of Putah and Stony creeks in Section 3. These omissions again reflect an odd lack of understanding of the Cascade Range and the Sacramento River hydrologic region.
- The *2010/2011 Water Transfer Program’s* EA states quite straightforwardly on page 3-12 that, “Surface water and groundwater interact on a regional basis, and, as such, gains and losses to groundwater vary significantly geographically and temporally. In areas where groundwater levels have declined, such as in Sacramento County, streams that formerly gained water from groundwater now lose water to the groundwater system through seepage.” Both the *2010/2011 Water Transfer Program’s* EA and the Project’s EA fail to expand upon what was initiated in this quotation: What is the geographic extent of this far-reaching and hydrologically essential pre-project understanding and how that has changed already from the baseline that we continue to believe is the year 2000? This *alone* requires substantive environmental review under NEPA and CEQA.
- *Id.* Page 3-12. “Groundwater production in the basin has recently been estimated to be about 2.5 million acre-feet or more in dry years.” What is the citation for this assertion?
- *Id.* Page 3-12. “Historically, groundwater levels in the Basin have remained steady, declining moderately during extended droughts and recovering to pre-drought levels after subsequent wet periods. DWR extensively monitors groundwater levels in the basin. The groundwater level monitoring grid includes active and inactive wells that were drilled by different methods, with different designs, for different uses. Types of well use include domestic, irrigation, observation, and other wells. The total depth of monitoring grid wells ranges from 18 to 1,380 feet below ground surface.” As presented above, groundwater levels have been changing, historically. Since the Bureau and DWR have access to a monitoring grid, for NEPA and CEQA compliance, they must present current facts, not general statements that relate to social science.
- *Id.* Page 3-12. “In general, groundwater flows inward from the edges of the basin and south parallel to the Sacramento River. In some areas there are groundwater depressions associated with extraction that influence local groundwater gradients.” Where are the groundwater depressions? How have they affected groundwater gradients? How will the Project exacerbate a negative existing condition?
- *Id.* Page 3-12. “Prior to the completion of CVP facilities in the area (1964-1971), pumping along the west side of the basin caused groundwater levels to decline. Following construction of the Tehama-Colusa Canal, the delivery of surface water and reduction in

groundwater extraction resulted in a recovery to historic groundwater levels by the mid to late-1990s.” Please provide the citation(s).

- *Id.* Pg 3-15 "According to the SWRCB, there are no elevated concentrations of arsenic or selenium in the Sacramento Groundwater Basin." The GAMA domestic well Project, Tehama County Focus Area, 2009, Arsenic in Domestic and Public Wells indicates variable levels of arsenic in the cited basin. The study found that, "Fourteen percent of the wells [in the Tehama County focus area] had concentrations of both arsenic and iron above their associated CDPH MCLs or secondary MCLs."
- *Id.* Page 3-15. "The State Water Code (Section 1745.10) requires that for short term water transfers, the transferred water may not be replaced with groundwater unless the following criteria are met (SWRCB 1999)..."
 - No matter how the Bureau and DWR attempt to present the Project as a "short-term water transfer," it is factually one of a series of actions in multiple years by the agencies, sellers, and buyers without the benefit of comprehensive environmental analysis under NEPA and CEQA as AquAlliance revealed in comments for the *2010/2011 Water Transfer Program EA/FONSI* and the Project's EA/FONSI.
 - *Id.* Page 3-16. "California Water Code Section 1810 and the CVPIA protect against injury to third parties as a result of water transfers. Three fundamental principles include (1) no injury to other legal users of water; (2) no unreasonable effects on fish, wildlife or other in-stream beneficial uses of water; and (3) no unreasonable effects on the overall economy or the environment in the counties from which the water is transferred. These principles must be met for approval of water transfers." Without monitoring and mitigation plans presented for review, the public has no means with which to determine the effectiveness of lack of effectiveness of the Bureau's decision to defer all responsibility in the areas of origin onto the "willing sellers" and the unsuspecting public and environment. The Bureau, at minimum, must at least *disclose*
 - How the Project will prevent "[i]njury to other legal users of water" including the environment?
 - How the Project will prevent "[u]nreasonable effects on fish, wildlife or other in-stream beneficial uses of water?"
 - And how the Project will prevent "[u]nreasonable effects on the overall economy or the environment in the counties from which the water is transferred?"

The disclosures and analyses contained in the *2010/2011 Water Transfer Program EA/FONSI*, its appendices, and the Project's EA/FONSI are inadequate to satisfy the California Water Code requirements and the Bureau's requirements under the CVPIA and NEPA. DWR has clearly failed its obligations under CEQA by providing no disclosure or analysis at all.

E. Other resource impacts flowing from corrected chains of cause and effect are unrecognized in the EA and should be considered in an EIS instead.

Regarding surface water reservoir operations in support of the *2013 Water Transfer Program*, we have several questions and concerns:

- Regarding fisheries, do the Bureau and DWR intend to comply with the State Water Resources Control Board's Water Rights Orders 90-05 and 91-01 in order to provide temperature control at or below 56 degrees Fahrenheit for anadromous fish, their redds, and hatching wild salmonid fry, and to provide minimum instream flows of 3,250 cubic feet per second (cfs) between September 1 and February 28, and 2,300 cfs between March 1 and August 31? How will the Bureau and DWR comply with Fish and Game Code Section 5937—to keep fish populations below and above their dams in good condition, as they approve transfers of CVP water from willing CVP and non-CVP contractors to willing buyers? Please reflect on our comments and fish population data above, which demonstrate that the SWP and CVP have a horrendous record since 2000 keeping fish alive, let alone thriving or recovering.
- Regarding public health and safety, the *2010/2011 Water Transfer Program's* EA negligently denies the potential for impacts (p.3-1) and the Project's EA doesn't even bring up the topic. Fluctuating domestic wells can lead to serious contamination from heavy metals and non-aqueous fluids. Additionally, there are numerous hazardous waste plumes in Butte County, which could easily migrate with the potential increased groundwater pumping proposed for the Project. Because the Bureau fails to disclose basic standards for the mitigation and monitoring requirements, it is unknown if hazardous plumes in the areas of origin will be monitored or not. Please note the attached map from the State Water Resources Control Board (2008) that highlights areas vulnerable to groundwater contamination throughout the state. A significant portion of both the areas of origin and the receiving areas are highlighted. When the potential for serious health and safety impacts exists, NEPA and CEQA require that this must be disclosed and analyzed.

In general, the *2013 Water Transfer Program* EA/FONSI—and by logical implication, DWR's actions—consistently avoids full disclosure of existing conditions and baseline data, rendering the Bureau's justifications for the *2013 Water Transfer Program* at best incoherent, and at worst, dangerous to groundwater dependent communities and businesses, domestic well owners, and vulnerable fisheries in tributary streams of the Sacramento River hydrologic region.

F. The *2013 Water Transfer Program* is likely to have a cumulatively significant impact on the environment.

The draft EA/FONSI does not reveal that the current Project is part of a much larger set of plans to develop groundwater in the region, to develop a “conjunctive” system for the region, and to integrate northern California's groundwater into the state's water supply. These are plans that the Bureau, together with DWR, sellers, and other have pursued and developed for many years. Indeed, one of the plans—the short-term phase of the Sacramento Valley Water Management

Program—is the subject of an ongoing scoping process for a Programmatic EIS that has not yet been completed.⁶

In assessing the significance of a project’s impact, the Bureau must consider “[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.” 40 C.F.R. §1508.25(a)(2). A “cumulative impact” includes “the impact on the environment which results from the incremental impact of the action when added to *other past, present and reasonably foreseeable future actions* regardless of what agency (Federal or non-Federal) or person undertakes such other actions.” *Id.* §1508.7. The regulations warn that “[s]ignificance cannot be avoided by terming an action temporary or by breaking it down into small component parts.” *Id.* §1508.27(b)(7).

An environmental impact statement should also consider “[c]onnected actions.” *Id.* §1508.25(a)(1). Actions are connected where they “[a]re interdependent parts of a larger action and depend on the larger action for their justification.” *Id.* §1508.25(a)(1)(iii). Further, an environmental impact statement should consider “[s]imilar actions, which when viewed together with other *reasonably foreseeable or proposed agency actions*, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography.” *Id.* §1508.25(a)(3) (emphasis added).

As provided in details below, instead of assessing the cumulative impacts of the proposed action as part of the larger program that even the Bureau has recognized should be subject to a programmatic EIS (but for which no programmatic EIS has been completed), the Bureau has attempted to separate this program and approve it through another inadequate EA. Further, the Bureau has failed to take into account the cumulative effects of other groundwater and surface water projects in the region, the development of “conjunctive” water systems, and the anticipated further integration of Sacramento Valley surface and ground water into the state water system.

The Bureau’s attempts to frame the *2013 Water Transfer Program* as an isolated *de minimis* project is a shell game, whereby an analysis of the cumulative impacts of individual actions is avoided in direct contravention of NEPA. *See Blue Mountains Biodiversity Project v. United States Forest Service*, 161 F.3d 1208, 1215 (9th Cir. 2008).

G. The Environmental Assessment Fails to Meet the Requirements of NEPA.

Even if an EIS was not clearly required here, which we believe it is, the draft EA/FONSI prepared by the Bureau violates NEPA on its own. As discussed above, the draft EA does not provide the analysis necessary to meet NEPA’s requirements and to support its proposed finding of no significant impact. Further, as outlined above, the draft document fails to provide a full and accurate description of the proposed Project, its purpose, its relationship to myriad other water transfer and groundwater extraction projects, its potentially significant adverse effects on salmon

⁶ *Id.* page 3.

critical habitat in streams of interest that are tributaries to the Sacramento River, and an assessment of the cumulative environmental impacts of the *2013 Water Transfer Program* when considered together with past, present, and reasonably foreseeable projects, plans, and actions of not only the Bureau and DWR, but also with the past, present, and reasonably foreseeable projects, plans, and actions of others.

Additionally, the draft EA/FONSI fails to provide sufficient evidence to support its assertions that the *2013 Water Transfer Program* would have no significant impacts on the human or natural environments, so neither decision makers nor the public are fully able to evaluate the significance of the *2013 Water Transfer Program*'s impacts. These informational failures complicate AquAlliance's efforts to provide meaningful comments on the full extent of the potential environmental impacts of the Project and on appropriate monitoring and mitigation measures. Accordingly, many of the AquAlliance's comments include requests for additional information.

1. The EA Fails to Consider a Reasonable Range of Alternatives.

NEPA's implementing regulations call for analysis of alternatives is "the heart of the environmental impact statement," 40 C.F.R. §1502.14, and they require an analysis of alternatives within an EA. *Id.* §1408.9. The statute itself specifically requires federal agencies to: *study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning available uses of resources.*

42 U.S.C. §4332(2)(E). Here, because the Bureau's EA considers only the proposed Project and a "No Action" alternative, the EA violates NEPA.

The case law makes clear that an adequate analysis of alternatives is an essential element of an EA, and is designed to allow the decision maker and the public to compare the environmental consequences of the proposed action with the environmental effects of other options for accomplishing the agency's purpose. The Ninth Circuit has explained that "[i]nformed and meaningful consideration of alternatives ... is ... an integral part of the statutory scheme." *Bob Marshall Alliance v. Hodel*, 852 F.2d 1223, 1228 (9th Cir. 1988) (holding that EA was flawed where it failed adequately to consider alternatives). An EA must consider a reasonable range of alternatives, and courts have not hesitated to overturn EAs that omit consideration of a reasonable and feasible alternative. *See People ex rel. Van de Kamp v. Marsh*, 687 F.Supp. 495, 499 (N.D. Cal. 1988); *Sierra Club v. Watkins*, 808 F.Supp. 852, 870-75 (D.D.C. 1991).

Here, there are only two alternatives presented: the No Action and the Proposed Action. The lack of *any* alternative action proposal is unreasonable and is by itself a violation of NEPA's requirement to consider a reasonable range of alternatives.

Even more significantly, there are numerous other alternative ways to ensure water is allocated reliably when California experiences dry hydrologic years. We described several elements of

reasonable alternatives above. These are the alternatives that should have been presented for the Bureau's draft EA/FONSI on the *2013 Water Transfer Program* to comply with NEPA. 42 U.S.C. § 4332(2)(E).

2. The EA Fails to Disclose and Analyze Adequately the Environmental Impacts of the Proposed Action

The discussion and analysis of environmental impacts contained in the EA is cursory and falls short of NEPA's requirements, because it lacks a clear and well-described narrative for the proposed *2013 Water Transfer Program*. Please recall that the EA doesn't contain a "purpose" statement. This obscures realistic chains of cause and effect, which in turn prevent accurate and comprehensive accounting of environmental baselines and measurement of the DWB's potential impacts. NEPA's implementing regulations require that an EA "provide sufficient evidence and analysis for determining whether to prepare an [EIS]." 40 C.F.R. §1508.9(a). For the reasons discussed above, the EA fails to discuss and analyze the environmental effects of the water transfers and groundwater substitution proposed by the *2013 Water Transfer Program*. The Bureau must consider and address the myriad environmental consequences that are likely to flow from this proposed agency action.

Along with our significant concerns about the adequacy of the proposed monitoring, the draft EA/FONSI also fails to explain what standards will be used to evaluate the monitoring data, and on what basis a decision to modify or terminate the pumping would be made. In light of the document's silence on these crucial issues, the draft EA/FONSI's conclusion that there will not be significant adverse impacts withers quickly under scrutiny.

3. The EA Fails to Analyze Cumulative Impacts Adequately.

The Ninth Circuit Court makes clear that NEPA mandates "a useful analysis of the cumulative impacts of past, present and future projects." *Muckleshoot Indian Tribe v. U.S. Forest Service*, 177 F.3d 800, 810 (9th Cir. 1999). Indeed, "[d]etail is required in describing the cumulative effects of a proposed action with other proposed actions." *Id.* The very cursory cumulative effects discussion in the EA plainly fails to meet this standard.

As discussed throughout these comments, the proposed Project does not exist in a vacuum, is another transfer program in a series of many that have also been termed either "temporary," "short term," "emergency," or "one-time" water transfers, and is cumulative to numerous broad programs or plans to develop regional groundwater resources and a conjunctive use system. The *2013 Water Transfer Program* is also only one of several proposed and existing projects that affect the regional aquifers. The existence of these numerous related projects makes an adequate analysis of cumulative impacts especially important.

4. The Bureau Has Segmented the Project Over Many Years

The Bureau's participation in planning, attempting to execute, and sometimes executing the following programs, plans and projects has circumvented the requirements of NEPA. DWR's failure to conduct comprehensive environmental review has segmented a known project for decades, which means that the Bureau is also failing to comply with state law as the CVPIA mandates. (EA at p. 10) Such segments include:

- The Sacramento Valley Water Management Agreement was signed in 2002 and the need for a programmatic EIS/EIR was clear and the process was initiated, but never completed.⁷
- Sacramento Valley Integrated Regional Water Management Plan (2006).
- The Sacramento Valley Water Management Plan. (2007)
- The Stony Creek Fan Partnership Orland Project Regulating Reservoir Feasibility Investigation.
- GCID's *Stony Creek Fan Aquifer Performance Testing Plan* to install seven production wells in 2009 that will extract 26,530 AF of groundwater as an experiment.
- GCID's Lower Tuscan Conjunctive Water Management Program (Bureau provided funding).
- GCID's water transfers in 2008 and in 2010.
- California Drought Water Bank for 2009.
- The Bureau of Reclamation's 2010/2011 Water Transfer Program of 395,910 af of CVP and non-CVP water with 154,237 AF of groundwater substitution (EA/FONSI p. 2-4 and 3-107) and
- The planned 2012 water transfers of 76,000 af of CVP water all through ground water substitution.
- The Bureau of Reclamation's 600,000 AF, North-to-South Water Transfer Program. EIS/EIR pending.
- The Bay Delta Conservation Plan.

5. The Bureau Has Failed to Consider the Cumulative Impact of Other Groundwater Development and Surface Water Diversions Affecting the Region

In addition to the improper segmentation evident by the Project EA/FONSI and the long list of projects and plans in Section 4 above, the assessment of environmental impacts is further deficient because the Bureau has failed to consider the cumulative impacts of the proposed groundwater extraction when taken in conjunction with other projects proposed for the development of groundwater and surface water.

⁷ *Id* p. 3

The Bureau, its contractors, and its partner DWR are party to numerous current and reasonably foreseeable water programs that are related to the water transfers contemplated in the Project EA including, but not limited to, the following:

- Sacramento Valley Integrated Regional Water Management Plan (2006)
- Sacramento Valley Regional Water Management Plan (January 2006)
- Stony Creek Fan Conjunctive Water Management Program
- Sacramento Valley Water Management Agreement (Phase 8, October 2001)
- Draft Initial Study for 2008-2009 Glenn-Colusa Irrigation District Landowner Groundwater Well Program
- Regional Integration of the Lower Tuscan Groundwater Formation into the Sacramento Valley Surface Water System Through Conjunctive Water Management (June 2005) (funded by the Bureau)
- Stony Creek Fan Aquifer Performance Testing Plan for 2008-09
- Annual forbearance agreements (2008 had an estimated 160,000 acre feet proposed).

We briefly describe some of their key elements here.

a) Stony Creek Fan Conjunctive Water Management Program. The SCF Aquifer Plan is part of and in furtherance of the Stony Creek Fan Conjunctive Water Management Program (“SCF Program”). This program is being carried out by GCID, Orland-Artois and Orland Unit Water Association.

The long-term objective of the SCF Program is the development of a “regional conjunctive water management program consisting of a direct and in-lieu recharge component, a groundwater production component, and supporting elements...” (SVWMA: Project 8A Stony Creek Fan Conjunctive Water Management Program (“SVWMA Project 8A”), at 8A-1). The potential supply from such a program was estimated at 50,000 af per year to 100,000 af per year. *Id.*

The SCF Program has three phases: (1) a feasibility study; (2) a demonstration project; and (3) project implementation. Phase I of the SCF Program has already been completed. The SCF Aquifer Plan described in a draft EA/FONSI is part of Phase II of the larger SCF Program. Phase III of the SCF Program will implement the program’s goal of integrating test and operational production wells into the water supply systems for GCID, Orland-Artois, and Orland Unit Water Association for long-term groundwater production in conjunction with surface water diversions.

The Bureau is well aware of the SCF Program, but declined to analyze the environmental effects of the program as a whole, and simply considered the effects of an isolated component of the larger program. Indeed, the Bureau awarded a grant to GCID to fund the SCF Program. The Bureau’s grant agreement states that the SCF Program “target[s] the Lower Tuscan Formation and possibly other deep aquifers in the west-central portion of the Sacramento Valley ... as the source for all or a portion of the additional groundwater production needed to meet [the SCF Partners’] respective integrated water management objectives.” BOR Assistance Agreement No.

06FG202103 at p. 2. The agreement further provides that “[a]dditional test wells and production wells will be installed within the Project Area.” *Id.*

b) The SCF Program is a Component of the Sacramento Valley Water Management Program. The Sacramento Valley Water Management Program (Phase 8) (“SVWMP”) also includes the SCF Program as one of its elements. (SVWMA Project 8A at pp. 8A-1 to 8A-13).

The SVWMP recognizes that the SCF Program “has the potential to improve operational flexibility on a regional basis resulting in measurable benefits locally in the form of predictable, sustainable supplies, *and improved reliability for water users’ elsewhere in the state.*” *Id.* at p. 8A-2 (emphasis added). By piecemealing this program improperly and analyzing only the small component of the SCF Program, the Bureau has failed to assess the environmental impacts associated not just with the anticipated conjunctive use of the groundwater, but also the effect of the anticipated export of water to other regions of the state.

Additionally, ten years ago, on August 5, 2003, the Bureau published a notice in the Federal Register announcing its intention to prepare a programmatic EIS to analyze the short-term phase of the SVWMP. 68 Fed. Reg. 46218, 46219 (Aug. 5, 2003). Like the SVWMP, this “Short-term Program” for which the Bureau stated its intent to conduct a programmatic EIS included implementation of the SCF Program. *Id.* at 46219, 46220.

c) The SCF Program is Also a Component of the Sacramento Valley Integrated Regional Water Management Program. The Bureau has been working with GCID and others to realize the Sacramento Valley Integrated Regional Water Management Program (“SVIRWMP”). SVIRWMP is comprised of a number of sub-regional projects, including the SCF Program. *See* SVIRWMP, Appendix A at A-5; BOR Assistance Agreement No. 06FG202103. Here again, even though the SCF Aquifer Plan is clearly a necessary component of the SCF Program – which is in turn a component of the SVIRWMP – the draft EA/FONSI failed to even acknowledge, let alone assess, the cumulative impacts of these related projects.

Most obviously, the draft EA wholly fails to assess the impact of the Bureau’s *Sacramento Valley Regional Water Management Plan (2006)* (SVRWMP) and the forbearance water transfer program that the Bureau and DWR facilitate jointly. As noted above, the Programmatic EIS for the 2002 Sacramento Valley Water Management Agreement or Phase 8 Settlement was initiated, but never completed, so the SVRWMP was the next federal product moving the Phase 8 Settlement forward. The stated purpose of the Phase 8 Settlement and the SVRWMP are to improve water quality standards in the Bay-Delta and local, regional, and statewide water supply reliability. In the 2008 forbearance program, 160,000 af was proposed for transfer to points south of the Delta. To illustrate the ongoing significance of the demand on Sacramento Valley water, we understand that GCID alone entered into “forbearance agreements” to provide 65,000 af of water to the San Luis and Delta Mendota Water Authority in 2008, 80,000 af to State Water Project contractors in 2005, and 60,000 af to the Metropolitan Water District of Southern California in 2003.

Less obvious, but certainly available to the Bureau, are the numerous implementation projects that Phase 8 signatories are pursuing, such as Glenn Colusa Irrigation District's (GCID) 2008 proposal to divert groundwater pumped from private wells to agricultural interests in the District. *See Attach.* (GCID Proposed Negative Declaration, GCID Landowner Groundwater Well Program for 2008-09). Additionally, the draft EA does not consider the cumulative effect of the Lower Tuscan Integrated Planning Program, a program funded by the Bureau that will "integrate the Lower Tuscan formation aquifer system into the management of regional water supplies." Grant Agreement at p. 4. This program, as described by the Bureau, will culminate in the presentation of a proposed water management program for the Lower Tuscan Formation for approval and implementation by the appropriate authorities. Clearly, the cumulative impact of this program and the *2013 Water Transfer Program's* proposed groundwater extraction should have been assessed.

d) There are serious concerns raised by the *2012 Water Transfer Program* to engage in conjunctive management of groundwater and surface water that are not even mentioned, let alone addressed, in the Project EA. For example, in 1994, following seven years of low annual precipitation, Western Canal Water District and other irrigation districts in Butte, Glenn and Colusa counties exported 105,000 af of water extracted from the Tuscan aquifers to buyers outside of the area. This early experiment in the *conjunctive use* of the groundwater resources – conducted without the benefit of environmental review – caused a significant and immediate adverse impact on the environment (Msangi 2006). Until the time of the water transfers, groundwater levels had dropped but the aquifers had sustained the normal demands of domestic and agricultural users. The water districts' extractions, however, lowered groundwater levels throughout the Durham and Cherokee areas of eastern Butte County (Msangi 2006). The water level fell and the water quality deteriorated in the wells serving the City of Durham (Scalmanini 1995). Irrigation wells failed on several orchards in the Durham area. One farm never recovered from the loss of its crop and later entered into bankruptcy. Residential wells dried up in the upper-gradient areas of the aquifers as far north as Durham.

Finally, with the myriad projects and programs that are ignored in the *2010/2011 Water Transfer Program's* EA and the Project's EA that have never been analyzed cumulatively, only the *2010/2011 Water Transfer Program's* EA discloses that there could be a *devastating* impact to groundwater: "The reduction in recharge due to the decrease in precipitation and runoff in the past years in addition to the increase in groundwater transfers would lower groundwater levels. Multi-year groundwater acquisition under cumulative programs operating in similar areas of the Sacramento Valley could further reduce groundwater levels. Groundwater levels may not fully recover following a transfer and may experience a substantial net decline in groundwater levels over several years. This would be a substantial cumulative effect," (EA p. 3-108). While the honesty is refreshing, the lack of comprehensive monitoring, mitigation, and project cessation mechanisms is startling. It is also noteworthy that this admission is not included in the Project's EA. This alone warrants the preparation of an EIS.

Here again, the current document does not discuss or analyze these potential impacts, their potential scope or severity, or potential mitigation efforts. Instead, it relies on the existence of local ordinances, plans, and oversight with the monitoring and mitigation efforts of individual “willing sellers” to cope with any adverse environmental effects. However, as we have shown above, for example, the Glenn County management plan is untested, does not provide adequate protection and monitoring, and relies on “voluntary” enforcement of the region’s important groundwater resources. To further clarify the inadequacy of relying on local plans and ordinances, Butte County’s Basin Management Objectives have no enforcement mechanism and Butte County’s Chapter 33, while it requires CEQA review for transfers that include groundwater, has never been tested. There is thus very limited local protection for groundwater within a county, and no authority or mechanism to influence pumping in a different county from a shared groundwater basin.

6. The 2013 Water Transfer Program is likely to serve as precedent for future actions with significant environmental effects.

As set forth above, this Project is part of a broader effort by the Bureau and DWR to develop groundwater resources and to integrate groundwater into the state system. For these reasons, the *2013 Water Transfer Program* is likely to “establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration” (40 C.F.R. §1508.27(b)(6)), and should be analyzed in an EIS.

7. The 2013 Water Transfer Program has potential adverse impacts for a threatened species.

As the Bureau of Reclamation is well aware, the purpose of the ESA is to conserve the ecosystems on which endangered and threatened species depend and to conserve and recover those species so that they no longer require the protections of the Act. 16 U.S.C. § 1531(b), ESA § 2(b); 16 U.S.C. § 1532(3), ESA §3(3) (defining “conservation” as “the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter are no longer necessary”). “[T]he ESA was enacted not merely to forestall the extinction of species (i.e., promote species survival), but to allow a species to recover to the point where it may be delisted.” *Gifford Pinchot Task Force v. U.S. Fish & Wildlife Service*, 378 F.3d 1059, 1069 (9th Cir. 2004). To ensure that the statutory purpose will be carried out, the ESA imposes both substantive and procedural requirements on all federal agencies to carry out programs for the conservation of listed species and to insure that their actions are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. 16 U.S.C. § 1536. See *NRDC v. Houston*, 146 F.3d 1118, 1127 (9th Cir. 1998) (action agencies have an “affirmative duty” to ensure that their actions do not jeopardize listed species and “independent obligations” to ensure that proposed actions are not likely to adversely affect listed species). To accomplish this goal, agencies must consult with the Fish and Wildlife Service whenever their

actions “may affect” a listed species. 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14(a). Section 7 consultation is required for “any action [that] may affect listed species or critical habitat.” 50 C.F.R. § 402.14. Agency “action” is defined in the ESA’s implementing regulations to “mean all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States.” 50 C.F.R. § 402.02.

The giant garter snake (“GGS”) is an endemic species to Central Valley California wetlands. (Draft Recovery Plan for the Giant Garter Snake (“DRP”) 1). The giant garter snake, as its name suggests, is the largest of all garter snake species, not to mention one of North America’s largest native snakes, reaching a length of up to 64 inches. Female GGS tend to be larger than males. GGS vary in color, especially depending on the region, from brown to olive, with white, yellow, or orange stripes. The GGS can be distinguished from the common garter snake by its lack of red markings and its larger size. GGS feed primarily on aquatic fish and specialize in ambushing small fish underwater, making aquatic habitat essential to their survival. Females give birth to live young from late July to early September, and brood size can vary from 10 to up to 46 young. Some studies have suggested that the GGS is sensitive to habitat change in that it prefers areas that are familiar and will not typically travel far distances.

The Project’s EA failure to discuss GGS is arbitrary and capricious. 1) Either the EA assertion on page 12 is incorrect stating that, “Idling rice fields would reduce the use of farm equipment...” in reference to emissions to air or the EA is failing to disclose impacts to GGS from fallowing. If there are plans to fallow, there will be potentially significant impacts to GGS and if fallowing won’t occur, emissions to air will not be reduced as claimed. Please clarify this. 2) Moving on, GGS depend on more than rice fields in the Sacramento Valley.⁸ “The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of (1) adequate water during the snake’s active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat...” (Id at p. 3) What analysis has occurred that removes GGS from consideration for potential significant impacts? If the 2013 Water Transfer Program will only use groundwater substitution to make river water sales possible, how will that affect streams, wetlands, and emergent, herbaceous wetland vegetation? How will it be monitored?

The Bureau’s Biological Assessment for the 2009 DWB disclosed that one GGS study in Colusa County revealed the “longest average movement distances of 0.62 miles, with the longest being 1.7 miles, for sixteen snakes in 2006, and an average of 0.32 miles, with the longest being 0.6 miles for eight snakes in 2007.” (BA at p.16) However, in response to droughts and other changes in water availability, the GGS has been known to travel up to 5 miles in only a few days,

⁸ **Programmatic Consultation with the U.S. Army Corps of Engineers**

404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo Counties, California

but the impacts on GGS survival and reproduction from such extreme conditions are unknown due to the deficiency in data and analysis.

Flooded rice fields, irrigation canals, streams, and wetlands in the Sacramento Valley can be used by the giant garter snake for foraging, cover and dispersal purposes. The Bureau's 2009 Biological Assessment acknowledged the failure of Bureau and DWR to complete the Conservation Strategy that was a requirement of the 2004 Biological Opinion. (BA at p. 19-20) To date it is still not done. What possible excuse delayed this essential planning effort?

The *2010/2011 Water Transfer Program* also proposed to delete or modify other mitigation measures previously adopted as a result of the EWA EIR process to substantially reduce significant impacts, but without showing they are infeasible. For example, the Bureau and DWR proposed to delete the 160 acre maximum for "idled block sizes" for rice fields left fallow rather than flooded and to substitute for it a 320 acre maximum. (See 2003 Draft EWA EIS/EIR, p. 10-55; 2004 Final EWA EIS/EIR, Appendix B, p. 18, Conservation Measure # 4.) There is no evidence to support this change. In light of the agencies failure to complete the required Conservation Strategy mentioned above and the data gathered in the Colusa County study, how can the EA suggest that doubling the fallowing acreage is in any way biologically defensible? The agencies additionally propose to delete the mitigation measure excluding Yolo County east of Highway 113 from the areas where rice fields may be left fallow rather than flooded, except in three specific areas. (See 2004 Final EWA EIS/EIR, Appendix B, p. 18, Conservation Measure # 2.) What is the explanation for this change? What are the impacts from this change?

Deleting these mitigation measures required by the EWA approval would violate NEPA and CEQA's requirements that govern whether, when, and how agencies may eliminate mitigation measures previously adopted under NEPA and CEQA. (See *Napa Citizens for Honest Government v. Napa County Board*.)

The *2010/2011 Water Transfer Program* failed to include sufficient safeguards to protect the giant garter snake and its habitat. The EA concluded, "The frequency and magnitude of rice land idling would likely increase through implementation of water transfer programs in the future. Increased rice idling transfers could result in chronic adverse effects to giant garter snake and their habitats and may result in long-term degradation to snake populations in the lower Sacramento Valley. In order to avoid potentially significant adverse impacts for the snake, additional surveys should be conducted prior to any alteration in water regime or landscape," (p. 3-110). To address this significant impact the Bureau proposed relying on the 2009 DWB Biological Opinion, which was a one-year BO. The expired BO highlighted the Bureau and DWR's avoidance of meeting federal and state laws stating, "This office has consulted with Reclamation, both informally and formally, approximately one-half dozen times over the past 8 years on various forbearance agreements and proposed water transfers for which water is made available for delivery south of the delta by fallowing rice (and other crops) or substituting other crops for rice in the Sacramento Valley. Although transfers of this nature were anticipated in our biological opinion on the environmental Water Account, that program expired in 2007 and, to

our knowledge, no water was ever made available to EWA from rice fallowing or rice substitution. The need to consult with such frequency on transfers involving water made available from rice fallowing or rice substitution suggests to us a need for programmatic environmental compliance documents, including a programmatic biological opinion that addresses the additive effects on giant garter snakes of repeated fallowing over time, and the long-term effects of potentially large fluctuations and reductions in the amount and distribution of rice habitat upon which giant garter snakes in the Sacramento Valley depend,” (p.1-2). AquAlliance agrees with the U.S. Fish and Wildlife Service that programmatic environmental compliance is needed under the Endangered Species Act, NEPA, CEQA, and the California Endangered Species Act.

It is conspicuously noticeable that GGS are not mentioned even if fallowing is not used although the statement from the EA on page 12 leaves some confusion. Increased groundwater extraction will impact the aquatic and terrestrial environment that GGS depend upon. The Bureau should also prepare an EIS because the *2013 Water Transfer Program* will, in combination with all its past and reasonably foreseeable plans, programs, and projects, likely have significant environmental effects on the Giant Garter Snake, a listed threatened species under the federal Endangered Species Act and California Endangered Species Act. 40 C.F.R. §1508.27(b)(9).

In addition to GGS, as discussed above, unsupported assertions, that impacts to aquatic species will be below a level of significance, ring hollow and lack foundational data (EA at pp. 10, 12, 17). Habitat values are also essential to many other special status species that utilize the aquatic and/or riparian landscape including, but not limited to, giant garter snake, bank swallow, greater sandhill crane, American shad, and more. Where is the documentation of the potential impacts to these species?

II. Purpose and Need Issues of the *2013 Water Transfer Program*

A. The Purpose and Need Section of the EA/FONSI fails to specify the policy framework upon which the *2013 Water Transfer Program* is based.

As mentioned many times, the Project’s EA/FONSI fails to provide a statement of purpose, and the need statement on page 4 is cursory at best. Avoiding the requirements of NEPA, and for DWR – CEQA, for the *2013 Water Transfer Program* does not reflect the actual environmental effects of the proposal—which are similar to the proposed 1994 Drought Water Bank and for which a final Program Environmental Impact Report was completed in November 1993. In 2000, the Governor’s Advisory Drought Planning Panel report, *Critical Water Shortage Contingency Plan* promised a program EIR on a drought-response water transfer program, but it was never undertaken. Twice in recent history, the state readily acknowledged that CEQA review for a major drought water banking program was appropriate. So, the 2009 DWB Notice of Exemption and complete avoidance of CEQA review for the *2013 Water Transfer Program* reflects an ongoing end-run around established water law and CEQA.

We question the merits of and need for the *2013 Water Transfer Program* itself. The need for transfers reflects less on the type of water year than on the failures by the Agencies to pursue a sensible water policy framework, given that California has a Mediterranean climate with major fluctuations in precipitation and long periods of drought (Anderson, 2009). AquAlliance believes that the Agencies continue to avoid the inconvenient truths about California's climate, the current and future needs from climate change, and go too far to help a few junior water right holders. The Project intends to directly benefit the areas of California whose water supplies are the least reliable by operation of state water law. Though their unreliable supplies have long been public knowledge, local, state, and federal agencies in these areas have failed to stop blatantly wasteful uses and diversions of water and to pursue aggressive planning for regional water self-sufficiency.

The EA/FONSI fails to provide a statement of purpose and the need statement on page 4 is cursory at best. At a minimum, a purpose statement must be presented in the EA and clearly identified. The purpose and need statements should also include specific criteria and a delineation of priorities that the Project must adhere to, but they are absent.

The EA/FONSI makes no attempt to place the *2013 Water Transfer Program* into the context of the 2009 California Water Plan that the state most recently completed, which contains many recommendations for increasing regional water self-sufficiency, but it appears that this plan is largely on the shelf now. Pursuing watershed self-sufficiency would be a proactive and sustainable through the many types of water years, which is why many coastal communities are aggressively meeting this challenge. It is distressing to see that the Bureau and the state of California resist such as strategy and continue to pursue multi-year, serial, "temporary" water transfers and large engineering projects that are prohibitively costly and low in water and environmental benefits. This is not a sustainable water policy for California.

The missing purpose section and weak need sections of the Project's EA/FONSI, the *2010/2011 Water Transfer Program*, and the *2009 Governor's drought emergency declaration* cry out for a cogent policy framework. What is the state doing to facilitate regional water self-sufficiency for these areas with the least reliable water rights and how is the Bureau assisting or motivating such action? Instead, the state and federal response to another dry year falls back on the continuation of multi-year, serial, "temporary" water transfers.

B. The 2013 Water Transfer Program is not needed because the state's current allocation system—in which the federal Bureau of Reclamation participates—wastes water profligately.

The incentive from the state's lax system of regulation of California's State Water Project and Central Valley projects is to deliver the water now, and worry about tomorrow later. Indeed, the State Water Resources Control Board (SWRCB) has been AWOL for decades. In response to inquiries from the Governor's Delta Vision Task Force in 2009, the SWRCB acknowledged that

while average runoff in the Delta watershed between 1921 and 2003 was 29 million acre-feet annually, the 6,300 active water right permits issued by the SWRCB is approximately 245 million acre-feet. In other words, **water rights on paper are 8.4 times greater than the real water in California streams diverted to supply those rights on an average annual basis.** *And the SWRCB acknowledges that this “water bubble” does not even take account of the higher priority rights to divert held by pre-1914 appropriators and riparian water right holders, of which there are another 10,110 disclosed right holders. Many more remain undisclosed.*

Like federal financial regulators failing to regulate the shadow financial sector, subprime mortgages, Ponzi schemes, and toxic assets of our recent economic history, the state of California has been derelict in its management of scarce water resources. As we mentioned above we are supplementing these comments on this matter of wasteful use and diversion of water by incorporating by reference the 2011 complaint to the State Water Resources Control Board of the California Water Impact Network the California Sportfishing Protection Alliance, and AquAlliance on public trust, waste and unreasonable use and method of diversion as additional evidence of a systematic failure of governance by the State Water Resources Control Board, the Department of Water Resources and the U.S. Bureau of Reclamation, filed with the Board on April 21, 2011 (attached).

We question the Bureau and DWR’s desire for the Project, since reservoir levels throughout California are quite decent and groundwater is and will be necessary to support river and stream flows, aquatic and terrestrial species, and economic activity in the areas origin as California grapples with unpredictable, but well known, precipitation patterns and climate change. Don Pedro Reservoir on the Tuolumne River is at 98 percent of historic average. (CDEC, May 20, 2013)⁹ The CVP’s Millerton is at 99% and Folsom is at 90%. *Id* These two reservoirs must provide water to the agricultural San Joaquin River Exchange Contractors first, and they have among the most senior rights on that river. Rice growers in the Sacramento Valley are receiving full deliveries from the CVP’s Shasta reservoir (88% of historic average) and their Yuba River water supplies. *Id* The CVP’s own New Melones Reservoir on the Stanislaus River, which contributes to Delta water quality as well as to meeting eastern San Joaquin Valley irrigation demands, is at 91 percent of normal for this time of year. *Id*

Moreover, the SWP’s terminal reservoirs at Pyramid (104 percent of average) and Castaic (93 percent of average) Lakes are slightly above and below normal levels for this time of year, presumably because DWR has been releasing water from Oroville (96% historic average) for delivery to these reservoirs. *Id*

We acknowledge that the snowpack is very poor this year.¹⁰ The fact that reservoirs of the CVP and SWP with more senior responsibilities in the water rights hierarchy are doing so well, but

⁹ <http://cdec.water.ca.gov/cdecapp/resapp/getResGraphsMain.action>

¹⁰ <http://cdec.water.ca.gov/snow/>

admittedly there is so little to refill them, certainly suggests caution for deliveries. Still, given what is known, these reservoir levels indicate that most major cities and most Central Valley farmers are very likely to have enough water for this year. The demands by junior water rights holders, who expect to receive little water this year, do so because of the low priority of their water service contracts within the Central Valley Project—their imported surface supplies are therefore less reliable in dry times. It is the normal and appropriate functioning of California’s system of water rights law that makes it so.

The efforts of the Bureau and DWR to initiate water sales from the Sacramento, Feather, and Yuba rivers with groundwater substitution are only intended to benefit the few western San Joaquin Valley farmers whose contractual surface water rights have always been less reliable than most—and whose lands are the most problematic for irrigation. Since these growers have chosen to harden demand by planting permanent crops, a very questionable business decision, will the Bureau please explain why this “tail” in water rights is wagging the dog? Compounding the insanity of growing perennial crops in a desert is the result where in excess of 1 million acres of irrigated land in the San Joaquin Valley and the Tulare Lake Basin are contaminated with salts and trace metals like selenium, boron, arsenic, and mercury. This water drains back—after leaching from these soils the salts and trace metals—into sloughs and wetlands and the San Joaquin River, carrying along these pollutants. Retirement of these lands from irrigation usage would stop wasteful use of precious fresh water resources and help stem further bioaccumulation of these toxins that have settled in the sediments of these water bodies.

The *2013 Water Transfer Program* would exacerbate pumping of fresh water from the Delta, which has already suffered from excessive pumping over the last 12 years. Pumped exports cause reverse flows to occur in Old and Middle Rivers and can result in entrainment of fish and other organisms in the pumps. Pumping can shrink the habitat for Delta smelt as well, since less water flows out past Chippis Island through Suisun Bay, which Delta smelt often prefer. AquAlliance shares the widely held view that operation of the Delta export pumps is the major factor causing the Pelagic Organism Decline (POD) and in the deteriorating populations of fall-run Chinook salmon. The State Water Resources Control Board received word in early December that the Fall Midwater Trawl surveys for September and October 2012 showed horrendous numbers for the target species. The indices for longfin smelt, splittal, and threadfin shad reveal the lowest in history.¹¹ Delta smelt, striped bass, and American shad numbers remain close to their lowest levels. *Id*

New capital facilities should be avoided to save on costly, unreliable, and destructive water supplies that new dams and massive, 40-foot diameter “peripheral tunnels” represent. Moreover, these facilities would need new water rights; yet the most reliable rights in California are always the ones that already exist—and of those, they are the ones that predate the California State Water Project and the federal Central Valley Project. We should apply our current rights far more efficiently—and realistically—than we do now. California should instead pursue a “no-

¹¹ <http://www.dfg.ca.gov/delta/data/fmwt/Indices/index.asp>

regrets” policy incorporating aggressive water conservation strategies, careful accounting of water use, research and technological innovation, and pro-active investments.¹²

III. General Comments

1. Where are the materials required in the Criteria Checklist for Complete Written Transfer Proposals, Appendix 1 of the 1993 *Interim Guidelines for Implementation of the Water Transfer Provisions of the Central Valley Project Improvement Act (Title XXXIV of Public Law 102-575)*? In particular, where are the following: “Comprehensive ground-water basin study or evaluation of ground-water supplies demonstrating transfer will have no significant long-term adverse impacts on ground-water conditions, inter-related surface streams, or other ground-water supplies in Project service area; OR Comprehensive evaluation of the potential impact on ground-water supplies accompanied by an adopted ground-water management plan?”
 - (3) Location map of ground-water well(s) to be utilized.
 - (4) Drillers log for ground-water well(s) to be utilized.
 - (5) Provide location of other ground-water wells in Project service area.
 - (6) Identify and document area(s) normally irrigation by wells.”
2. How is the EA cumulative total for transfers, 190,906 AF, reached (p. 29)? The direct Project impacts are listed as 37,505 AF (EA at p. 9), the non-CVP groundwater substitution is 92,806, non-CVP reservoir water is 95,000, and other non-CVP water is 3,100 (EA at p. 31). It would help the public understand the proposed Project if the total quantity of water involved in the Project wasn’t so opaque.
3. The following paragraph in the EA raises numerous questions and concerns.

“Reclamation approves transfers consistent with provisions of state law and/or the CVPIA that protect against injury to third parties as a result of water transfers. Several important CVPIA principles include requirements that the transfer will not violate the provisions of Federal or State law, will have no significant adverse effect on the ability to deliver CVP water, will be limited to water that would have been consumptively used or irretrievably lost to beneficial use, will have no significant long-term adverse impact on groundwater conditions, and will not adversely affect water supplies for fish and wildlife purposes. Reclamation will not approve any transfer of water for which these basic principles have not been adequately addressed.” (EA at p. 10)

 - a. How is water for the Project considered, “[c]onsumptively used or irretrievably lost to beneficial use,” with groundwater substitution in the Sacramento Valley? Page 4 of the *Interim Guidelines for Implementation of the Water Transfer Provisions of the Central Valley Project*

¹² See especially, Pacific Institute, *More with Less: Agricultural Water Conservation and Efficiency in California, A Special Focus on the Delta*, September 2008; Los Angeles Economic Development Corporation, *Where Will We Get the Water? Assessing Southern California’s Future Water Strategies*, August 2008, and Lisa Kresge and Katy Mamen, *California Water Stewards: Innovative On-farm Water Management Practices*, California Institute for Rural Studies, January 2009.

Improvement Act (Title XXXIV of Public Law 102-575) define irretrievable loss to beneficial use as “[d]eep percolation to an unusable groundwater aquifer (e.g., saline sink or a groundwater aquifer that is polluted to the degree that water from the aquifer cannot be directly used.” The groundwater basins that are part of the Project do not fit this definition.

- b. The groundwater pumped for the Project is a substitute and would not have been used consumptively except for the sale of river water. This violates section H of the *Interim Guidelines for Implementation of the Water Transfer Provisions of the Central Valley Project Improvement Act (Title XXXIV of Public Law 102-575)* (p. 4)

If the Project is approved, it flies in the face of CVPIA requirements.

4. Shasta County is not listed in the Affected Environment section although Anderson Cottonwood Irrigation District is participating in the proposed Project (EA at p. 21). If the Bureau intended to identify the counties by groundwater basin, the EA must call out the Redding Basin and Shasta County.

IV. Conclusion

The Bureau’s *2010/2011 Water Transfer Program’s* EA/FONSI stated on page 3-16: *California Water Code Section 1810 and the CVPIA protect against injury to third parties as a result of water transfers. Three fundamental principles include (1) no injury to other legal users of water; (2) no unreasonable effects on fish, wildlife or other in-stream beneficial uses of water; and (3) no unreasonable effects on the overall economy or the environment in the counties from which the water is transferred.*

The current Project’s EA/FONSI presents this differently:

- “Reclamation approves transfers consistent with provisions of state law and/or the CVPIA that protect against injury to third parties as a result of water transfers.” (EA at p.12)
- “[w]ill not adversely affect water supplies for fish and wildlife purposes.” (EA at p.12)
- Adds, “[w]ill have no significant long-term adverse impact on groundwater conditions...” (EA at p. 12)
- Omits, “[n]o unreasonable effects on the overall economy or the environment in the counties from which the water is transferred.” 2020/2011 Water Transfer Program EA at p. 3-16)

We unreservedly state to you that the two draft EA/FONSI, since the *2010/2011 Water Transfer Program’s* EA/FONSI is incorporated by reference, appear to describe a project, since they are quite similar, that would fail all of the tests required by the CVPIA and state law as currently described. The *2010/2011 Water Transfer Program* had and the *2013 Water Transfer Program* clearly has the potential to affect the human and natural environments, both within the

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Sacramento Valley as well as in the areas of conveyance and delivery. It is entirely likely that injuries to other legal users of water, including those entirely dependent on groundwater in the Sacramento Valley, will occur if this project is approved. Groundwater, fishery and wildlife resources are also likely to suffer harm as instream users of water in the Sacramento Valley as well as terrestrial habitat upon which fishery and wildlife resources depend. And the economic effects of the proposed Project are at best poorly understood through the EA/FONSI. To its credit, at least the Bureau studied the proposed project, while DWR has completely avoided CEQA, thereby enabling the agency to ignore these potential impacts outside a courtroom.

Taken together, the Bureau and DWR treat these serious issues carelessly in the EA/FONSI, the *Draft Technical Information for Water Transfers in 2013* and in DWR's specious avoidance of CEQA review. In so doing, the Agencies deprive decision makers and the public of their ability to evaluate the potential environmental effects of this Project and violate the full-disclosure purposes and methods of both the National Environmental Policy Act and the California Environmental Quality Act.

Sincerely,

A handwritten signature in black ink, appearing to read "B. Vlamis". The signature is fluid and cursive, with a prominent flourish at the end.

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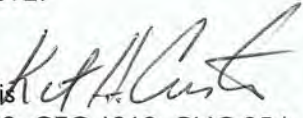
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RE: Comments and Recommendations on U.S. Bureau of Reclamation and San Luis & Delta-Mendota Water Authority Draft Long-Term Water Transfer DRAFT EIS/EIR, dated September 2014

This letter provides comments and recommendations on the information provided in the September 2014 Draft Long-Term Water Transfer Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) prepared by the U.S. Bureau of Reclamation (BoR) and San Luis & Delta-Mendota Water Authority (SLDMWA). This document evaluates the potential impacts of alternatives over a 10-year period, 2015 through 2024, for transferring Central Valley Project (CVP) and non-CVP water from north of the Sacramento-San Joaquin Delta (Delta) to CVP contractors south of the Delta. These transfers require the use of CVP and State Water Project (SWP) facilities. This Draft EIS/EIR evaluated impacts of alternatives for water transfers made available through groundwater substitution, cropland idling, crop shifting, reservoir release, and conservation.

This letter focuses mostly on the groundwater substitution element of the transfers for the Sacramento Valley groundwater basin and provides comments and recommendations regarding the potential impacts, technical information submitted, and monitoring and mitigation measures. Comments and recommendations are also provided regarding the biological resources, crop idling/crop shifting when those resources or activities impact or are impacted by the groundwater substitution transfers. This letter has two parts. The first part comments on the Draft Long-Term Water Transfer Draft EIS/EIR. The second part provides additional technical information on surface water-groundwater interactions that are relevant to the evaluation of potential impacts from the proposed water transfers, monitoring during the transfers and designing and implementing mitigation measures.

I. Comments and Recommendations on the Draft Long-Term Water Transfer DRAFT EIS/EIR

The Draft EIS/EIR evaluated a number of potential environmental impacts from the groundwater substitution transfers using a finite element groundwater model, SACFEM2013. The potential impacts evaluated include: groundwater levels; surface water flow; water quality; biological resources, including vegetation, wildlife and fisheries; and the associated cumulative effects and impacts. Two mitigation measures, WS-1 and GW-1, are provided for monitoring and

mitigating potential impacts from groundwater substitution transfers. I will provide comments and recommendations on these topics following seven comments and recommendations on general issues, assumptions and methods that are used throughout the Draft EIS/EIR.

General Comments

- I. The Draft EIS/EIR has an underlying assumption that specific information on each proposed transfer will be evaluated in the future by the Bureau of Reclamation, the California Department of Water Resources (DWR), perhaps the California State Water Resources Control Board (SWRCB), and local agencies, presumably the County, or other designated local agency (Sections 1.5, 3.1.4.1-WS-1 and 3.3.4.1-GW-1). The Draft EIS/EIR relies on the results of the SACFEM2013 groundwater modeling effort to validate the conclusion of less than significant and reasonable impacts that cause no injury from the groundwater substitution transfer pumping. This conclusion is reached based on model simulation results, and assumption of implementation of mitigation measures WS-1 and GW-1. However, the Draft EIS/EIR provides only limited information on the wells to be used in the groundwater substitution transfers (see Table 3.3-3), and no information on non-participating wells that may be impacted. Information that is still needed to evaluate the potential impacts simulated by the groundwater modeling and the potential significance of the groundwater substitution transfer pumping includes, but isn't limited to:
 - a. proposed transfer wells locations that are sufficiently accurate to allow for determination of distances between the wells and areas of potential impact,
 - b. the distances between the transfer wells and surface water features,
 - c. the number of non-participating wells in the vicinity of the transfer wells that may be impacted by the pumping,
 - d. the distance between the transfer wells and non-participant wells that may be impacted by the transfer pumping, including domestic, public water supply and agricultural wells,
 - e. the number of non-participating wells in the vicinity of the transfer wells that can be expected to be pumped to provide public water supply or irrigation water during the same period as the transfer pumping,
 - f. the amount of well interference anticipated at each of the non-participating domestic, public water supply and agricultural wells in the vicinity of transfer wells,
 - g. the aquifers that the non-participating wells in the vicinity of the transfer wells are drawing groundwater from,
 - h. groundwater level hydrographs near the non-participating and participating transfer wells, to document the pre-transfer trends and fluctuations in groundwater elevations in order to evaluate the current conditions and serve as a reference for monitoring impacts from transfer pumping,
 - i. the identity and locations of wells that will be used to monitor groundwater substitution transfer pumping impacts, the aquifers these wells are monitoring, frequency for taking and reporting measurements, and the types and methods for monitoring and reporting,
 - j. groundwater level decline thresholds at each monitoring well that require actions be taken to reduce or cease groundwater substitution transfer pumping to prevent impacts from excessive drawdown, including impacts to non-participating wells, surface water features, fisheries, vegetation and wildlife, other surface structures, and regional economics.

This list addresses only the minimum of information needed about the groundwater wells and does not address other elements of the groundwater substitution transfer, which I will discuss under separate sections, including the WS-1 and GW-1 mitigation measures, the SACFEM2013 groundwater modeling effort, and stream depletion impacts.

I recommend the Draft EIS/EIR be revised to include the additional well information and monitoring requirements listed above. I recommend that mitigation measures WS-1 and GW-1 be revised to provide specific requirements for monitoring, thresholds of significance, and actions to be taken when the thresholds are exceeded.

2. The only maps provided by the Draft EIS/EIR that show the location of the groundwater substitution transfer wells, and the rivers and streams potentially impacted are the simulated drawdown Figures 3.3-26 to 3.3-31, which are at a scale of approximately 1 inch to 18 miles on letter size paper. These figures show clusters of wells and several rivers, creeks and canals. A few are labeled, but apparently not all of the streams and creeks evaluated for groundwater substitution impacts are shown. Figures 3.7-1 and 3.8-2 show the major rivers and reservoirs evaluated in the biological analyses, and Tables 3.7-2, 3.7-3, and 3.8-3 list up to 34 small rivers or creeks that were apparently evaluated for stream depletion using the SACFEM2013 groundwater model. Without river/stream/creek labels on the drawdown figures at a scale that allows for reasonable measurement and review, it is difficult to determine the anticipated drawdown at the 34 small rivers and creeks or other important habitat areas.

The Fisheries Section 3.7, and Vegetation and Wildlife Section 3.8 provide discussions of the potential impacts from groundwater substitution transfer induced stream depletion (Sections 3.7.2.1.1, 3.8.2.1.1 and 3.8.2.1.4). The Well Acceptance Criteria of Table B-1 in Appendix B of the October 2013 joint DWR and BoR document titled *Draft Technical Information for Preparing Water Transfer Proposals (DTIPWTP)* lists in the table footnotes eight major and three minor surface water features tributary to the Delta that are affected by groundwater pumping. Apparently, the Well Acceptance Criteria in Table B-1 will be applied to these eleven surface water features as part of mitigation measure GW-1. Whether the Well Acceptance Criteria will also be applied to the creeks listed in Tables 3.7-2, 3.7-3 and 3.8-2 is not specifically stated in the Draft EIS/EIR or GW-1.

The lack of maps with sufficient detail to see the relationship between the wells and the surface water features prevents adequate review of the Draft EIS/EIR analysis to determine whether mitigation measures WS-1 and GW-1 will be effective at mitigating pumping impacts. As I will discuss in Part 2 of this letter, the distance between a surface water feature and a pumping well is a critical parameter in estimating the rate and duration of stream depletion. Maps are needed of each seller's service area at a scale that allows for reasonably accurate measurement of distances between the groundwater substitution transfer wells and surface water features, other non-participating wells, proposed monitoring wells, fisheries, vegetation and wildlife areas, critical surface structures, and regional economic features.

I recommend the Draft EIS/EIR be revised to provide additional maps of each seller's service area at a scale that allows for reasonably accurate measurement of distances between the groundwater substitution transfer wells and surface water features listed in Tables 3.7-2, 3.7-3, 3.8-3 and B-1 as well as other non-listed surface water dependent features such as wetlands and riparian areas, non-participating wells, the proposed monitoring wells, wildlife areas, critical surface structures, regional economic features, and other structures that might be impacted by groundwater substitution pumping.

3. The Draft EIS/EIR evaluated a number of potential environmental impacts from the groundwater substitution transfers using the finite element groundwater model SACFEM2013. The results of the modeling effort were used in the assessment of the

potential biological resource impacts from reductions in surface water flow caused by groundwater substitution transfer pumping (pages 3.7-18 to 3.7-30, and 3.8-49 to 3.8-67). The Draft EIS/EIR assumes that SACFEM2013 model results are sufficiently accurate to justify removing most of the small creeks from a detailed effects analysis (Table 3.7-3 and 3.8-3).

Statements are given that the mean monthly reduction in the Sacramento, Feather, Yuba and American rivers will be less than 10 percent (pages 3.7-25 and 3.8-49) and that other stream requirements of flow magnitude, timing, temperature, and water quality would continue to be met. However, actual SACFEM2013 model results on anticipated changes in flow, temperature and water quality are not provided for all of the surface water features that may be potentially impacted by the groundwater substitution transfer projects. Creeks that passed a preliminary screening, Tables 3.7-3 and 3.7-4, were selected to be modeled by water year type for stream depletion that exceeds 1 cubic feet per second (cfs) and 10% reduction in mean monthly flow. Results of the modeling effort are presented in Tables 3.8-4 to 3.8-7.

The Draft EIS/EIR notes that not all surface water features were evaluated because some lacked sufficient historical flow data, or they were too small to model (page 3.7-20). The Draft EIS/EIR then assumes that the pumping impacts to un-modeled small surface water features are similar to nearby modeled features. No maps with sufficient detail are provided to allow for determination of the spatial relationship between the modeled and un-modeled surface water features, or the relationship between the groundwater substitution transfer wells and the modeled and un-modeled surface water features (see comment no. 2). The distance between a well and a surface water feature is a critical parameter in determining the rate and timing of surface water depletion resulting from groundwater pumping. The validity of the assumption that the un-modeled surface water features will respond similarly to the modeled is dependent on the distance between them and their respective distances to the pumping transfer well(s). I will discuss in more detail in Part 2 the importance of distance in the calculation of stream depletion.

The Draft EIS/EIR also provides Figures B-5 and B-6 of Draft EIS/EIR Appendix B that graph in aggregate the changes in stream-aquifer interactions, presumably equal to changes in stream flow, based on the SACFEM2013 simulations. While these graphs are interesting for several reasons, they don't provide information specific to each seller service area on flow losses expected in each river and creek. No figures are provided that show the longitudinal- or cross-sections of channel where impacts are expected, or the rate of stream depletion in each channel section. Maps with rates and times of stream depletion by longitudinal channel section are needed to allow for an adequate review of the Draft EIR/EIS conclusion of less than significant and reasonable impacts with no injury. These maps are also needed to evaluate the specific locations for monitoring potential impacts.

Statements are made in Section 3.7 that reductions in surface flow due to groundwater substitution pumping would be observed in monitoring wells in the region as required by mitigation measure GW-1. Thus detailed maps that show the locations of the monitoring wells and the areas of potential impact along with the rates and seasons of anticipated stream depletion are needed for each service area. These maps are also needed to allow for evaluation of the cumulative effects whenever pumping by multiple sellers can impact the same resource. Without site-specific information on expected locations and changes in flow at each potentially impacted surface water feature, it's difficult to evaluate the adequacy of any monitoring effort.

I recommend the Draft EIS/EIR be revised to provide additional information on the anticipated changes in surface water flow, temperature, water quality and channel geomorphology for each river, creek and surface water feature in the areas of groundwater substitution transfer pumping. In addition, I recommend that maps showing the along channel longitudinal sections, the maximum anticipated changes in flow rate, water temperature, water quality, and the timing of the maximum anticipated rate of stream depletion due to groundwater substitution transfer pumping be provided at an appropriate scale to allow for adequate measurement and review in the Draft EIS/EIR, and for use in the WS-I and GW-I mitigation monitoring programs.

4. The results of the SACFEM2013 simulation are used to evaluate stream depletion quantities and impacts for vegetation and wildlife resources that are dependent on surface water (Sections 3.7 and 3.8), and to determine the expected lowering of groundwater levels in the areas of transfer pumping (Section 3.3). The groundwater substitution transfer pumping simulation was run from water year (WY) 1970 to WY 2003 and assumed 12 periods of groundwater substitution transfer at various annual transfer volumes as shown in Figure 3.3-25. The apparent Draft EIS/EIR baseline for analysis of groundwater pumping impacts ends with WY 2003 because of limitations of the CalSim II surface water operations model. The CalSim II model was jointly developed by DWR and BoR and is used to determine available export capacity of the Delta. The WY 2003 time limitation was adopted in the SACFEM2013 groundwater-modeling effort apparently because of the desire to combine the simulation of groundwater impacts with estimating the timing of when groundwater substitution water could be transferred through the Delta (Section 3.3.2.1.1). The description of the SACFEM2013 modeling effort states that the volume of groundwater pumping was determined by “comparing the supply in the seller service area to the demand in the buyer service area” (page 3.3-60).

While this is an interesting modeling exercise, and much can be learned from it, the simulations didn't evaluate the impacts of pumping the maximum annual amount proposed for each of the 10 years of the project. It is important that with any simulation used to analyze potential project impacts that the maximum levels of stress, pumping, proposed by the project be simulated at each of the project locations for the entire duration of the project. This is especially important whenever the simulations are used to justify the conclusion that project impacts will be less than significant, reasonable and cause no injury. Because the groundwater modeling effort didn't include the most recent 11 years of record, it appears to have missed simulating the most recent periods of groundwater substitution transfer pumping and other groundwater impacting events, such as recent changes in groundwater elevations and groundwater storage (DWR, 2014b), and the reduced recharge due to the recent periods of drought. Without taking the hydrologic conditions during the recent 11 years into account, the results of the SACFEM2013 model simulation may not accurately depict the current conditions or predict the effects from the proposed groundwater substitution transfer pumping during the next 10 years.

Although the Draft EIS/EIR project description is specific on the volumes and periods of groundwater substitution transfer pumping as shown in Tables 2-4 and 2-5, the write-up of the groundwater modeling effort aggregated the volume pumped (Sections 3.3.2.4.2 and B.4.3.1.2 in Appendix B). The simulated volume of groundwater pumped doesn't reach the maximum being requested by the project in any individual year or for all ten years (Figures B-4 in Appendix B and 3.3-25). Note, the annual groundwater substitution transfer amounts shown in Figure B-4 in Appendix B are not the same as the amounts simulated by the SACFEM2013 model as shown in Figure 3.3-25. The presentation of the SACFEM2013

model results in Sections 3.3.2.4.2 and B.4.3.1.2 don't tabulate or provide detailed maps by seller service area on the pumping rates, cumulative pumped volumes, pumping times and durations, or which aquifers were pumped in the simulations. The model documentation doesn't provide the maximum drawdown or the expected centers of maximum drawdown for each seller service area.

The documentation of the SACFEM2013 model results should also discuss the variations in potential impacts that might result from pumping transfer wells other than those simulated. If the groundwater simulation didn't pump all of the transfer wells listed in Table 3.3-3 for each seller at their maximum rate, then the modeling documentation should describe how the impacts from the simulation should be evaluated for the non-simulated transfer wells and for those well simulated at less than maximum pumping. For example, if the modeling effort provides the pumping time and distance drawdown characteristics of each well this information can be used to estimate the drawdown at different distances, pumping rates, and durations of pumping (see pages 238 to 244 in Driscoll, 1986). The Draft EIS/EIR should provide the time-drawdown and distance-drawdown hydraulic characteristics for each groundwater substitution transfer well so that non-simulated impacts can be estimated. The Draft EIS/EIR should then describe a method(s) for estimating the drawdown at different distances, rates and durations of pumping so that non-participant well owners can estimate and evaluate the potential impacts to their well(s) from well interference due to the pumping of groundwater substitution transfer well(s).

Because the rate of stream depletion is scaled to pumping rate and because the model documentation doesn't indicate the pumping locations, rates, volumes, times or durations that produced the pumped volumes shown in Figure 3.3-25, or the stream depletions shown in Figures B-5 and B-6 in Appendix B, there is uncertainty whether the SACFEM2013 modeling simulated the maximum rate of stream depletion for the proposed 10-year project. The annual volume of groundwater pumping shown in Figure 3.3-25 are less than the maximum requested, and pumping for a continuous 10 years was not simulated. This suggests that the stream-interaction values or stream depletion(?) shown in Figures B-5 and B-6 of Appendix B are not the maximum level of impact that might occur from the 10-year project.

Without information on the rate, timing and duration of the groundwater pumping, there can be no evaluation of whether the annual simulated impacts are representative of the two pumping seasons listed in Table 2-5, or just a single 3-month pumping season. Whenever the simulated annual pumping rate was greater than the single season maximum of 163,571 acre-feet (AF), two seasons of pumping are required, but the percentage in each season is unknown. If the simulated pumping time represents only one season or a mixture of the two seasons, then the simulation may not reflect the actual timing and/or duration of maximum groundwater substitution pumping impacts proposed in Table 2-5. If a simulation doesn't evaluate the project under existing conditions or simulate the maximum stress allowed by the project description, then it raises a question of whether the Draft EIS/EIR adequately evaluated the projects potential impacts. Without thorough documentation of the SACFEM2013 groundwater impact simulation, it is difficult to review and analyze the model's predictions for potential impacts from each seller's groundwater substitution transfer project, or use the model results in designing and setting impact thresholds for the groundwater monitoring required in mitigation measure GW-1.

I recommend the Draft EIS/EIR be revised to provide a more complete description of the SACFEM2013 groundwater modeling effort, including tabulation of the groundwater substitution pumping rates, volumes, durations,

and dates for each simulated well; the hydraulic characteristics of each well simulated; the aquifer(s) pumped by each simulation well; the impacts from the maximum proposed pumping, annually and during the 10-years of the proposed project; sufficiently detailed maps of the well locations in each seller's service area that non-participants and the public can use to identify any well's relationship to the groundwater substitution transfer wells and understand the potential impacts to groundwater levels. I recommend the Draft EIS/EIR provide, for each transfer well, the pumping time and distance drawdown characteristics such that drawdown for durations, distances and rates of pumping other than those simulated can be estimated. I recommend the Draft EIS/EIR also provide an explanation of why the simulation is representative of the current (2014) conditions, how the simulation can be used to assess current and future conditions, and how the simulation can be used to evaluate, monitor and set impact thresholds for future impacts from the 10-year project at the maximum groundwater substitution transfer pumping volumes listed in Tables 2-4 and 2-5.

5. The Draft EIS/EIR was written from the perspective of the process of transferring surface waters through the Delta. This surface water point of view has carried over into some of the analyses of impacts and mitigations for groundwater pumping. For example, the discussions of potential impacts to surface water users, fisheries, and other stream dependent biological resources are thought of as occurring "downstream" of the groundwater substitution wells. While it is correct that groundwater pumping can impact down gradient resources, pumping can also affect up gradient and lateral resources. A pumped well creates a depression in the surrounding aquifer, often referred to as a "cone of depression." Thus, the area of impact around a pumping well is not a single point, but a region whose extent is sometimes called the "area, radius or zone of influence." The length of stream affected by groundwater pumping is related to the distance between the well and the stream (Figures 16 and 29 from Barlow and Leake, 2012; Exhibits I.1 and I.2). Miller and Durnford (2005) noted that for an ideal aquifer and stream at longer durations of pumping, when the stream depletion rate approaches the well pumping rate, 50% the stream depletion occurs within a stream reach length of twice the distance between the stream and well, and 87% of the depletion occurs within a reach length of 10 times the stream to well distance. Obviously, for non-ideal aquifers and streams the length of stream depleted will vary from the ideal, but this illustrates that stream depletion caused by a pumping well is not focused at one point, but occurs along a length of stream with impacts that occur upstream and downstream from the point on the stream that is typically closest to the well.

Because groundwater is generally flowing, the water table or piezometric surface has a slope. This slope causes the cone of depression around a pumping well to elongate along the direction of regional flow. The elongated cone of depression is often referred to as a "capture zone" (Frind and others, 2002) and determining its extent is a basic part of a pump and treat groundwater cleanup program (USEPA, 2008a). This "capture zone" is related to stream depletion capture because the pumping well intercepts groundwater that would eventually discharge to surface water or be used by surface vegetation. If the "capture zone" extends far enough it may cross a surface water feature and induce greater seepage. However, unlike the capture needed for a contaminant plume, stream depletion can occur without the actual molecule of water that enters the well having to originate from the stream (Figure 29; Exhibit I.2).

The stream depletion occurs when groundwater is either intercepted before reaching the stream or seepage from the stream is increased. This water only has to backfill the change

in storage caused by pumping, it doesn't have to enter the well. The "capture zone" also extends upgradient to the recharge area that's the normal source of water flowing past the well. The aquifer recharge that flows past the pumping well may be derived from a wide mountain front area, it could be a section of another river that crosses the the "capture zone", or an overlying area of agricultural irrigation. In a complex hydrogeologic setting, numerical modeling that utilize particle tracking is needed to define where a pumping well is recharged and where it may deplete surface water features (Frind and others, 2002; Franke and others, 1998).

The concepts of a wide zone of influence and an elongated "capture zone" are important for the Sacramento Valley groundwater substitution transfers projects because the analysis and monitoring of potential pumping impacts requires a multidirectional evaluation. It can't be assumed that stream depletion impacts from pumping occur only downstream from the point on the stream closest to the pumping well. Any monitoring of the effects of groundwater substitution pumping on surface or ground water levels, rates and areas of stream depletion, fisheries, vegetation and wildlife impacts, and other critical structures needs to cover a much wider area than what is needed for a direct surface water diversion. This is a fundamental issue with the Draft EIS/EIR. The environmental analyses, monitoring requirements and mitigation measures appear to be developed without adequately considering the multidirectional, wide extent of potential impacts from groundwater substitution transfer pumping.

I recommend the Draft EIS/EIR be revised to address the wide extent of potential impacts for groundwater substitution transfer pumping. This should include conducting numerical modeling of the groundwater basin using particle tracking to determine which surface water features and other structures are potentially impacted by the pumping of each transfer well and to determine the extent of stream depletion along each potentially impacted surface water feature. The monitoring and mitigation measures WS-I and GW-I should also be revised to account for a wide area of potential impact from groundwater substitution transfer pumping.

6. The Draft EIS/EIR is written with the assumption that project specific evaluation for each seller agency will be done at a later time by the BoR and/or DWR, and at the local level (see Section 3.3.1.2.3, mitigation measure GW-I in Section 3.3.4.1, and Section 3.1 in the DTIPWRP). The Draft EIS/EIR lists in Table 3.3-1 and Table 3-1 of the DTIPWRP the Groundwater Management Plans (GMP), agreements and county ordinances that regulate the sellers at a local level. The Draft EIS/EIR discusses only two county ordinances, the Colusa Ordinance No. 615 and Yolo Export Ordinance No. 1617, one agreement, the Water Forum Agreement in Sacramento County, and one conjunctive use program, the American River Basin Regional Conjunctive Use Program. The Table 3-1 in the DTIPWRP lists short descriptions of the county ordinances related to groundwater transfers, if one exists. These descriptions don't always identify the actual ordinance number that applies to a groundwater substitution transfer, but sources for additional information are provided in the table.

The DTIPWRP (page 27) and GW-I (page 3.3-88) instructs the entity participating in a groundwater substitution transfer that they are responsible for compliance with local groundwater management plans and ordinances. Except for the brief discussion of the two ordinances, one agreement, and one conjunctive use program listed above, the Draft EIS/EIR doesn't describe the requirements of local GMPs, ordinances, and agreements listed in Tables 3.3-1 (page 3.3-8) and Table 3-1 (page 27). Thus, the actual groundwater substitution

transfer project permit requirements, restrictions, conditions, or exemptions required for each seller service area by BoR, DWR, and one or more County GMP or groundwater ordinance will apparently be determined at a future date. It follows that any actual monitoring requirements, mitigation measures, thresholds of significance required by BoR, DWR or local governing agencies will also be determined at a future date. The mechanism for the public to participate in the determination of the actual groundwater substitution transfer project permit requirements, restrictions, conditions, mitigation measures or exemptions isn't specified in the Draft EIS/EIR.

Addition information is needed on what the local regulations require for exporting groundwater out of each seller's groundwater basin. The Draft EIS/EIR needs to discuss how the local regulations ensure that the project complies with California Water Code (WC) Sections 1220, 1745.10, 1810, 10750, 10753.7, 10920-10936, and 12924 (for more detailed discussion of these Water Codes see Draft EIS/EIR Section 3.3.1.2.2). Although the Draft EIS/EIR doesn't document, compare or evaluate the requirements of all local agencies that have authority over groundwater substitution transfers in each seller service area, the Draft EIS/EIR concludes that the environmental impacts from groundwater substitution transfer pumping by each of the sellers will either be less than significant and cause no injury, or be mitigated to less than significant through mitigation measures WS-I, and GW-I with its reliance on compliance with local regulations. Because the spatial limits of groundwater substitution pumping impacts are controlled by hydrogeology, hydrology, and rates, durations and seasons of pumping, the impacts may not be limited to the boundaries of each seller's service area, GMPs, or County. There is a possibility that a seller's groundwater substitution area of impact will occur in multiple local jurisdictions, which should results in project requirements coming from multiple local as well as state and federal agencies. The Draft EIS/EIR doesn't discuss which of the multiple local agencies would be the lead agency, how an agreement between agencies would be reached, or how the requirements of the other agencies will be enforced. The Draft EIS/EIR only briefly mentions the Northern Sacramento Valley Integrated Regional Water Management Plan (IRWMP) (page 3.3-91 and -92) and doesn't mention the American River IRWMP (<http://www.rwah2o.org/rwa/programs/irwmp/>), the Yuba County IRWMP (<http://yubairwmp.org/the-plan-irwmp/content/irwmp-plan>), or the Yolo County IRWMP (<http://www.yolowra.org/irwmp.html>). The Draft EIR/EIS doesn't provide information on the water management requirements of the IRWMP covering each seller service area or how the groundwater substitution transfers will be accounted for in the IRWMP process.

Because the Draft EIS/EIR requires that each individual transfer project meet the requirements of Water Code sections listed above, and because it assumes that each of the sellers will separately comply with all federal, state and local regulation, GMPs, IRWMPs, ordinances or agreements, the Draft EIS/EIR should provide an analysis of how these local regulations, GMPs, ordinances or agreements will ensure each seller's project achieves the goals of no injury, less than significant and reasonable impacts. Each seller's project analysis should identify what future analyses, ordinances, project conditions, exemptions, monitoring and mitigation measures are required to ensure that each of the seller's project meets or exceed the goals of the Draft EIS/EIR.

I recommend the Draft EIS/EIR be revised to include a discussion and comparison of the local regulations, GMPs, IRWMPs, ordinances and agreements that govern each of the seller's proposed groundwater substitution transfers. I recommend each analysis demonstrate that each seller's project will meet or exceed the environmental protection goals of the Draft EIS/EIR. I recommend an analysis that compares local and regional management plans,

ordinances, regulations, and agreements with the monitoring and mitigation measures in the Draft EIS/EIR to identify any additional mitigation measures needed to ensure compliance with local, regional, state and federal regulations. I recommend an analysis that includes: (1) a discussion on how the local lead agency will be determined; (2) how multiagency jurisdictions will be enforced; (3) how conflicts between different local, regional, state and federal regulatory jurisdictions will be resolved; and (4) how public participation will occur.

7. The Draft EIS/EIR provides only one groundwater elevation map of the Sacramento Valley groundwater basin, Figure 3.3-4, which shows contours from wells screened from a depth greater than 100 feet to less than 400 feet below ground surface (bgs) (>100 to < 400 feet bgs) and only for the northern portion of the proposed groundwater substitution transfer seller area. The Draft EIS/EIR doesn't provide maps showing groundwater elevations, or depth to groundwater, for groundwater substitution transfer seller areas in Placer, Sutter, Yolo, Yuba, and Sacramento counties.

The DWR provides on a web site a number of additional groundwater level and depth to groundwater maps at:

http://www.water.ca.gov/groundwater/data_and_monitoring/northern_region/Groundwater_Level/gw_level_monitoring.cfm#Well%20Depth%20Summary%20Maps.

For example, there are maps that show the change in groundwater levels from the spring of 2004 to spring of 2014 for shallow screened wells (<200 feet bgs), intermediate wells (>200 to <600 feet bgs), deep wells (>600 feet bgs), and well screened in the >100 to < 400 feet bgs interval. In addition, the DWR web site has a series of well depth summary maps for Butte, Colusa, Glenn, and Tehama counties, and the Redding Basin that show the density of wells screened at less than 150 feet bgs, and between 150 and 500 feet bgs, along with contours of the depth to groundwater in the summer of 2013. There are also numerous other groundwater elevation contour maps on DWR's web page, going back to 2006. Historical and recent groundwater elevation and depth contours maps for Placer, Sutter, Yolo, Yuba, and Sacramento counties may be available from the groundwater substitution transfer sellers, other water agencies in those counties, the IRWMP documents, or technical reports on groundwater management (for example, Northern California Water Association, 2014a, b, and c).

Historic change and current groundwater contour maps are critical to establishing an environmental baseline for the groundwater substitution transfers. This information is needed to evaluate the impacts from groundwater substitution transfers because it establishes the present groundwater basin conditions and document the changes and trends in groundwater levels in the last 10-plus years, which were not simulated by the SACFEM2013 modeling.

Information on the depth to shallow groundwater is critically important because of the analysis of impacts to vegetation and wildlife in Section 3.8 assumed, based on the results of the SACFEM2013 model, that the current depth to shallow groundwater is greater than 15 feet bgs for most of the Sacramento Valley groundwater basin (page 3.8-32). Because the simulation showed a condition of greater than 15 feet depth to groundwater, the Draft EIS/EIR concluded that impacts from lowering of the shallow water table as a result of the groundwater substitution transfer pumping would be less than significant (page 3.8-47).

This assumption however appears to conflict with the DWR shallow well depth summary maps (DWR, 2014a) that show contours of the depth to groundwater in wells less than 150 feet bgs in the summer 2013. These maps show extensive areas around the Sutter Buttes

and to the north were the depth to groundwater is less than 10 feet and 20 feet (Exhibit 2.1). These maps also show extensive areas where the depth to groundwater is less than 40 feet, a depth significant to some tree species such as the valley oak (page 3.8-32). There is also a recent trend of lower groundwater levels in a number of areas in the Sacramento Valley as shown on the DWR 2004 to 2014 groundwater change maps for shallow, intermediate, deep aquifer zones available from the web site listed above (DWR, 2014b). Exhibit 2.1 has a composite map of the shallow zone well depth maps and traces of the shallow zone 2004 to 2014 groundwater elevation change contours.

These groundwater elevation, depth and changes in elevation maps are important for documenting baseline groundwater conditions. The recent trend of decreased groundwater levels should be included in the analysis of groundwater substitution pumping impacts because the drawdowns shown in Figures 3.3-26 to 3.3-31 will interact with existing conditions, and may cause additional long-term decreases in groundwater levels. The Draft EIS/EIR's assessment of the impacts from groundwater substitution transfer pumping to existing and future wells, fisheries, vegetation and wildlife, and surface structures should factor in these recent trends in groundwater levels and not rely solely on SACFEM2013 model simulations that ended in 2003. In addition, the hydrographs in Appendix E that show the SACFEM2013 model results should identify wells near the selected 34-hydrograph locations where groundwater level measurements have been taken and show these actual groundwater levels on the hydrographs. Currently the public is left with the task of finding groundwater level data near the 34 selected hydrograph locations and then validating the simulation results by making comparisons between the simulated water levels and the actual water levels. This model validation task should be part of the Draft EIS/EIR.

I recommend the Draft EIS/EIR be revised to include maps of recent groundwater levels and depths to groundwater along with changes in groundwater levels and depths for at least the last 11 years for all of the counties where the seller agencies propose a groundwater substitution transfer project. I recommend that the Draft EIS/EIR be revised to provide additional verification of the SACFEM2013 model results by comparing them to measured groundwater levels in the vicinity of the 34 selected modeling hydrograph locations. I also recommend the hydrographs of actual water level measurements in the vicinity be included on the simulation hydrographs, so that the public can review the accuracy of the simulation. I recommend contour maps showing the current depth to groundwater be made from actual shallow groundwater measurements and that these contours be shown on maps of the surface water features identified and evaluated in Draft EIS/EIR Sections 3.3-Groundwater, 3.7-Fisheries (Table 3.7-3), and 3.8-Vegetation and Wildlife (Table 3.8-3). I recommend that the SACFEM2013 simulation drawdowns be combined with the current (2014) groundwater elevations for each groundwater substitution transfer aquifer to show the cumulative impacts of the 10-year project on existing groundwater elevations.

Groundwater Model SACFEM2013

A finite element groundwater model, SACFEM2013, was used to evaluate the potential for changes in groundwater levels and stream depletion from groundwater substitution transfer pumping during the 10-year period of the project. The results of the simulations were used to evaluate the impacts to fisheries, vegetation and wildlife (Section 3.7 and 3.8). Section 3.3.2.1 discusses the use of the model for estimating regional groundwater level declines due to groundwater substitution pumping. Figures 3.3-26 to 3.3-31 provide simulated changes in

groundwater elevation or head for three intervals, up to 35 feet bgs, 200 to 300 feet bgs, and 700 to 900 feet bgs. Figures 3.3-32 to 3.3-40 and Appendix E provide hydrographs of model simulations for 34 selected locations shown on the simulated groundwater elevation change maps. Sections 3.7.2.1.1, 3.7.2.1.3, 3.7.2.4.1, 3.8.2.1.1, 3.8.2.1.4, and 3.8.2.4.1 provide discussion on the potential impacts of groundwater substitution transfer pumping on fisheries, vegetation and wildlife resources from a drop in the shallow groundwater table and depletion of stream flows.

The SACFEM2013 model was set up to simulate transient flow conditions from WY 1970 to WY 2010 (page 3.3-60). Historic data from 1970 to 2003 were used to estimate the potential impacts from groundwater substitution transfers during the 10-year period of the project. The simulation terminated at 2003 because that was the last simulation period available for the CalSim II model, a planning model designed to simulate operations of the CVP and SWP reservoirs and water delivery systems. Additional SACFEM2013 model documentation is given in Appendix D, which provides information on the model gridding, layering, assumptions and calculation methods. Several of the model designs and parameters selected likely influenced the model's ability to predict future impacts from the 10-year groundwater substitution transfer project. Those include: the time period of the model, the assumptions about the amount and frequency of groundwater substitution pumping, the model's nodal spacing, estimates of aquifer properties, the number of streams simulated, streambed parameters, and specified-flux boundaries. There are at least two other groundwater simulation models developed for the Sacramento Valley, a U.S. Geological Survey model, USGS-CVHM (Faunt, ed., 2009) and a DWR-C2VSim model (Brush and others, 2013a and 2013b).

A comparison between the SACFEM2013 and these two other models provides an interesting assessment of how these three models estimated the hydrogeologic character and conditions of the Sacramento Valley. A comparison also demonstrates that there is no one correct groundwater model, that models with different parameter distributions can achieve reasonable calibration. With models of differing hydrogeologic characteristics, the predictions of future impacts by each model should be expected to differ. Determining which of the models accurately predicts future impacts requires the validation of each model's prediction with new field data. The Draft EIS/EIR mitigation measures for groundwater substitution transfer pumping shouldn't assume that the SACFEM2013 model results are all that is needed to demonstrate no injury and less than significant impacts from the proposed project. Validation of the model-based conclusion of no impacts requires collection of new field data and comparison to simulation predictions throughout and beyond the 10-year project.

A comparison of portions of the SACFEM2013 simulation for the Draft EIS/EIR with the two other models is given below.

8. *Period of Modeled Historic Groundwater Conditions* – Although the model simulation period ended in 2003, the Draft EIS/EIR indicates that the model was run to 2010, but the results were not provided. From the model write-up it is unknown whether the latest groundwater elevations were a factor in the modeling effort. The simulation hydrographs in Appendix E terminate in 2004. Apparently, the hydrologic conditions for the latest 10 years are not included because the Draft EIS/EIR doesn't discuss how the model simulations agree with the current baseline conditions. Specifically, the change in groundwater elevation between 2004 and 2014 as documented by DWR (2014b) in a series of three maps. I've

provided in attached Exhibits 3.1 to 3.3 maps that are composites of DWR's 2004 to 2014 groundwater change maps with Draft EIS/EIR Figures 3.3-29, 3.3-30 and 3.3-31, the SACFEM2013 1990 hydrologic conditions simulations of drawdown by zone. The 1990 hydrologic condition was selected for comparison because the sequence of groundwater pumping events is the closest match to the actual pumping requested in the Draft EIS/EIR. Note that the depth intervals of the two sets of maps don't exactly coincide, but they are generally grouped as shallow, intermediate and deep aquifers.

Exhibits 3.1 to 3.3 show that the simulated changes in groundwater elevation from the 10-year groundwater substitution transfer project appear to widen the existing groundwater depressions. The pumping depression southwest of Orland will expand to the east and northeast, as will the depression in the Williams area. A pumping depression will develop in the Live Oaks area and to the east. In the southeastern Sacramento area, the pumping depression from the 10-year project will apparently extend southeastward beyond the limits of the Sacramento Valley transfer project boundary. Combining the existing areas of recent sustained groundwater drawdown with the additional drawdown from the groundwater substitution transfer pumping could slow the recovery of groundwater elevations. The 10-year project pumping east of Orland may connect the two existing groundwater depressions around Orland and Chico to create one large depression. Because the DWR 2004 to 2014 groundwater change maps don't extend completely to the southern portions of the Sacramento Valley groundwater substitution transfer area in Placer, Sutter, Yolo, Yuba, and Sacramento counties, no evaluation can be made about the impact of 10 years of groundwater substitution transfer pumping on existing groundwater conditions in those or adjacent areas.

I recommended the Draft EIS/EIR be revised to discuss how the SACFEM2013 simulations incorporate the changes in groundwater level from 2004 to 2014 in assessing the potential impacts from the proposed 10 years of groundwater substitution transfer pumping. I recommended this discussion include evaluation of the rate and duration of groundwater level recovery that factors in the existing (2014) groundwater levels. I also recommend the Draft EIS/EIR be revised to discuss how during the 10 years of project transfers through the Delta will be made with a CalSim II model that's only current to the year 2003.

9. *Simulation Pumping Volume and Frequency* - The model simulated a series of groundwater pumping events in 12 out of the 34 years of simulation (page 3.3-60). The logic of a multiyear, variable hydrology simulation was that it allowed for evaluation of the cumulative effects of pumping in previous years (page 3.3-61). Figure 3.3-25 shows the simulated periods of groundwater substitution transfer pumping. The 1990 simulation period most closely matches the multiyear pumping being requested by the 10-year project. The 1990 simulation period included groundwater pumping 7 out of 10 years, with pumping values ranging from approximately 95,000 acre-feet per year (AFY) to approximately 262,000 AFY, as measured from Figure 3.3-35. Note the actual pumping rates, volumes, and pumping durations were not provided in the simulation documentation. Apparently, none of the modeled groundwater substitution pumping simulation periods was given the actual maximum groundwater substitution pumping value of 290,495 AFY as calculated from Table 2-5. The time-weighted annual average pumping rate for the 1990 simulation period is approximately 126,900 AF, as measured from Figure 3.3-35. This represents approximately 44% of the maximum pumping rate requested in the Draft EIS/EIR ($126,900 \text{ AF} / 290,495 \text{ AF} = 0.437$). Therefore the SACFEM2013 Draft EIS/EIR simulations may only represent a portion of the project's potential impacts from groundwater substitution transfer pumping.

I recommend the Draft EIS/EIR be revised to discuss how the SACFEM2013 simulations provide a full and accurate estimation of the potential impacts from the groundwater substitution transfer pumping throughout the 10-year project. I also recommend the Draft EIS/EIR be revised to include SACFEM2013 simulations at the maximum requested annual volume of 290,495 AF for each of the 10 years of pumping.

10. *Simulation Grid Size* - The SACFEM2013 documentation states that the grid used for groundwater substitution transfer simulations has 153,812 nodes and 306,813 elements (page D-3 of Appendix D). The model nodal spacing varies from 410 feet to 3,000 feet, with an approximate nodal spacing of 1,640 feet along streams and flood bypasses. While this nodal spacing is reasonable for regional groundwater simulations, the results of the simulations may not provide the detail needed to evaluate drawdown interference between the groundwater substitution transfer wells and adjacent non-participating wells. Information is needed on the locations of the groundwater substitution transfer wells and the adjacent non-participating wells in order to determine whether the current simulation grid spacing can accurately estimate well interference. The Draft EIS/EIR analysis of groundwater substitution pumping impacts should be based on an appropriate model grid spacing to establish accurate maximum thresholds for well interference caused by the transfer well pumping. The Draft EIS/EIR should provide sufficient information that an owner of a non-participating well can determine accurately the maximum anticipated increase in drawdown at their well during the 10 years of groundwater substitution transfer pumping. Whether this amount of increased drawdown is significant at each non-participating well is a matter of the current well design and groundwater conditions at each well. The Draft EIS/EIR should establish values for the maximum allowable well interference drawdown from groundwater substitution transfer pumping, which should be based on the costs and inconvenience of lowering the water level. The Draft EIS/EIR should establish the economic costs and level of injury that are reasonable for a non-participating well owner to assume and will keep the impacts from the 10-year project in compliance with the no injury rule as required by WC Section 1706, 1725 and 1736 (Section 1.3.2.3).

I recommend the Draft EIS/EIR be revised to discuss how the maximum thresholds for water level drawdown due to well interference from groundwater substitution transfer pumping will be established for non-participating wells, and provide a process for assigning a threshold to each non-participating well, along with monitoring requirements and specific mitigation measures should the threshold be exceeded. The Draft EIS/EIR also should be revised to provide the threshold values for well system repair costs used in set the maximum allowable well interference drawdown, along with the documentation and analysis of why the well interference drawdown and cost thresholds are considered reasonable and result in no injury to non-participating well owners, and comply with the Water Code.

11. *Simulation Hydrogeologic Parameter Values* - The SACFEM2013 model was developed with seven layers of varying thickness that extend from the shallow water table to the base of fresh water. The USGS-CVHM model has ten layers, while the DWR-C2VSim model has 3 layers. All of the models assume that the uppermost layer, layer 1, was unconfined and the lower layers are confined aquifer. The hydrogeologic parameters values differ for each of these models as shown in a summary table in Exhibit 4.1. Both the CVHM and C2VSim models divided the Central Valley in to 21 subregions (Figure 3, Brush and others, 2013a; Exhibit 4.4). The SACFEM2013 doesn't use subregions from the Sacramento Valley model. As discussed below, the SACFEM2013 appears to use the same distribution of the

horizontal hydraulic conductivity, K_h , for all model layers (Figure D-4 of Appendix D). Both the CVHM and the C2VSim models appear to have more varied hydraulic conductivity distributions than SACS2013.

Development of the SACS2013 simulations used horizontal hydraulic conductivity values derived from the well logs of large-diameter irrigation wells. Shallow and low-yielding wells, less than 100 gallons per minute (gpm), and domestic-type wells were not used (page D-12 of Appendix D). The values of specific capacity (gallons per minute per foot of drawdown) from the DWR well completion reports were used to estimate transmissivity around a well using an empirical equation for confined aquifer developed from Jacob's modified non-equilibrium equation (see equation 8 page D-13 and Appendix 16D of Driscoll, 1986 in Exhibit 4.6). Transmissivity was converted to K_h by assuming the aquifer thickness was equal to the length of the well screen interval. These well K_h values were then averaged using a geometric mean with surrounding wells within a critical distance of 6 miles. The results of the geometric mean averaging were then gridded using a kriging to produce K_h values across the modeled area (Figure D-4 in Appendix D). The transmissivity of each model layer was then calculated at each node by multiplying the kriged geometric mean value of K_h by the aquifer layer thickness. The vertical hydraulic conductivity, K_v , was calculated by assuming a uniform $K_h:K_v$ ratio of 50:1 for layer 1 and 500:1 for layers 2 to 7.

The CVHM model (Faunt, ed., 2009) used the percentage of coarse-grained material from well logs and boreholes as the primary variable in a sediment texture analysis of the Central Valley, which was divided into nine textural provinces and domains (Figures A10 to A14; Exhibits 4.7a to 4.7i). The Sacramento Valley has three textural domains, Redding, eastern, and western Sacramento domains (page 30, Faunt, ed., 2009). The coarse-grained fraction was correlated to horizontal (K_h) and vertical (K_v) conductivity (page 154, Faunt, ed., 2009). The K_h values were estimated using kriging and a weighted arithmetic mean, a type of power mean, whereas the K_v value estimates used either a harmonic or geometric mean. Faunt (ed., 2009) notes that the arithmetic mean is most influenced by the coarser-grained material, whereas the fine-grained material more heavily weights both the harmonic and geometric means. Figure C14 (Exhibit 4.7j) shows the relationship between the percentage of coarse-grained deposits and hydraulic conductivity for the different types of means. For the Sacramento Valley the texture-weighted power-mean value was -0.5, a value midway between the harmonic and geometric means (Table C8, Exhibit 4.3).

Table C8 lists the end member hydraulic conductivity values used in the CVHM model with those for the Sacramento Valley ranging from 670 feet/day (ft/day) for coarse-grained to 0.075 ft/day for fine-grained. The table also lists field and laboratory values of K_h and K_v for coarse and fine-grained deposits. The Redding textural domain has the highest percentage of coarse-grained material of the three in Sacramento Valley, a mean of 39 percent, with the western portion becoming coarser with depth (page 30, Faunt, ed., 2009). The western and eastern Sacramento domains are finer-grained, with the eastern mean at 32 percent coarse-grained deposits, and the western mean at 25 percent. Figure A15B(A?) (Exhibit 4.7k) shows the cumulative distribution of kriged sediment textures for each layer of the CVHM model for the Sacramento Valley. Figures A12A to A12E (Exhibits 4.7c to 4.7g) show the distribution of coarse-grained deposits in CVHM groundwater model layers 1, 3, Corcoran Clay, 6 and 9 for the Sacramento and San Joaquin Valleys. Isolated coarser-grained deposits that occur in layer 1 are associated with the Sacramento River, distal parts of fans from the Cascade Range and northern Sierra Nevada, and the American River (page 30, Faunt, ed., 2009; Figure A14, Exhibit 4.7i). Although the texture maps, Figures A12A to A12E of CVHM, and the hydraulic conductivity distribution map of Figure D4 of SACS2013, show different characteristic of each model's hydraulic conductivity, they can be compared by

their visual complexity. The CVHM texture also varies by model layer, whereas the SACFEM2013 apparently applied the same Kh distribution to each layer. The CVHM western and eastern Sacramento domains appear to have smaller coarse-grained areas than the SACFEM2013 higher hydraulic conductivity areas (Figures A12, C14 and A15 in Exhibits 4.7c, 4.7j, and 4.7k versus D4 in Appendix D). Figure 12E (Exhibit 4.7g) shows layer 9 with high percentages of coarse-grained deposits that have higher Kh values (Figure C14) in the western parts of the Redding (10) and northern western portion of the western Sacramento (11) province. Whereas Figure D4 of SACFEM2013 shows these same areas as having the lowest Kh values, suggesting finer-grained textures dominate.

The C2Vsim model divided the Sacramento Valley into seven subregions, as did the USGS-CVHM model. Like the USGS model, hydraulic conductivity varies with the three model layers for the Sacramento Valley. The spatial variability of the Kh and Kv values for the C2Vsim model is greater than with the SACFEM2013 model (compare Figures 34 and 35 from Brush and others, 2013a in Exhibits 4.8a to 4.8f to Figures D4 of Appendix D). Table 5 of Brush and others, 2013a (Exhibit 4.2) shows the range of model parameters for the saturated groundwater portion of the C2Vsim model. Kh values range from 2.2 ft/day to 100 ft/day, and Kv from 0.005 ft/day to 0.299 ft/day. The highest Kh value for the C2Vsim model is less than for SACFEM2013 (100 ft/day vs 450 ft/day), while the lowest values are lower (0.005 ft/day vs <0.1 ft/day).

I recommend the Draft EIS/EIR discuss the uncertainty in aquifer hydraulic parameter estimations for the groundwater substitution transfer pumping simulations and the sensitivity of the model results to the uncertainty in the groundwater hydraulic parameters. I recommend the Draft EIS/EIR discuss how the uncertainty in hydraulic conductivity parameters influences: (1) estimates of potential stream depletion (Section 3.3), (2) evaluations of fisheries impacts (Section 3.7), (3) evaluations of vegetation and wildlife impacts (Section 3.8), and (4) the screening procedures that removed a number of the small streams from further environmental impact analysis (Table 3.7-3 and 3.8-3).

12. *Simulation Groundwater Storage Parameters* - The SACFEM2013 simulations assigned to the upper unconfined model layer 1 a uniform specific yield (Sy) value of 0.12 (dimensionless) (page D-14 in Appendix D; Exhibit 4.1). For the confined model layers 2 to 7 a uniform specific storage, Ss, value of 6.5×10^{-5} per foot (ft) was used (page D-14 of Appendix D; Exhibit 4.1). Both the CVHM and C2Vsim simulations used a range of values of Sy and Ss that were more variable than SACFEM2013 (Exhibits 4.1, 4.8n, and 4.8o). The CVHM simulation used a range of Sy and Ss values, (CVHM Table C8, Exhibits 4.3). The CVHM simulation also used a range of Ss values for coarse-grain elastic and fine-grained elastic and inelastic deposits to simulating subsidence from groundwater pumping. The C2Vsim simulations used a range of Sy values for model layer 1 and separate ranges of Ss values for layers 2 and 3 (C2Vsim Table 5, Exhibits 4.2; Exhibits 4.8g to 4.8i). The C2Vsim and CVHM models assigned a range of coefficients for elastic (Sce) and inelastic (Sci) deposits used in simulating subsidence (Exhibits 4.1, 4.8j to 4.8m). Note, the Ss values are multiplied by the aquifer thickness at each model node at to obtain the dimensionless value of storativity (S) for confined aquifers ($S = Ss \times \text{thickness}$), which is similar to the dimensionless Sy parameter for an unconfined aquifer.

I recommend the Draft EIS/EIR discuss the uncertainty in aquifer storage parameter estimations for the groundwater substitution transfer pumping simulations and the sensitivity of the model results to the uncertainty in the groundwater storage parameters. I recommend the Draft EIS/EIR discuss how

uncertainty in groundwater storage parameters influences: (1) estimates of potential stream depletion (Section 3.3), (2) evaluations of fisheries impacts (Section 3.7), (3) evaluations of vegetation and wildlife impacts (Section 3.8), and (4) the screening procedures that removed a number of the small streams from further environmental impact analysis (Table 3.7-3 and 3.8-3).

13. *Simulation River and Stream Parameters* - All three models simulated the interactions between the groundwater and streams or rivers. The rate and direction of movement of water between streams and shallow groundwater is governed by the vertical hydraulic conductivity of the streambed, K_{vb} , thickness of the streambed, m , the wetted perimeter of the stream, w , and the difference in elevation between groundwater table and stream. The hydraulic parameters of a streambed are combined into a term called conductance, C , which is calculated as the product of K_{vb} times the wetted perimeter divided by the streambed thickness ($C = [K_{vb} \times w]/m$).

The SACFEM2013 simulations assigned all eastern streambeds draining from the Sierra Nevada a K_{vb} value of 6.56 ft/day (2 meters/day), except the Bear River and Big Chico Creek, whose values were unstated (page D-7 of Appendix D). For all western streambeds draining the Coast Ranges, a higher value of K_{vb} at or above 16.4 ft/day (5 meters/day) was assigned. Figure 3.3-24 in the Draft EIS/EIR shows the SACFEM2013 groundwater boundary and the simulated rivers and streams. This map may not be showing all of the small streams evaluated in the simulation based on the streams listed in Tables 3.7-3 and 3.8-3 (also see general comment no. 2).

The streambed K_{vb} values used in CVHM simulation are shown in Figure C26 (Exhibit 5.3). The values of K_{vb} for the Sacramento Valley varying from approximately 0.04 ft/day to 5.6 ft/day are shown in Figure C26. Results of the CVHM simulation of surface water-groundwater interactions, gains and losses, from 1961 to 1977 are compared to measured and simulated stream gauge values in Figures C19A and C19B (Exhibits 5.4a and 5.4b).

The C2VSim simulations also used varying values for streambed K_{vb} ranging from 0 to 44 ft/day with a mean of 1.8 ft/day and lake bed K_{vb} of 0.67 ft/day (page 100, Brush and others, 2013a; Exhibit 5.1). Simulated streambed conductance values are shown in Figure 40 of Brush and others, 2013a (Exhibit 5.2).

I recommend the Draft EIS/EIR discuss the uncertainty in streambed parameter estimations for the groundwater substitution transfer pumping simulations and the sensitivity of the model results to the uncertainty in the hydraulic characteristics of the streambeds. I recommend the Draft EIS/EIR discuss how uncertainty in the hydraulic characteristics of the streambeds influences: (1) estimates of potential stream depletion (Section 3.3), (2) evaluations of fisheries impacts (Section 3.7), (3) evaluations of vegetation and wildlife impacts (Section 3.8), and (4) the screening procedures that removed a number of the small streams from further environmental impact analysis (Table 3.7-3 and 3.8-3).

14. *Groundwater Flow Between Sub-regions* - Of the three previously discussed regional groundwater models for the Sacramento Valley, only the reports for the C2VSim simulation provided information on the volume of groundwater that flows laterally among groundwater subregions. The C2VSim simulation results show that groundwater flow between subregions has changed significantly in some areas (Figures 81A to 81C of Brush and others, 2013a and Figure 39 of Brush and others, 2013b; Exhibits 6.1a to 6.1c and 6.2). The SACFEM2013 simulations results presented in the Draft EIS/EIR don't provide information on the exchange between subregion areas used in simulations by the USGS (Faunt, ed.,

2009) and DWR (Brush and others, 2013a and 2013b). Therefore, the flow of groundwater between the subregions and/or counties of the 10-year project's groundwater substitution transfer sellers wasn't evaluated for potential impacts on neighboring areas. The loss or gain of groundwater from neighboring subregions should be evaluated in the Draft EIS/EIR.

Accounting for subsurface flow among subregions is an important part of the water balance because it is measures of the amount of impact that groundwater pumping in one subregion has on it's neighboring subregions. The subsurface inter-basin movement of groundwater is an important element in the analysis of the environmental impacts from the 10-year groundwater substitution transfer projects because the groundwater substitution transfer pumping by sellers in one region can have a significant impact on the groundwater levels, storage and stream depletion in adjacent regions.

The C2VSim simulations calculated the volume of groundwater that flowed between the subregions and presented the results for three decades, 1922-1929, 1960-1969, and 2000-2009, and for the total simulation period, 1922-2009. Tables 10 through 13 (Brush and others, 2014a; Exhibits 6.3a to d) provide the sum of inter-region groundwater flow for each model subregion, but not the individual values of flow among adjoining subregions. Figures 81 and 39 (Exhibits 6.1a to 6.1c and 6.2) give the simulated annual volume of inter-region flow for the three decades and from 1922 to 2009. An estimate of a portion of the long-term changes in groundwater storage in each subregion can be made by comparing the change in annual volume and flow direction between sub-regions.

For example, in the 1922 to 1929 simulation period subregion 9 (Sacramento-San Joaquin Delta) received 81,000 AFY of groundwater flow from adjoining subregions 6, 8, 10 and 11 (Exhibit 6.1a). By 1969 the simulation shows that subregion 9 was still receiving a small volume, 2,000 AFY, of groundwater flow from subregion 6, but losing approximately 56,000 AFY to subregions 8, 10, and 11 (Exhibit 6.1b). A change in groundwater storage from 1929 to 1969 in the Delta of 135,000 AFY; from a plus 81,000 AFY to a minus 54,000 AFY. For 2002-2009, the simulation shows that the Delta still receiving a small volume, 4,000 AFY, of groundwater flow from subregion 6, but now losing 137,000 AFY to subregions 8, 10 and 11 (Exhibit 6.1c). A loss in storage in the Delta of 214,000 AFY from 1929. The 2000-2009 simulation period shows that subregion 8 is receiving a large portion of the groundwater flow out of the Delta, 112,000 AFY, a reversal in groundwater flow direction and a cumulative annual loss to the Delta from 1922-1929 of 147,000 AFY. Subregion 8 in turn loses 17,000 AFY of groundwater flow to subregion 7 in 2000-2009, and receives 123,000 AFY from subregion 11 (Exhibit 6.1c). A reversal of 1922-1929 when subregion 8 received 1,000 AFY from subregions 7 and gave 1,000 AFY to subregion 11.

The 10-year transfer project proposes under the groundwater substitution to pump up to approximately 75,000 AFY from subregions 7 and 8, Table 2-5. This additional pumping will likely cause additional groundwater to flow from the subregion 9, the Delta, and subregion 11 into subregion 8, and eventually to subregion 7. Similar shifts in direction and annual volumes of groundwater flow have occurred with the other Central Valley subregions. The changes direction and volume of flow between the Delta and surrounding subregions appear to be the largest shift in groundwater flow for in Sacramento Valley area.

I recommend the Draft EIS/EIR be revised to evaluate the subsurface flows between subregions in Sacramento Valley due to the proposed groundwater substitution transfer pumping. I recommend the Draft EIS/EIR be revised to include groundwater model simulations that account for the rates, volumes, times, and changes in direction of groundwater flow between the seller pumping areas and the surrounding non-participating regions. I recommend the Draft

EIS/EIR also analysis the short- and long-term impacts from the changes in subregional groundwater flow caused by the 10-year transfer project.

Mitigation Measure WS-1

15. The purpose of mitigation measure WS-1 as stated in Draft EIS/EIR Section 3.1.4.1 is to mitigate potential impacts to CVP and SWP water supplies from stream depletion caused by groundwater substitution transfer pumping. The stream depletion factor (BoR-SDF) is imposed by the BoR and DWR because they *will not move transfer water if doing so violates the no injury rule* (page 3.1-21). The no injury rule is discussed in Section 1.3.2.3 and cites CA WC Sections 1725, 1736 and 1706. The language from WC 1736 that also requires transfers to not result in unreasonable effects to fish, wildlife, or other instream beneficial uses is discussed in the subsequent Section 1.3.2.4.

Draft EIS/EIR Sections 3.1.2.4.1 (page 3.1-15) and 3.1.6.1 (page 3.1-21) discuss the impacts from groundwater substitution transfers on surface water. On page 3.1-16 the Draft EIS/EIR states that groundwater recharge, presumably greater because of groundwater substitution pumping, occurring during higher flows would decrease flow in surface waterways. During periods of high flow, the decrease in surface flow won't affect water supplies or the ability to meet flow or quality standards. The document also states that if groundwater recharge occurs during dry periods, presumably occurring when groundwater substitution transfers are needed, groundwater recharge would decrease flows and affect BoR and DWR operations. BoR and DWR would then need to either decrease Delta exports or release additional flows from surface storage to meet the required standards. These statements are followed by seemingly conflicting statements that:

Transfers would not affect whether the water flow and quality standards are met, however, the actions taken by Reclamation and DWR to meet these standards because of instream flow reductions due to the groundwater recharge could affect CVP and SWP water supplies. (page 3.1-16)

Increased releases from storage would vacate storage that could be filled during wet periods, but would affect water supplies in subsequent years if the storage is not refilled. (page 3.1-17)

The potential for the reduction in surface water storage to eventually cause reductions in streamflow and water quality isn't clearly addressed in the Draft EIS/EIR.

Overall, the increased supplies delivered from water transfers would be greater than the decrease in supply because of streamflow depletion; however, the impacts from streamflow depletion may affect water users that are not parties to water transfers. On average, the losses due to groundwater and surface water interaction would result in approximately 15,800 AF of water annually compared to the No Action/No Project Alternative, or approximately a loss of 0.3 percent of the supply. (page 3.1-18)

In a period of multiple dry years (such as 1987-1992), the streamflow depletion causes a 2.8 percent reduction in CVP and SWP supplies, or 71,200 AF. (page 3.1-18)

To reduce these effects, Mitigation Measure WS-1 includes a streamflow depletion factor to be incorporated into transfers to account for the potential water supply impacts to the CVP and SWP. Mitigation Measure WS-1 would reduce the impacts to less than significant. (page 3.1-18)

Additional information on the requirements of WS-1 appears to be contained in the October 2013 joint DWR and BoR document titled *Draft Technical Information for Preparing Water Transfer Proposals (DTIPWTP)* because the discussion in that document's Section 3.4.3

on estimating the effects of transfer operations on streamflow says that a default BoR-SDF of 12 percent will be applied “unless available monitoring data analyzed by Project Agencies supports the need for the development of a transfer proposal site-specific SDF” (page 33). The document also states that:

Although real time streamflow depletion due to groundwater substitution pumping for water transfers cannot be directly measured, impacts on streamflow due to groundwater pumping can be modeled. Project Agencies have applied the results from prior modeling efforts to evaluate potential groundwater transfers in the Sacramento Valley to establish an estimated average streamflow depletion factor (SDF) for transfers requiring the use of Project Facilities.

I have several comments on this analysis of stream depletion impacts and mitigation measure WS-1:

- a. Sections 2.3.2.2 and 2.3.2.3 discuss potential groundwater substitution and crop idling transfers and the limitations on the timing of the transfers. Transfers typically occur from July to September, but could also occur from April to June if conditions in the Delta allow for transfer. Surface water to be used in groundwater substitution and crop idling transfers would be stored during April to June if the condition of the Delta is unacceptable for transfer.

My understanding of the BoR-SDF in mitigation measure WS-1 is that at the same time transfer surface waters are flowing towards the Delta, a portion of that water is assigned to the waterway to “offset” or compensate for stream depletion caused by groundwater substitution pumping. The Draft EIS/EIR doesn’t seem to address the issue of how to compensate for groundwater substitution pumping impacts occurring before or after the transfer water flows to the Delta, the long-term losses caused by the pumping in subsequent years, and cumulative impacts from multiple years of pumping by all sellers. Yet the Draft EIS/EIR acknowledges that stream depletion is cumulative and a cumulative increase in depletion can be significantly greater than with a single event (Section 4.3.1.2 in Appendix B). The SACFEM2013 simulation shows that stream depletion will continue for a number of years after the groundwater substitution pumping event (Figures B-4, B-5 and B-6 in Draft EIS/EIR Appendix B). Mitigation measure WS-1 doesn’t appear to fully address how mitigation will occur for stream depletion impacts from groundwater substitution pumping during entire duration of the impact.

I recommend mitigation measure WS-1 be revised to clearly address how reductions in stream flows caused by groundwater substitution transfer pumping will be mitigated to less than significant for all of the times when stream depletion is occurring, including the time before and after the water is physically transferred; long-term impacts; and cumulative impacts from multiple sellers over multiple years of participating in groundwater substitution transfers.

- b. Although mitigation measure WS-1 doesn’t state that its implementation is linked to the October 2013 DTIPWTP (that linkage is part of mitigation measure GW-1), the DTIPWTP discusses the use of the BoR-SDF in the methodology for determining the amount of water available for groundwater substitution transfer, and the effects of the groundwater substitution pumping on streamflow in Section 3.4 (page 31). Item 5 on page 31 gives the formula for using four steps in determining the amount of transferable water, one of which is subtraction of the

estimated streamflow reduction. Section 3.4.3 states on page 33 of the DTIPWTP that:

Although real time streamflow depletion due to groundwater substitution pumping for water transfers cannot be directly measured, impacts on streamflow due to groundwater pumping can be modeled. Project Agencies have applied the results from prior modeling efforts to evaluate potential groundwater transfers in the Sacramento Valley to establish an estimated average streamflow depletion factor (SDF) for transfers requiring the use of Project Facilities.

Project Agencies will apply a 12 percent SDF for each project meeting the criteria contained in this chapter unless available monitoring data analyzed by Project Agencies supports the need for the development of a transfer proposal site-specific SDF.

Project Agencies are developing tools to more accurately evaluate the impacts of groundwater substitution transfers on streamflow. These tools may be implemented in the near future and may include a site-specific analysis that could be applied to each transfer proposal.

Mitigation measure WS-1 states on page 3.1-21 that:

The exact percentage of the streamflow depletion factor will be assessed and determined on a regular basis by Reclamation and DWR, in consultation with buyers and sellers, based on the best technical information available at that time. The percentage will be determined based on hydrologic conditions, groundwater and surface water modeling, monitoring information, and past transfer data.

From these statements it appears that: (1) the BoR, DWR and other Project Agencies have previously analyzed the amount of stream depletion caused by past groundwater substitution transfers, and (2) the default of 12% BoR-SDF may not be applied to groundwater substitution during the 10 years of transfers because transfer-specific studies will be needed. The Draft EIS/EIR doesn't provide information or cite references on the previous modeling and/or monitoring efforts to determine the correct stream depletion factor. It also doesn't provide specific information on the method(s) and review process to be used in implementing mitigation measure WS-1, or what additional assessments are needed to determine the "exact percentage" for the BoR-SDF. Mitigation measure WS-1 appears to require that the assessment, the calculation methodology, and determination of the correct BoR-SDF be done at a future time. The Draft EIS/EIR doesn't state whether other regulatory agencies and/or the public will have an opportunity in the future to review and comment on the methodology and determination of the "exact percentage" of the BoR-SDF for each groundwater substitution transfer seller. The Draft EIS/EIR also doesn't state whether other regulatory agencies and/or public comments will be considered by BoR and DWR in determining the BoR-SDF percentage.

The statement that real time stream depletion can't be directly measured contradicts other statements in the Draft EIS/EIR, requirements of mitigation measure GW-1, and the scientific literature. For example: Section 3.5 of the DTIPWTP states that one of the objectives of the monitoring plan is to:

Determine the extent of surface water-groundwater interaction in the areas where groundwater is pumped for the transfer. (page 34)

This objective is in the project's monitoring program therefore it appears to

indicate that some method is available for monitoring the surface water-groundwater interactions, not just the pre-pumping model simulations. The Fisheries (3.7) and Vegetation Wildlife (3.8) sections of the Draft EIS/EIR appear to state that flow reductions in surface waterways caused by groundwater substitution pumping will be monitored. Paragraphs similar to the ones given below state that monitoring wells are part of the mitigation measure for surface waters:

In addition, flow reductions as the result of groundwater declines would be observed at monitoring wells in the region and adverse effects on riparian vegetation would be mitigated by implementation of Mitigation Measure GW-1 (See Section 3.3, Groundwater Resources), because it requires monitoring of wells and implementing a mitigation plan if the seller's monitoring efforts indicate that the operation of the wells for groundwater substitution pumping are causing substantial adverse impacts. The mitigation plan would include curtailment of pumping until natural recharge corrects the environmental impact. Therefore, the impacts to fisheries resources would be less than significant in these streams. (pages 3.7-26 and 3.7-56)

In addition, the Proposed Action has the potential to cause flow reductions of greater than ten percent on other small creeks where no data are available on existing streamflows to be able to determine this. The impacts of groundwater substitution on flows in small streams and associated water ways would be mitigated by implementation of Mitigation Measure GW-1 (see Section 3.3, Groundwater Resources) because it requires monitoring of wells and implementing a mitigation plan if the seller's monitoring efforts indicate that the operation of the wells for groundwater substitution pumping are causing substantial adverse impacts. The mitigation plan would include curtailment of pumping until natural recharge corrects the environmental impact. Implementation of these measures would reduce significant effects on vegetation and wildlife resources associated with streams to less than significant. (pages 3.8-51, 3.8-58 and 3.8-68)

All of these statements seem to contradict the statement in mitigation measure WS-1 that stream depletion can't be measured in real time. Although the Draft EIS/EIR doesn't provide the technical method(s) for determining surface water flow using monitoring in groundwater wells, it's reliance on mitigation measure GW-1 to ensure that streamflows are adequate implies that a method is available. Because WS-1 and GW-1 both have one of the same objectives, to mitigate streamflow losses due to groundwater substitution pumping, the mitigation measure are linked. Thus, the real time monitoring of groundwater intended to mitigate streamflow losses under GW-1 might also facilitate real time monitoring of streamflow needed for WS-1. I'll provide in Part 2 of this letter some additional discussion and references to scientific literature on studies and methods for measuring stream seepage and stream depletion caused by groundwater pumping.

I recommend the Draft EIS/EIR be revised to clearly discuss the methods available for determining the value of the BoR-SDF for each groundwater substitution transfer well. I recommend the Draft EIS/EIR be revised to discuss the procedure for Project Agency review and approval, along with process for review and comment by other public agencies and the public. I recommend the Draft EIS/EIR be revised to discuss the methods and results of prior BoR-SDF determinations. I recommend the Draft EIS/EIR be revised to define the data needed to

determine the “exact percentage” of stream depletion from groundwater substitution pumping during the 10-year transfer project, the technical method(s) that will be used to calculate the amount of stream depletion and the BoR-SDF, and the method(s) for monitoring surface water flow losses and verifying the effectiveness of the BoR-SDF and mitigation measure WS-I.

- c. Section 3.4.1 of the DTIPWTP discusses calculation of baseline groundwater pumping for groundwater substitution transfers. Baseline groundwater pumping and stream depletion reduction are part of the four-step process for determining the amount of transferable water (page 31). Water transfer sellers wanting to use groundwater substitution pumping are requested to submit information to:

Identify all wells that discharge to the contiguous surface water delivery system within which a well is proposed for use in the transfer program, and

The amount of groundwater pumped monthly during 2013 for each well that discharges to the contiguous surface water delivery system.

Section 3.4.2 discusses measuring groundwater pumping provided for groundwater substitution transfers and states that:

Sellers should provide pumping records from all wells that discharge to a contiguous surface water delivery system used in groundwater substitution transfers. (page 32)

The requirement that the groundwater transfer pumping baseline and metering of transfer pumping be conditioned on the water being discharged to the *contiguous surface water delivery system* suggests that if the groundwater substitution pumping discharges to a non-contiguous surface water or directly to a field that the establishment of a pre-transfer pumping baseline and transfer metering aren't required. Is that the case? If it is the case, then how is the amount of transferable water determined whenever the groundwater substitution transfer pumping doesn't discharge to a *contiguous surface water delivery system*? If the pre-transfer baseline pumping is removed from the calculation, does that increase or decrease the amount of transferable water and how does that change the BoR-SDF requirement? Is metering required for groundwater substitution transfer wells that don't discharge to a *contiguous surface streams water delivery system*? If not, how will measurement of transferred water and the required amount of the BoR-SDF be verified? All of these factors are relevant because they are linked to mitigation measure WS-I through the DTIPWTP four-step process to determine the amount of transferrable water. The amount of transferrable water incorporates the BoR-SDF to prevent injury and reduce groundwater substitution pumping stream depletion impacts to less than significant.

I recommend the Draft EIS/EIR be revised to provide a discussion of how the baseline for pre-transfer groundwater pumping will be determined and how metering of all groundwater substitution transfer pumping for wells will be done regardless of whether the well discharges to a contiguous surface water delivery system. I recommend the Draft EIS/EIR be revised to discuss how the BoR-SDF will be determined, monitored, and it's effectiveness verified for all groundwater substitution transfer wells regardless of whether the well discharges to a contiguous surface water delivery system.

Mitigation Measure GW-1

16. The Draft EIS/EIR has only two mitigation measures that apply to the groundwater substitution transfers, WS-1 and GW-1. GW-1 is the principle mitigation measure for the 10-year transfer project's Draft EIS/EIR and is discussed in Section 3.3.4.1. The requirements contained in the October 2013 joint DWR and BoR *Draft Technical Information for Preparing Water Transfer Proposals* (DTIPWTP) and its 2014 Addendum are included in GW-1 by reference. The monitoring and mitigation measures of GW-1 are generally statements of objectives and requirements for development in the future monitoring and mitigation plans that are approved by BoR and perhaps DWR. GW-1 doesn't appear to provide any future opportunity for review and comment by parties that may be impacted by the groundwater substitution transfers such as the non-participating well owners, the public, or other regulatory agencies. GW-1 has statements such as:

The monitoring program will incorporate a sufficient number of monitoring wells to accurately characterize groundwater levels and response in the area before, during, and after transfer pumping takes place. (page 3.3-88)

The monitoring program will include a plan to coordinate the collection and organization of monitoring data, and communication with the well operators and other decision makers. (page 3.3-89)

Potential sellers will also be required to complete and implement a mitigation plan. (page 3.3-89)

To ensure that mitigation plans will be feasible, effective, and tailored to local conditions, the plan must include the following elements: (page 3.3-90 and 3.3-91)

- *A procedure for the seller to receive reports of purported environmental or effects to non-transferring parties;*
- *A procedure for investigating any reported effect;*
- *Development of mitigation options, in cooperation with the affected parties, for legitimate significant effects*
- *Assurances that adequate financial resources are available to cover reasonably anticipated mitigation needs.*

Reclamation will verify that sellers adopt and implement these measures to minimize the potential for adverse effects related to groundwater extraction. (page 3.3-91)

GW-1 does have some specifics on requirements for the frequency of groundwater level monitoring, such as weekly monitoring during the transfer period (page 3.3-89). Requirements for the frequency of reporting are less specific. Summary tables to BoR during and after transfer-related groundwater pumping, and a summary report sometime after the post-project reporting period. The project reporting period extends through March of the year following the transfer (page 3.3-90). The requirement for only a single year of groundwater monitoring appears to be insufficient given the duration of the simulated pumping impacts (see Figure B-5 in Appendix B). Other reporting requirements such as groundwater elevation contour maps are given as "should be included" rather than "shall be included" (page 3.3-90).

The BoR should already have monitoring and mitigation plans and evaluation reports based on the requirements of the DTIPWTP for past groundwater substitution transfers, which likely were undertaken by some of the same sellers as the proposed 10-year transfer project. The Draft EIS/EIR should provide these existing BoR approved monitoring programs and mitigation plans as examples of what level of technical specificity is required

to meet the objectives of GW-1 that include: (1) *mitigate adverse environmental effects that occur*; (2) *minimize potential effects to other legal users of water*; (3) *provide a process for review and response to reported effects*; and (4) *assure that a local mitigation strategy is in place prior to the groundwater transfer* (page 3.3-91). In addition, examples of periodic reporting tables and final evaluation reports should be provided to demonstrate the effectiveness of the GW-1 process at preventing or mitigating impacts from the groundwater substitution transfer pumping. Other deficiencies in GW-1 have been discussed above in my comments nos. 1, 2, 3, 5, 6 and 15, and below in comment no. 18.

I recommend the Draft EIS/EIR be revised to include specifics on additional requirements that must be part of mitigation measure GW-1 including: (1) required distances from wells and surface water features, and aquifer zones for groundwater elevation monitoring; (2) the duration of the required post-transfer monitoring that accounts for the effects of the 10 years of pumping; (3) specifics requirements on scale and detail for maps, figures and tables needed to document groundwater substitution pumping impacts; and (4) specific threshold for changes in groundwater elevation, groundwater quality and subsidence that will be considered significant. I recommend the Draft EIR/EIS be revised to provide existing BoR approved monitoring and mitigation plans and reports for past groundwater substitution transfers as examples of the types of technical information necessary to ensure no injury with less than significant impacts and appropriate mitigations. I recommend the Draft EIS/EIR be revised to provide specifics on how the public will be able to participate in the BoR and DWR approval and revision process for the 10-year transfer project monitoring and mitigation plans. I also recommend the Draft EIS/EIR revise GW-1 to include the issues discussed elsewhere in my comments nos. 1, 2, 3, 5, 6, 15 and 18.

Water Quality

17. The Draft EIS/EIR discusses water quality in Section 3.2, but focuses on potential impacts to surface waters. Discussions of impacts from groundwater substitution transfer pumping on groundwater quality are given in Section 3.3 (pages 3.3-33 to 3.3-35). The Draft EIS/EIR discusses the potential for impacts to groundwater quality from migration of contaminants as a result of groundwater substitution pumping, but provides only a general description of the current condition of groundwater quality. Section 3.3 gives the following statements on water quality:

Groundwater Quality: Changes in groundwater levels and the potential change in groundwater flow directions could cause a change in groundwater quality through a number of mechanisms. One mechanism is the potential mobilization of areas of poorer quality water, drawn down from shallow zones, or drawn up into previously unaffected areas. Changes in groundwater gradients and flow directions could also cause (and speed) the lateral migration of poorer quality water. (pages 3.3-59 and 3.3-60)

Degradation in groundwater quality such that it would exceed regulatory standards or would substantially impair reasonably anticipated beneficial uses of groundwater; or (page 3.3-61)

Additional pumping is not expected to be in locations or at rates that would cause substantial long-term changes in groundwater levels that would cause changes to groundwater quality. Consequently, changes to groundwater quality due to increased pumping would be less than significant in the Redding Area Groundwater Basin. (page 3.3-66)

Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. Groundwater extraction under the Proposed Action would be limited to short-term withdrawals during the irrigation season. Consequently, effects from the migration of reduced groundwater quality would be less than significant. (page 3.3-83)

Groundwater extracted could be of reduced quality relative to the surface water supply deliveries the seller districts normally receive; however, groundwater quality in the area is normally adequate for agricultural purposes. Distribution of groundwater for municipal supply is subject to groundwater quality monitoring and quality limits prior to distribution to customers. Therefore, potential impacts to the distribution of groundwater would be minimal and this impact would be less than significant. (page 3.3-84)

The Draft EIS/EIR notes that several groundwater quality programs are active in the seller regions (pages 3.3-6 to 3.3-10). No maps are provided that show the baseline groundwater quality and known areas of poor or contaminated groundwater. Groundwater quality information on the Sacramento Valley area is available from existing reports by the USGS (1984, 2008b, 2010, and 2011) and Northern California Water Association (NCWA, 2014c). The Draft EIS/EIR doesn't compare the known groundwater quality problem areas with the SACFEM2013 simulated drawdowns to demonstrate that the proposed projects won't draw in or expand the areas of known poor water quality. The Draft EIS/EIR analysis doesn't appear to consider the impacts to the quality of water from private wells. Pumping done as part of the groundwater substitution transfer may cause water quality impacts from geochemical changes resulting from a lowering the water table below historic elevations, which exposes aquifer material to different oxidation/reduction potentials and can alter the mixing ratio of different quality aquifer zones being pumped. Changes in groundwater level can also alter the direction and/or rate of movement of contaminated groundwater plumes both horizontally and vertically, which may expose non-participating wells to contaminants they would not otherwise encounter.

As noted above in my general comment no. 7, the DWR well depth summary maps for the northern Sacramento Valley show that there are potentially thousands of private well owners in and adjacent to the proposed project areas of the groundwater substitution drawdown. Exhibit 2.1 has a composite map of DWR's northern Sacramento Valley well depth summary maps (DWR, 2014a) for the shallow aquifer zone, wells less than 150 feet deep and the areas of groundwater decline from 2004 to 2014 (DWR, 2014b). Exhibit 7.1 has a table that summarizes the range of the number of shallow wells by county that lie within the areas of groundwater decline from 2004 to 2014. In my general comment no. 5, I discussed the concept of capture zones for wells and the need for groundwater modeling using particle tracking to identify the areas where a well receives recharge. Particle tracking to define a well capture zone(s) can also be used to determine if known zones or areas of poor or contaminated water will migrate as a result of the groundwater substitution transfer pumping. Particle tracking can also identify private and municipal wells that lie within the capture zone of a groundwater substitution transfer well and might experience a reduction in water quality from the transfer pumping. Particle tracking can identify locations where mitigation monitoring of groundwater quality should be conducted to quantify changes in groundwater quality.

Even though there are already a number of shallow wells impacted by historic groundwater level declines, the Draft EIS/EIR reaches the conclusion that the groundwater substitution transfer pumping will not cause injury or a significant impact to groundwater quality. This

conclusion is reached in part because the assumed beneficial use of groundwater substitution pumped water is agricultural, or urban, where the quality of water delivered is monitored by an urban water agency. Only these two beneficial uses are assumed even though Table 3.2-2 lists numerous other uses for waters in the seller service areas. The Draft EIS/EIR doesn't provide sufficient information on existing water quality conditions in the Sacramento Valley to allow for evaluation of potential geochemical changes that groundwater substitution pumping might cause. The Draft EIS/EIR sets a standard of significance in degradation of groundwater quality that requires contaminants exceed regulatory standards or impair reasonably anticipated beneficial uses (page 3.3-61). This standard of significance ignores the regulatory requirements of the Water Quality Control Basin Plans (Basin Plans) (http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/index.shtml). The Draft EIS/EIR only briefly discusses the role of the Basin Plans in maintaining water quality (page 3.2-7). In addition this water quality threshold of significance likely violates the State Water Resources Control Board Resolution No. 68-16, titled *Statement of Policy with Respect to Maintaining High Quality of Waters in California*, that states:

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

“The nondegradation policy of the State Board (Resolution No. 68-16) applies to surface and groundwaters that are currently better quality than the quality established in ‘adopted policies.’ In terms of water quality objectives, the basin plans are the source of adopted policies.”

I recommend the Draft EIS/EIR be revised to document the known condition of the groundwater quality in the Sacramento Valley and Redding Basin and include available maps. I recommend that this assessment evaluate the potential impacts from migration of known areas of poor groundwater quality that could be further impaired or spread as a result of the groundwater substitution transfer pumping. I recommend a groundwater quality mitigation measure be provided for evaluation the existing water quality in wells (assuming owner cooperation) within and adjacent to known areas of poor groundwater quality that lie within and adjacent to the simulated groundwater transfer drawdown areas, especially those that lie within the capture zone. I recommend the groundwater quality mitigation measure include: (1) procedures for sampling wells, (2) methods of water quality analysis, (3) a QA/QC program, (4) standards and threshold for water quality impairment consistent with public health requirements and Basin Plan beneficial uses and SWRCB Resolution No. 68-16, (5) provisions for independent oversight and review by regulatory agencies and affected well owners, and (6) specific reporting and notification requirements that keep the owners of non-participating wells, the public, and regulatory agencies informed. I recommend the groundwater quality mitigation measure include provisions for modification and/or treatment of non-participating wells should the quality of water delivered be significantly altered by groundwater substitution transfers. I recommend the groundwater quality mitigation measure be in effect during the 10-year period of transfer pumping and the following recovery period until groundwater flows return to the pre-project condition. I recommend the Draft EIS/EIR also

require a funding mechanism for implementing the groundwater quality mitigation measures for the entire 10-year duration of the groundwater substitution transfers and the recovery period. I recommend the costs of the groundwater quality mitigation monitoring be the responsibility of the project proponents, not the non-participating wells owners or the public. These costs should include reimbursement of any costs incurred by regulatory agency oversight and costs incurred by non-participating well owners.

Subsidence

18. The impacts of subsidence due to groundwater substitution transfer pumping are discussed in Section 3.3. Section 3.3.1.3.2 discusses groundwater-related land subsidence and notes that Global Positioning System (GPS) surveying is conducted by DWR every three years at 339 elevation survey monuments throughout the northern Sacramento Valley (page 3.3-28). In addition, eleven extensometers, as shown in Figure 3.3-11, monitor land subsidence. Figure 3.3-11 provides graphs of the subsidence for five of the eleven extensometers; no information is provided on the results on the GPS surveys. Mitigation measure GW-1 also incorporates by reference the October 2013 DTIPWRP and its 2014 Addendum. The DTIPWRP doesn't add any additional monitoring or mitigation requirements for subsidence, stating that areas that are susceptible to land subsidence may require land surface elevation surveys, and that the Project Agencies will work with the water transfer proponent to develop a mutually agreed upon subsidence monitoring program (pages 34 and 37). Apparently the Draft EIS/EIR expects that the mutually agreed upon subsidence monitoring programs will be a future mitigation measure. The Draft EIS/EIR doesn't discuss how other regulatory agencies or the public will participate in the reviewing and commenting on any future subsidence mitigation measure.

The Draft EIS/EIR relies on local GMPs and county ordinances to prevent impacts from subsidence, but doesn't discuss any specific monitoring or mitigation measures for each proposed groundwater substitution transfer pumping area (page 3.3-7). The Draft EIS/EIR acknowledges that subsidence has occurred in the past in portions of the Sacramento Valley in Yolo County (page 3.3-29), and that the Redding groundwater basin has never been monitored (page 3.3-17). Yet only a qualitative assessment of potential project impacts was done by comparing SACFEM2013 simulated groundwater drawdowns with areas of existing subsidence and by comparing estimates of pre-consolidated heads/historic low heads (page 3.3-61).

The Draft EIS/EIR relies on the mitigation measure GW-1 to prevent and remedy any significant impacts from subsidence. The requirements in mitigation measure GW-1 for subsidence impacts specify that the BoR will determine, apparently in the future and only when mutually agreed upon, the "strategic" monitoring locations throughout the transfer area where land surface elevations will be measured at the beginning and end of each transfer year (page 3.3-89). When the land surface elevation survey indicates an elevation decrease in an area, more subsidence monitoring will be required, which could include: (1) extensometer monitoring, (2) continuous GPS monitoring, or (3) extensive land-elevation benchmark surveys conducted by a licensed surveyor. More extensive monitoring will be required for areas of documented historic or higher susceptibility to land subsidence (page 3.3-89). The Draft EIS/EIR concludes that with these subsidence monitoring mitigation measures of GW-1, impacts will be reduced to less than significant (page 3.3-66).

Exhibits 8.1a to 8.1c provides composite maps using as a base DWR's *Spring 2004 to 2014 Change in Groundwater Elevations* (DWR, 2014b) for the shallow (less than 200 feet bgs), intermediate (200 to 600 feet bgs) and the deep (greater than 600 feet bgs) aquifer

zones in the northern Sacramento Valley. A map of the natural gas pipelines in the Sacramento Valley (Exhibit 8.6) has been scaled and combined with Exhibits 8.1a to 8.1c. Exhibit 8.2 depicts on DWR's (2014b) intermediate zone change in groundwater elevation map, the locations of extensometers and the GPS subsidence grid (from Figure 6 in DWR, 2008; Exhibit 8.4), and the known subsidence area southeast of Williams and into Yolo County (from Draft EIS/EIR Figure 3.3-11)).

The subsidence area in Yolo County isn't fully shown on the DWR's 2014 groundwater elevation change maps, but is shown in the composite maps (Exhibits 8.1a to 8.1c). These exhibits and Exhibit 8.2 show that the western line of extensometers lies along the eastern edge of the intermediate zone of greatest groundwater elevation change, and aligns with the central axis of the mapped changes in groundwater elevation in deeper aquifer zone. The extensometers don't appear to lie within the area of known subsidence southeast of Williams and into Yolo County (Figure 3.3-11). The GPS subsidence grid network does extend across eastern portion of the known subsidence area southeast of Williams and into Yolo County depicted in Figure 3.3-11 and the groundwater elevation change in the intermediate aquifer zone southwest of Orland (Exhibit 8.2).

Although there are several areas in the Sacramento Valley of known decrease in groundwater elevations, known areas of subsidence (Faunt, ed., 2009; Exhibit 8.3), and apparently a GPS network with repeated elevation measurements (Exhibit 8.4), the Draft EIS/EIR doesn't provide any specific information on the "strategic" locations where groundwater substitution pumping done under the 10-year transfer project will require additional subsidence monitoring. The historic subsidence data along with the GPS grid elevation data, historic groundwater elevation change data and the future areas of drawdown from the 10 years of groundwater substitution pumping shown in Figures 3.3-26 to 3.3-31 should be sufficient information to develop the initial "strategic" locations for monitoring potential subsidence. The Draft EIS/EIR should be able to provide the specific thresholds of subsidence that will trigger the need for additional extensometer monitoring, continuous GPS monitoring, or extensive land-elevation benchmark surveys by a licensed surveyor as required by GW-1. The Draft EIS/EIR should also specify in mitigation measure GW-1, the frequency and methods of collecting and reporting subsidence measurements, and discuss how the non-participating landowners and the public can obtain this information in a timely manner. In addition, the Draft EIS/EIR should provide a discussion of the thresholds that will trigger implementation of the reimbursement mitigation measure required by GW-1 for repair or modifications to infrastructure damaged by non-reversible subsidence, and the procedures for seeking monetary recovery from subsidence damage (page 3.3-90). The revised Draft EIS/EIR should review the information provided by Galloway and others (2008), and the Pipeline Research Council International (2009) regarding land subsidence hazards.

An objective of the mitigation measure GW-1 is to mitigate adverse environmental effects from groundwater substitution transfer pumping (page 3.3-88). As part of the preliminary assessment of potential environmental impacts from subsidence due to groundwater substitution pumping, a review and determination of the critical structures that might be impacted is recommended. There are a number of critical structures in the Sacramento Valley that may be susceptible to settlement and lateral movement. These include natural gas pipelines, gas transfer and storage facilities, gas wells, railroads, bridges, water and sewer pipelines, water wells, canals, levees, other industrial facilities. Exhibits 8.5 to 8.11 provide several maps of gas pipeline, and gas and oil related facilities obtained from the web sites of the CA Energy Commission (CEC) and the CA Department of Conservation's Division of Oil, Gas and Geothermal Resources (DOGGR). In addition, composite maps (Exhibits 8.1a

to 8.1c) are provided that show the locations of the natural gas pipelines (Exhibit 8.6) with the DWR 2004 to 2014 change in groundwater elevation maps (DWR, 2014b). Additional maps of railroads, bridges, canals, levees, water and sewer pipelines and important industrial facilities should be sought and the location of those structures compared to the potential areas of subsidence from groundwater substitution transfer pumping. Specific “strategic” subsidence monitoring locations should be given in mitigation measure GW-I based on analysis of the susceptible infrastructure locations and the potential subsidence areas. The local, state and federal agencies that regulate these critical structures and pipelines as well as the facility owners should be contacted for information on the limitations on the amount of movement and subsidence the infrastructures can withstand. The limitations on movement and subsidence should be incorporated into any triggers or thresholds for additional monitoring and implementing mitigations needed to reduce subsidence impacts to less than significant and cause no injury.

I recommend that: (1) the Draft EIS/EIR be revised to provide information on initial “strategic” locations and types of subsidence monitoring that are necessary based on the existing conditions and the proposed groundwater substitution pumping areas; (2) the Draft EIS/EIR and mitigation measure GW-I be revised to provide specific thresholds of subsidence that will trigger the need for additional subsidence monitoring; (3) mitigation measure GW-I be revised to include the frequency and methods of collecting and reporting subsidence measurements; (4) the Draft EIS/EIR discuss how the non-participating landowners and the public can obtain subsidence information in a timely manner; (5) the Draft EIS/EIR and GW-I be revised to provide the thresholds that trigger implementation of the reimbursement mitigation measure required by GW-I for repair or modifications to infrastructure damaged by non-reversible subsidence along with the procedures for seeking monetary recovery from subsidence damage; and (6) the Draft EIS/EIR be revised to provide a map and inventory of critical structures in the Sacramento Valley that may be susceptible to settlement and lateral movement. These structures should include natural gas pipelines, gas transfer and storage facilities, gas wells, power plants, railroads, bridges, water and sewer pipelines, water wells, canals, levees, other industrial facilities. I further recommend that the Draft EIS/EIR solicit advice from local, state and federal agencies, as well as the infrastructure owners on the amount of subsidence that these critical structures and pipelines can withstand, and provide copies of their responses and incorporate their requirements in mitigation measure GW-I to ensure the stability and function of these facilities.

Geology and Seismicity

19. Environmental impacts from the project to geologic and soil resources are discussed in Section 3.4 of the Draft EIS/EIR. The Draft EIS/EIR assumes that because the projects don’t *involve the construction or modification of infrastructure that could be adversely affected by seismic events, seismicity is not discussed in this section.* The Geology and Soils section therefore focused on *chemical processes, properties, and potential erodibility of soils due to cropland idling transfers.* Impacts of subsidence are discussed in Section 3.3 of the Draft EIS/EIR and above in my comment no. 18.

The Draft EIS/EIR reasoning that because the projects don’t involve new construction or modification of existing structures that there are no potential seismic impacts from the activity undertaken during the transfers is incorrect. The project area has numerous

existing structures that could be affected by the groundwater substitution transfer pumping, specifically settlement induced by subsidence. Although the seismicity in the Sacramento Valley is lower than many areas of California, it's not insignificant. There is a potential for the groundwater substitution transfer projects to increase the impacts of seismic shaking because of subsidence causing additional stress on existing structures. The discussion in Section 3.3 on potential subsidence from groundwater substitution pumping was only qualitative because the SACFEM2013 simulations didn't calculate an estimate of subsidence from the transfer projects (page 3.3-61). The subsidence assessment also didn't acknowledge or consider the numerous natural gas pipelines or other critical facilities and structures that occur the Sacramento Valley. Exhibits 8.5 to 8.11 provide a series of maps that show some of the major natural gas pipelines, oil refineries, terminal storage, and power plants in the Sacramento Valley. In addition, there are a number of railroads, bridges, canals, and water and sewer pipelines within the transfer project area. As I discussed in my comment no. 18 on subsidence impacts, some of these existing structures and pipelines are sited within or traverse areas of known subsidence, existing areas of large groundwater drawdown, and areas within the proposed groundwater substitution transfer pumping. There are a number of technical documents on seismic impacts to pipelines (O'Rourke and Norberg, 1992; O'Rourke and Liu, 1999, 2012) as well as a proceeding from a recent ASCE conference on pipelines (Miami, Florida, August 2012).

The characteristics of future seismic shaking in California can be assessed using the following web resources provided by the California Geological Survey (CGS) in conjunction with the U.S. Geological Survey and other academic and professional organizations:

California Fault Activity Map web site:

<http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html>

Probabilistic Seismic Hazard Mapping web site:

<http://www.consrv.ca.gov/cgs/rghm/psha/pages/index.aspx>

Probabilistic Seismic Ground Motion Interpolator web site:

http://www.quake.ca.gov/gmaps/PSHA/psha_interpolator.html

Earthquake Shaking Potential for California Map web site:

http://www.conservation.ca.gov/cgs/information/publications/ms/Documents/MS48_revised.pdf

In addition to the potential impacts to existing infrastructure from seismic shaking, the occurrence of faults within the Sacramento Valley may influence the movement of groundwater. The USGS-CVHM groundwater model (Faunt, ed., 2009) incorporated a number of horizontal flow groundwater barriers (Figure C1-A, pages 160, 203, and 204; Exhibits 9.1, 9.2, 9.3a and 9.3b) that appear to align with faults shown in a series of screen plots from the interactive web site 2010 Fault Activity Map for California (CGS, 2010) (Exhibits 9.4a to 9.4d, 9.5 and 9.6). The SACFEM2013 model documentation didn't indicate that faults were considered as potential flow barriers and the resulting simulation maps in Figures 3.3-26 to 3.3-31 don't show any flow barriers.

I recommend that the Draft EIS/EIR be revised to: (1) assess the potential environmental impacts from seismic shaking on critical structures and pipelines in areas of potential subsidence caused by the groundwater substitution transfer pumping; (2) provide maps that identify and locate existing pipelines and critical structures such as storage facilities, railroads and bridges within the areas

affected by groundwater substitution pumping; (3) solicit and provide results of the advice from local, state and federal agencies, as well as the infrastructure owners, on the amount of subsidence that these critical structures and pipelines can withstand under in both static and seismic conditions; (4) provide a mitigation measure(s) that addresses the requirements for monitoring the subsidence in the area of these critical structures and pipelines; and (5) provide specific monitoring and reporting requirements for potential seismic impacts to critical structures that includes establishing any additional structures for monitoring and taking subsidence measurements, and conducting additional periodic surveys of ground elevation and displacement. I recommend the Draft EIS/EIR be revised to provide the thresholds that trigger implementation of the reimbursement mitigation measure required by GW-1 for repair or modifications to infrastructure that may be damaged by seismic movement in areas that have exceeded the thresholds for non-reversible subsidence, and provide procedures for seeking monetary recovery from subsidence damage. I also recommend the Draft EIS/EIR be revised to discuss the importance and impacts of the horizontal flow barriers and/or faults within the Sacramento Valley on the results of the drawdown and stream depletion simulations of SACFEM2013.

II. Additional Technical Information Relevant to the Assessment of Potential Environmental Impacts from the 10-Year Groundwater Substitution Transfers.

Historic Changes in Groundwater Storage

20. The Draft EIS/EIR provides SACFEM2013 simulations of groundwater substitution transfer pumping effects for WY 1970 to WY 2003. The discussion of the simulation didn't provide specifics on how the model simulated the current conditions of the Sacramento Valley groundwater system or the potential impacts from the 10-year groundwater substitution transfer project based on current conditions. A DWR groundwater contour map, Figure 3.3-4, shows the elevations in the spring of 2013 for wells screened at depths greater than 100 ft. bgs. and less than 400 ft. bgs. Figures 3.3-8 and 3.3-9 provide the locations and simulation hydrographs for selected monitoring wells in the Sacramento Valley. Appendix E provides additional monitoring well simulation hydrographs for selected wells at locations shown on Figures 3.3-26 to 3.3-31. As discussed above in comments no. 7, these hydrographs appear to show only simulated groundwater elevations. Actual measured groundwater elevations are needed to evaluate the accuracy of the simulations. The Draft EIS/EIR briefly discusses on page 3.3-12 the groundwater production, levels and storage for the Redding Basin, and on pages 3.3-21 to 3.3-27 there is a similar discussion for the Sacramento Valley. Faunt (ed., 2009) is cited for the conditions of the Sacramento Valley groundwater budget and Figure 3.3-10, taken from Faunt (ed., 2009; Figure B9; Exhibit 10.2a), shows the historic change in groundwater storage in the Central Valley as determined by the CVHM model simulations. Based in part on the information in Faunt (ed., 2009), the Draft EIS/EIR concludes that the Sacramento Valley basin's groundwater storage has been relatively constant over the long term, decreasing during dry years and increasing during wetter periods. However, the Draft EIR/EIS's discussion of the status of groundwater in the Sacramento Valley doesn't utilize all of the information on groundwater storage or water balance available in Faunt (ed., 2009), more recent simulation studies by Brush and others (2013a and 2013b), or the summary of groundwater conditions in recent reports by the Northern California Water Association (NCWA) (2014a and 2014b).

Faunt (ed., 2009) provides in Table B3 (Exhibit 10.1) selected average annual hydrologic budget values for WYs 1962-2003. In addition, Figures B10-A and B10-B of Faunt (ed., 2009) show bar graphs for the average annual groundwater budget for the Sacramento Valley and the Delta and Eastside Streams (Exhibits 10.2b and 10.2c). Table B3 gives the water balances for subregions in the Sacramento Valley (1 to 7) and the Eastside Streams (8). Table B3 gives values for the *net storage from specific yield and compressibility of water*; positive values indicate an increase in storage, while a negative value is a decrease. For Sacramento Valley, the sum of the annual average from 1962 to 2003 in net storage is given as -99,000 AFY and for the Eastside streams -26,000 AFY. Unfortunately, the components in Table B3 don't seem to be a complete groundwater water budget, so following the calculations of the average annual net change in groundwater storage isn't obvious. Figures 10A and 10B (Exhibits 10.2a and 10.2b), however, do provide bar graphs of the groundwater water budgets with values for the entire Sacramento Valley and the Delta and Eastside Streams. If it's assumed that groundwater pumping shown as a negative value in Figures 10A and 10B represents an outflow from groundwater storage, then other negative values would also be considered outflows. Positive values are therefore assumed to be inflows to groundwater storage.

For the entire Sacramento Valley (subregions 1 to 7), Faunt (ed., 2009) shows the net change in annual groundwater storage as the sum of the negative outflows and positive inflow in Figure 10A at a negative 650,000 AFY (-0.65 million AFY) ($2.88 - [0.29+0.03+1.66+1.37+0.18] = 2.88 - 3.53 = -0.65$). The values in Figure 10B can be summed in a similar manner and yield a net change in storage of a positive 90,000 AFY for the Delta and Eastside Streams. Unfortunately, the bar graph in Figure 10B for the Eastside Streams (subregion 8) doesn't have numerical values. A visual comparison of the inflow and outflow bars suggests that for subregion 8 the outflows, mostly pumping, are at or slightly greater than the inflows.

The groundwater budget information by Faunt (ed., 2009) can be compared with two other more recent sources of Sacramento Valley information contained in four documents, Brush and others (2013a and 2013b) and NCWA (2014a and 2014b). Brush and others report on the recent version of the C2VSim groundwater model (version R374) and provide simulation results. The NCWA reports also used the C2VSim (R374) model, but provided additional analysis and results of the historic land development, water use and water balances in Sacramento Valley. Some of the information developed by Brush and others (2013a and 2013b), and Faunt (ed., 2009) on the condition of the Sacramento Valley groundwater system was previously discussed in my comments on the SACFEM2013 model simulations, nos. 8 to 14.

My comment no. 14 on groundwater flow between subregions is also relevant to this discussion of the historic changes in groundwater storage. Accounting for the transfer of groundwater between regions is critical for understanding the impacts of pumping in one region or area on the adjacent regions. The sources of water backfilling a groundwater depression don't all have to come from surface waters, ie., stream depletion, precipitation, deep percolation, and artificial recharge. Some of that "recharge" can come from adjacent aquifers by horizontal and vertical flow. When pumping creates a depression in the water table or piezometric surface, the depression steepens the gradient thereby increasing the rate of flow towards it; the depression can also change the direction of groundwater flow. Often the "recharge" to a pumping depression comes from adjacent groundwater storage that lies outside the zone of influence of the pumping. When the rates and volumes of recharge from surface waters are insufficient to rapidly backfill a pumping depression, the impact on groundwater storage and elevations in adjacent regions increases.

Brush and others (2013a) provide a breakdown of water budget by subregion, Tables 10 to 13 (Exhibits 6.3a to 6.3d), but only for the selected three decades (1922-1929, 1960-1969, and 2000-2009), and for the total modeled period from 1922 to 2009. They do provide values for the change in groundwater storage for all 21 of the Central Valley subregions and 5 hydrologic regions. Of particular importance to the discussion of the current condition of the groundwater basin are the results of the C2VSim simulations of the annual average change in groundwater storage for each of the three decades and from 1922 to 2009, Tables 10 to 13 (Exhibits 6.3a to 6.3d). For the Sacramento Valley (subregions 1 to 7), Table 10 lists the 1922-2009 change in storage as -165,417 AFY (I'm assuming the units of the table are acre-feet), and for the Eastern Streams (subregion 8) -135,304 AFY. For the most recent decade, 2000-2009, the average annual change in groundwater storage has increased in both the Sacramento Valley and the Eastern Streams to -303,425 AFY and -140,715 AFY, respectively (Table 13). Although the tables in Brush and others don't list the groundwater flow between subbasins, Figures 81A to 81C (2013a) and Figure 39 (2013b) (Exhibits 6.1a to 6.1c and 6.2) provide this information for the selected decades and for the total simulation period. As discussed above in my comment no. 14, the change in interbasin groundwater flow can be significant particularly when recharge in a region is deficient. The Draft EIS/EIR should specifically discuss and account for any changes in the rate and direction of interbasin groundwater flow. Interbasin groundwater flow may become a hidden long-term impact that increases the time needed for recovery of groundwater levels from groundwater substitution transfer pumping, and can extend the impact from groundwater substitution transfer pumping to areas outside of the groundwater substitution transfer seller's boundary.

Two recent reports on the condition of groundwater in the Sacramento Valley are provided by the Northern California Water Association (NCWA, 2014a and 2014b). Tables 3-6, 3-7, and 3-8 in the NCWA technical supplement report (2014b; Exhibits 10.5a to 10.5c) provide water balance information for the Sacramento Valley for the same three decades as Brush and others (2013a). The NCWA tables separate the water balance elements into three types, land uses (Table 3-6), streams and rivers (Table 3-7), and groundwater (Table 3-8). The values of the change in groundwater storage given in Table 3-8 are similar to those given by Brush and others (2013a). The NCWA technical supplement report (2014b) also provides additional information on the 1922 to 2009 water balance through the use of graphs and bar charts. Figures 3-22 and 3-24 (Exhibits 10.6c and 10.6d) provide graphs of simulated estimates of annual groundwater pumping in the Sacramento Valley and the annual stream accretion. Positive stream accretion occurs when groundwater discharges to surface water, negative when groundwater is recharged. Other graphs include simulated deep percolation, Figures 3-26 and 3-27 (Exhibits 10.6e and 10.6f), annual diversions, Figures 3-19 and 3-20 (Exhibits 10.6a and 10.6b), and relative percentages of surface water to groundwater supplies, Figure 3-29 (10.6g).

The NCWA technical supplement report (2014b) notes in Sections 3.8 and 3.8.4 that negative changes in groundwater storage

... suggest that the groundwater basin is under stress and experiencing overdraft in some locations. Review of the Sacramento Valley water balance, as characterized based on C2VSim R374 and summarized in Tables 3-6 through 3-8 reveals substantial changes in water balance parameters over time that affect overall groundwater conditions. ... Over time, it appears that losses from surface streams have increased as a result of declining groundwater levels. The declining levels result from increased demand for groundwater as a source of supply without corresponding increases in groundwater recharge. (page 41)

A contributing factor to the decrease in accretions to rivers and streams over the last 90 years is that deep percolation of surface water supplies (and other forms of recharge) has not increased in a manner that offsets increased groundwater pumping. (page 48)

The simulated groundwater pumping graph in NCWA Figure 3-22 and stream accretion graph in NCWA Figure 3-24 were combined into one graph by scaling and adjusting their axes (Exhibits 10.7). The vertical scales of these two graphs were adjusted so that a zero value of stream accretion aligned with 1.5 million acre-feet (MAF) of annual groundwater pumping. This alignment was done to reflect the fact that in the early 1920s, groundwater pumping was approximately 0.5 MAF per year (MAFY) while stream accretion was approximately 1.0 MAFY. As shown in the combined graph, stream accretion generally decreases at approximately the same rate as groundwater pumping increases. Thus, at a point of no appreciable groundwater pumping, pre-1920s, the total long-term average annual stream accretion was likely 1.5 MAF, based on the C2VSim simulations.

Drawn on top of the stream depletion and groundwater pumping graphs are several visually fit, straight trend lines. These lines, which run from 1940 to the mid-1970s and the late 1980s to mid-1990s, are mirror images reflected around the horizontal 0 accretion axis. Information provided at the bottom of the composite graph was taken from NCWA Tables 3-7 and 3-8 (Exhibits 10.5b and 10.5c). The slope of the trend line from 1940 to the mid-1970s is approximately (+-)27,000 AFY, and (+-)85,000 AFY in the late 1980s to the mid-1990s; a 3-fold increase in slope. After the mid-1990s the slope of groundwater pumping flattens to be similar to that of the 1940s–mid-1970s, while the stream depletion line became almost flat, ie., no change in rate of accretion. The reason for the stream depletion rate being flat is unknown, but there are several factors that could contribute to a fixed rate of stream accretion.

First, after depleting 1.5 MAFY from the Sacramento Valley streams, the surface waters may not be able to provide much more, at least no increase to match the pumping. Second, this may also be a consequence of the model design because the number of streams simulated was limited. Third, the model's grid may not extend out far enough to encompass all of the streams that contribute to groundwater recharge. More information on the areas of where streams gain and lose in the Sacramento Valley is needed to determine if there are any sections of stream, gaining or losing, that might still have the ability to interact at a variable rate in the future, ie., during and after the 10-year groundwater substitution transfer project.

A third graph is drawn on the composite accretion-pumping graph in Exhibit 10.7 that shows the C2VSim simulated cumulative change in groundwater storage for the Sacramento Valley from 1922 to 2009. This graph was taken from Figure 35 of Brush and others, 2013b (Exhibit 10.4). A straight trend line with a negative slope of approximately -163,417 AFY is drawn on top of the third graph, which is the value for average annual change in storage from 1922 to 2009 given in Table 10 of Brush and others (2013a; Exhibit 6.3a) for the seven subregions of the Sacramento Valley. The selected graph of the cumulative change in groundwater storage is one of three available.

The graph of cumulative change in groundwater storage for the Sacramento Valley in Figure 35 differs from the graph in Figure 83 in Brush and others (2013a; Exhibit 10.3) and in Figure B9 of Faunt (ed., 2009; Exhibit 10.2a). Both of Figure 83 and Figure B9 show a gain in groundwater storage with their Sacramento Valley graphs lying generally above the horizontal line of zero change in storage. The cumulative change in groundwater storage graph from Figure 35 (Exhibit 10.4) was selected because:

- its slope is a close match for the average annual change in storage from 1922 to 2009 of -163,417 AFY given in Table 10,
- the values for change in groundwater storage in the three selected decades are all negative (Table 3-8, NCWA, 2014b), which the other two graphs don't clearly indicate,
- the calculation of average annual change in groundwater storage from 1962 to 2003 shown in Table B3 and Figures B10-A and B10-B of Faunt (ed., 2009) are negative, which conflicts with Figures B9 and 83, and
- change in DWR groundwater elevation maps from spring 2004 to spring 2014 (Exhibit 3.1, 3.2 and 3.3) suggest that there are significant regions of the Sacramento Valley that have lost groundwater storage, which suggests that the current condition is one of a loss in storage rather than a gain.

Additional review and analysis of the changes in groundwater storage in the Sacramento Valley is needed. Any additional review of changes in groundwater storage in the Sacramento Valley should consider the recent changes in groundwater elevations such as those shown in DWR (2014b) for WYs 2004 to 2014, and Figures 2-4 and 2-5 of NCWA, 2014b (Exhibit 10.8 and 10.9), as well as other studies such as the support documents for the regional IRWMPs.

I recommend the Draft EIS/EIR be revised to provide a more comprehensive assessment of the historic change in groundwater storage in the Sacramento Valley groundwater basin, and other seller sources areas within the proposed 10-year groundwater substitution transfer project. I also recommend that the Draft EIS/EIR be revised to include an assessment of the impacts of groundwater flow among subregions due to the proposed 10-year groundwater substitution transfer project.

The Concept of the Stream Depletion Factor, SDF

21. The Draft EIS/EIR proposes that a stream depletion factor, BoR-SDF, be applied to groundwater substitution transfers as mitigation for flow losses due to groundwater pumping. The Draft EIS/EIR implies that the BoR-SDF will be a fixed percentage of the transferred groundwater substitution water. The main text of the Draft EIS/EIR doesn't clearly specify the BoR-SDF percentage, but appended documents state that the default is 12%, *unless available monitoring data analyzed by Project Agencies supports the need for the development of a transfer proposal site-specific SDF* (page 33 in the DTIPWTP). Elsewhere in the Draft EIS/EIR, the average annual surface water-groundwater interaction losses are estimated at approximately 15,800 AF and in multiple dry years losses of 71,200 AFY are anticipated (page 3.1-18). The Draft EIS/EIR proposes mitigation measure WS-1, which utilizes the BoR-SDF with the transfers to account for the losses from stream depletions, and thereby reduces the water supply impacts to less than significant (page 3.1-18). As I discussed above in my comment no. 9, the maximum annual groundwater substitution pumping is 290,495 AF as calculated from Table 2-5. The estimated annual average surface water-groundwater interaction loss of 15,800 AF is 5.4 % of the maximum allowable annual groundwater substitution transfer, while a loss of 71,200 AF is 24.5%.

The use of a fixed percentage of transfer water to mitigate increased stream flow losses from the groundwater substitution pumping may not result in the reduction of stream flow impacts to less than significant. I've discussed above in my comment no. 15 several of the issues about the design of mitigation measure WS-1. The following are additional comments on WS-1 specific to the fixed percentage BoR-SDF and how it differs from the concept of stream depletion commonly used in scientific literature.

Jenkins (1968a and b; Barlow and Leake, 2012) defined the “stream depletion factor” (herein called the Jenkins-SDF) as the product of the square of the distance between a well and a surface water body (a^2) multiplied by the storage coefficient (S or S_y) divided by the transmissivity (T) (Jenkins-SDF = distance² × storage coefficient/transmissivity = $a^2 \times S/T$) (see Table I and page 14 in Barlow and Leake, 2012). The units of the Jenkins-SDF are in time, i.e., days, years, etc. The Jenkins-SDF also occurs in Theis’ well function, $W(u)$ (see pages 136 and 150 in Domenico and Schwartz, 1990). Domenico and Schwartz (1990) showed that the Jenkins-SDF can be expressed as a dimensionless Fourier number, which occurs in all unsteady groundwater flow problems. The Jenkins-SDF has several other important characteristics that are not part of the BoR-SDF, which likely influence the actual rate and volume of surface water lost due to groundwater substitution transfer pumping.

1. The value of stream depletion varies with the duration of pumping and unlike the BoR-SDF isn’t a fixed value. For an ideal aquifer (homogeneous, isotropic and infinite), two ideal curves normalized to the Jenkins-SDF value can be created that show stream depletion as a percentage of the total pumping rate or total pumped volume against the normalized logarithm of pumping time (see Figure I from Miller and Durnford, 2005; Exhibit 11.1). In Figure I, equation no. 1 shows the instantaneous rate of stream depletion as a percentage of the maximum pumping rate versus the logarithm of normalized time, and equation no. 2 shows the volume of depletion as a percentage of the total volume pumped versus the logarithm of normalized time. Jenkins somewhat arbitrarily defined his SDF as the pumping duration equal to the calculated stream depletion factor ($a^2 \times S/T$). Jenkins noted that for the ideal aquifer at the time of the SDF, the cumulative volume of water depleted from the stream equals 28% of the total volume pumped (Jenkins, 1968a; Wallace and Durnford, 2005 and 2007). As shown in Figure I in Exhibit 11.1, when the actual pumping duration is normalized to the Jenkins-SDF, the ideal volume curve always goes through 28% when the pumping time equals the Jenkins-SDF (time/SDF = 1; Jenkins, 1968a).
2. An important factor in the Jenkins-SDF is that stream depletion varies with the square of the distance between the well and the stream, whereas, the depletion rate varies only linearly with changes in S or T . The ratio of T/S is also called the hydraulic diffusivity, D , which has units of length²/time (see Table I and Box A in Barlow and Leake, 2012). The rate that hydraulic stress propagates through an aquifer is a function of the diffusivity. Greater values of D result in more rapid propagation of hydraulic stresses. Barlow and Leake (2012) note that the ratio T/S (or T/S_y) controls the timing of stream depletion and not each value individually. Streamflow depletion can occur more rapidly in confined aquifers than in unconfined aquifers because S is much smaller than S_y , resulting in a larger D value.
3. For a given duration of pumping, the percentage of instantaneous depletion is greater than the percentage of volume depleted. For the ideal aquifer at a pumping duration equal to the Jenkins-SDF value, the instantaneous depletion is 48% of the maximum pumping rate, while the cumulative volume of depletion is 28% of the total pumped volume (Figure I, Exhibit 11.1). For a non-ideal aquifer where numerical simulations are needed to estimate stream depletion, eg., the SACFEM2013 simulations, the time when the cumulative volume of stream depletion is at 28% of the total volume pumped can be used as an “effective” Jenkins-SDF to allow for evaluation and comparison of potential impacts from pumping.
4. Stream depletion continues to occur after pumping ceases. Jenkins (1968a, b) referred to this as residual depletion. Depending on the duration of pumping and the value of the Jenkins-SDF, stream depletion can be greater after pumping ceases (see

pages 42 to 45 in Barlow and Leake, 2012). Barlow and Leake (2012 on page 43) give the following five key points regarding stream depletion after cessation of pumping:

- a. *Maximum depletion can occur after pumping stops, particularly for aquifers with low diffusivity or for large distances between pumping locations and the stream.*
 - b. *Over the time interval from when pumping starts until the water table recovers to original pre-pumping levels, the volume of depletion will equal the volume pumped.*
 - c. *Higher aquifer diffusivity and smaller distances between the pumping location and the stream increase the maximum rate of depletion that occurs through time, but decrease the time interval until water levels are fully recovered after pumping stops.*
 - d. *Lower aquifer diffusivity and larger distances between the pumping location and the stream decrease the maximum rate of depletion that occurs through time, but increase the time interval until water levels are fully recovered after pumping stops.*
 - e. *Low-permeability streambed sediments, such as those illustrated in figure 11, can extend the period of time during which depletion occurs after pumping stops.*
 - f. *In many cases, the time from cessation of pumping until full recovery can be longer than the time that the well was pumped.*
5. As noted above in key point no. 4b, the volume of stream depletion will eventually equal the total pumped volume. The time required for full aquifer recovery from pumping depends on the value of the Jenkins-SDF, availability of water to capture, the rate and duration of recharge above what normally occurs, and other factors like the streambed sediment permeability and aquifer layering. Figure 1 in Exhibit 11.1 also shows that for an ideal aquifer the time needed to reach 95% depletion is approximately 127 times the Jenkins-SDF value. This is consistent with the estimates made by Wallace and others (1990) in Table 3 (Exhibit 11.2) on the time it takes to reach 95% depletion, which they consider a point where a new dynamic equilibrium is established. Although the 127-times-SDF multiplier assumes continuous pumping, the fact is the time for full recovery by residual depletion without pumping shouldn't be any sooner than it takes to obtain 95% stream depletion with pumping. In other words, rate and volume of loss from a stream can't be any higher without pumping than with pumping, all other parameters being equal. This means that without some additional source of recharge above what normally occurs, including natural wet and dry cycles, the total time required to achieve full recovery from the 10 years of groundwater substitution transfer pumping will be much longer than the 5 years cited in the Draft EIS/EIR (pages 3.3-80). For additional discussion of the stream depletion under natural variations in recharge and discharge see Maddock and Vionnet (1998).

Another factor that isn't clearly acknowledged in the Draft EIS/EIR is the difference between the instantaneous depletion rate and cumulative volumetric depletion rate. The Draft EIS/EIR appears to focus on cumulative volumetric depletion in mitigation measure WS-1. However, the instantaneous stream depletion rate is probably more important when evaluating impacts to fisheries and stream habitat. The instantaneous rate of flow, instantaneous depth of flow and the corresponding instantaneous wetted perimeter of flow at any point in a stream are the best measures of habitat value to the fish and other water dependent species. The cumulative volume of stream depletion relative to the total pumped volume, on the other hand, can't be easily translated stream to instantaneous flow, water depth or wetted perimeter at a point in a stream because discharges having different hydrographs can result in the same total volume of flow. For example, if I estimate that the stream depletion during a 3- to 6-month period of groundwater substitution pumping will be a maximum of 1 cubic-foot-per-second, I can evaluate the significance of this change to the stream's habitat value using the stream's historic hydrograph and fluvial geomorphology. However, if I estimate that over the same period of pumping the stream will lose, at the end

of pumping, a total 12 percent of the total volume pumped, I can't determine what changes will occur in the habitat function of the stream at a specific time and place. Perhaps, if I assume that the cumulative volume of stream depletion increases linearly with time, going from zero at time zero, to 12% at the end of pumping, then I could also assume that the instantaneous rate of stream depletion would also change linearly from 0% at the start to 24% of the pumping rate at the end of pumping. Remember that in this case the area under the instantaneous depletion curve is triangular, and therefore the maximum instantaneous depletion rate would be twice the total cumulative depletion rate. In reality, the ratio of instantaneous to volumetric depletion for the ideal Jenkins-SDF curves vary with pumping duration; the ratio is approximately 1.7:1 for time/SDF = 1 (Figure 1, Exhibit 11.1). Figure 1 also shows for the ideal curve that when the instantaneous depletion (eq. 1) is 24%, the volumetric depletion is 10% (eq. 2), a ratio of 2.4:1, and when eq. 1 is at 83%, eq. 2 is at 70%, a ratio of 1.19:1.

Mitigation measure WS-1 appears to be based on the cumulative volume of water pumped for each period of groundwater substitution transfers, not the instantaneous rate of stream depletion caused by the pumping. Mitigation measure WS-1 uses of a fixed value for compensating stream losses, which is inconsistent with the hydraulics of stream depletion. Because stream depletion actually increases with pumping time, mitigation measure WS-1 needs to specify the maximum duration of pumping allowed, ensuring that the depletion rate stays below the WS-1 value, ie., 12%. This maximum duration of pumping should be established based on impacts to stream habitat from instantaneous changes in stream flow, not the cumulative change in volume. The maximum duration of allowable pumping would change with the distance between the well and stream and with the diffusivity around each well because these control the rate of stream depletion. The well acceptance criteria in Table B-1 of Appendix B in the DTIPWTP suggests that some calculation has been made to establish the specified setback distances, but no methodology or calculation is given in the Draft EIS/EIR. The Draft EIS/EIR should document how the maximum allowable stream depletion rate, instantaneous and volumetric, and the associated maximum duration of pumping will be calculated for each well in the groundwater substitution transfer project.

Although the Draft EIS/EIR doesn't fully evaluate the potential stream depletion that may occur with the proposed 10-year groundwater substitution transfer project, another report prepared by CH2MHill (2010) and submitted to DWR provides additional analysis on the simulated impacts from the 2009 groundwater substitution transfers. The simulations of the 2009 transfer impacts were done using the SACFEM model, presumably an earlier version of the SACFEM2013 model. Figures 4, 5 and 6 in the CH2MHill 2010 report provide simulation graphs of stream depletion for three groundwater substitution transfer periods, 1976, 1987 and 1994 (Exhibits 11.3a to 11.3c). Graphs (a) to (c) in each figure appear somewhat like Figures B-5 and B-6 in Appendix B of the Draft EIS/EIR in that they show a depletion peak shortly after pumping starts, with a gradual decay following the cessation of pumping. Graphs (d) of Figures 4, 5 and 6 are not provided in the Draft EIS/EIR, but provide important additional information. These (d) graphs show the cumulative depletion for each of the three scenarios and are essentially the volumetric depletion curve of eq. 2 in Miller and Durnford's Figure 1 (Exhibit 11.1). These cumulative volume depletion curves are important because they show the time needed to fully recover from the three groundwater substitution transfer pumping events. For example, Figure 4(d) shows that recovery from the pumping event in 1976 is only approximately 60% after 25 years; much longer than the 5 years for 55% to 75% recovery stated in the Draft EIS/EIR (pages 3.3-70). For comparison, Figure 4(d) of CH2Mhill (2010) is plotted on Miller and Durnford's Figure 1 in Exhibit 11.1 by normalizing the values plotted in 4(d) by an effective Jenkins-SDF value of 2.4 years.

Notice that for the simulated Figure 4(d) Jenkins-SDF curve, depletion initially occurs sooner than with an ideal aquifer, but then depletion slows. At 127 times the SDF, approximately 300 years, the depletion is at approximately 80%.

A point can be identified on each graph (d) where the volume of stream depletion is equal to 28%, the Jenkins-SDF point, and the time since pumping started measured. For example, in Figure 4(d) approximately at approximately 2.4 years after the beginning of pumping the volume of depletion reaches 28%. For Figure 5(d) the time to 28% is similar, estimated at 2.3 years. The time interval to 28% volumetric depletion in Figure 6(d) is significantly greater at an estimated 7.5 years. The results presented in both Figures 4 and 5 are from simulation of stream depletion during dry or critically dry years followed by normal or dry years, while the simulation scenario of Figure 6 is for a critical year followed by wet years. All of the cumulative (d) graphs are filtered for the Delta conditions. This may be the reason it takes longer for stream depletion to reach 28% during a wet period than dry period when one might expect the opposite because of the increased stream flow would provides more water for recharge.

The point of this discussion is that the simulated stream depletions from the SACFEM2013 modeling can also be presented as cumulative depletion response curves that are normalized by the effective Jenkin-SDF time. The stream depletion can then be estimated for any rate or duration of pumping at an individual well when the stream depletion response curves given as percentages of both the maximum pumping rate and total volume pumped are normalized to the effective Jenkins-SDF (without the Delta conditions filter). Losses for different distances between the well and surface water feature can be roughly estimated without the need to run another simulation by adjusting the Jenkins-SDF curves by the ratio of the square of the different distances. Cumulative depletion for different pumping rates during and following the 10-year groundwater substitution transfer project can be estimated by the principle of superposition (Wallace and other, 1990; Barlow and Leake, 2012). As I discussed in my comment no. 15b, additional discussion is needed in the Draft EIS/EIR on how the amount of stream depletion for WS-I is calculated. This discussion should include normalized stream depletion response curves for each groundwater substitution transfer well so that impacts from pumping can be estimated for different pumping durations and rates.

Barlow and Leake (2012) provide an extensive discussion of the factors controlling stream depletion including several misconceptions (pages 39 to 45). Review of their discussion of stream depletion misconceptions is recommended as part of any revision of the Draft EIS/EIR. Barlow and Leake identified the following misconceptions regarding stream depletion (page 39):

- *Misconception 1. Total development of groundwater resources from an aquifer system is “safe” or “sustainable” at rates up to the average rate of recharge.*
- *Misconception 2. Depletion is dependent on the rate and direction of water movement in the aquifer.*
- *Misconception 3. Depletion stops when pumping ceases.*
- *Misconception 4. Pumping groundwater exclusively below a confining layer will eliminate the possibility of depletion of surface water connected to the overlying groundwater system.*

I recommend that the Draft EIS/EIR be revised to document stream depletion response curves for each groundwater substitution transfer well. These response curves should be normalized to the effective Jenkins-SDF value, given as a percentage of the pumping rate and total pumped volume, along with the

distance between the well and the modeled surface water feature. Multiple stream depletion response curves should be provided, if necessary. I recommend that the Draft EIS/EIR be revised to review how the BoR-SDF value accounts for the variability in rate and volume of stream depletion. I recommend that the Draft EIS/EIR be revised to document how the maximum allowable instantaneous and volumetric stream depletion rates, and the associated maximum duration of pumping will be calculated for each well in the groundwater substitution transfer project to ensure that the BoR-SDR provides adequate flow mitigation. I recommend that the Draft EIS/EIR be revised to discuss how WS-I addresses the common stream depletion misconceptions noted by Barlow and Leake (2012).

Measurement of Stream Seepage in Real Time

22. Barlow and Leake (2012) state that methods for determining the effects of pumping on stream flow follow two general approaches: (1) collection and analysis of field data, and (2) analytical and numerical modeling (page 50). The Draft EIS/EIR states in the OTIPWTP that stream depletion can't be measured in real time (page 33) and instead relies on simulations of groundwater pumping to determine impacts to surface waters. As discussed in **my comment no. 15b**, the Draft EIS/EIR also states that monitoring of surface water-groundwater interaction is part of mitigation measures WS-I and GW-I. The statement that stream depletion measurements, ie., stream seepage rates, surface water depths, and surface flows, can't be done in "real time" conflicts with scientific literature. Measurements of stream flow and water depth are fundamental to stream surveys. Although measurement of the seepage rate from or into a stream is done less often and is generally more difficult than other direct surface water measurements, procedures for making these measurements are well documented (Barlow and Leake, 2012; Rosenberry and LaBaugh, 2008; Zamora, 2008; Stonestrom and Constantz, ed., 2003; Constantz, 2008; Kalbus and others, 2006). Linking field measurements to changes in stream flow and seepage to adjacent groundwater pumping is made more difficult because of the lag between the start of pumping and stream response, damping of the pumping response with increases in distance between the well and measured surface water body, and the variation in seepage rate with the increases in pumping time or pumping cycles. Measurements of surface water and groundwater flow are also difficult because of inherent measurement errors that are sometimes greater than the change in flow being sought. Barlow and Leake (2012) discuss the measurement of stream depletion and conclude that:

Two general approaches are used to monitor streamflow depletion: (1) short-term field tests lasting several hours to several months to determine local-scale effects of pumping from a specific well or well field on streams that are in relative close proximity to the location of withdrawal and (2) statistical analyses of hydrologic and climatic data collected over a period of many years to test correlations between long-term changes in streamflow conditions with basinwide development of groundwater resources. Direct measurement of streamflow depletion is made difficult by the limitations of streamflow-measurement techniques to accurately detect a pumping-induced change in streamflow, the ability to differentiate a pumping-induced change in streamflow from other stresses that cause streamflow fluctuations, and by the diffusive effects of a groundwater system that delay the arrival and reduce the peak effect of a particular pumping stress. (Page 77)

The Draft EIS/EIR provides the following statements in the DTIPWTP regarding groundwater substitution transfers, which are therefore part of mitigation measure GW-I:

- ... must account for ... the extent to which transfer-related groundwater pumping decreases

streamflow (resulting from surface water-groundwater interaction), and the timing of those decreases in available surface water supply. (page 25);

- *Project Agencies are developing tools to more accurately evaluate the impacts of groundwater substitution transfers on streamflow. These tools may be implemented in the near future and may include a site-specific analysis that could be applied to each transfer proposal. (page 33);*
- *Water transfer proponents transferring water via groundwater substitution transfers must establish a monitoring program capable of identifying any adverse transfer related effects before they become significant. (page 34);*

The objectives of the DTIPWTP groundwater substitution transfer-monitoring program include:

- *Determine the extent of surface water-groundwater interaction in the areas where groundwater is pumped for the transfer;*
- *Determine the direct effects of transfer pumping on the groundwater basin, observable until March of the year following the transfer;*
- *Assess the magnitude and potential significance of any effects on other legal users of water, instream beneficial uses, the environment, and the economy. (page 34)*

All of these statements and monitoring objectives imply that measurement of impacts to surface water from groundwater substitution transfer pumping is possible. While measurement of stream depletion is complex and problematic, it is possible. The conflicting statements in the Draft EIS/EIR that “real time” measurements can’t be done while apparently including a requirement for field monitoring of the effects of stream depletion in mitigation measures WS-I and GW-I need further explanation.

I recommend that the Draft EIS/EIR be revised to evaluate and discuss the methods, techniques and procedures available for monitoring and measuring the rate, volume and impacts of stream depletion due to groundwater substitution transfer pumping. The revised Draft EIS/EIR should provide specific mitigation measures, procedures and methods for monitoring groundwater substitution transfer pumping impacts on surface water features, including the frequency of monitoring and reporting.

Other Available Data to Consider in the Establishing Baseline Conditions

23. The Draft EIS/EIR for the 10-year long-term water transfer project should provide a review of the existing technical documents that describe historic environmental, surface water and groundwater conditions in the Sacramento Valley. The information in these technical documents is critical for establish an accurate and complete environmental baseline and for evaluating the potential impacts from future water transfers. Exhibit 12.1 provides an annotated bibliography provided by researchers with AquAlliance (Nora and Jim) of some of the available technical reports on groundwater resources in the Sacramento Valley. In addition to creating a complete bibliography of relevant technical reports, the Draft EIS/EIR should provide an index map showing the areas or locations covered by each report should be developed. For an example of an index map, see the 1:250000 scale regional geologic map sheets produced by the California Geological Survey.

Other information is likely available from local government agencies that would document the current condition of the groundwater basin both quantity and quality. For example, Exhibit 12.2 has a list provide by B. Smith, a researcher with AquAlliance, of recently well permits issued since January 1, 2009 for wells that have gone dry in Shasta County. A GIS should be used to plot the locations of the wells that have gone dry. The locations of these dry wells should then be compared to the current groundwater levels, past groundwater

substitution transfer pumping areas, and the proposed 10-year long-term project pumping areas. This type of spatial analysis would help to establish an accurate baseline on groundwater elevations and impacts on existing wells, and provide the foundation for assessing the potential impacts from the 10-year long-term groundwater substitution transfer pumping. Other relevant information on baseline conditions in the 10-year Transfer Project area can be found in the Integrated Regional Water Management Plans for the Northern Sacramento Valley Basin, the American River Basin, Yuba County, and Yolo County, see my comment no. 6.

I recommend the Draft EIS/EIR be revised to provide an annotated bibliography and index map(s) of all documents that are relevant to proposed 10-year long-term water transfer project and describe or provide data on the historic and environmental, surface water and groundwater baseline conditions in the Sacramento Valley. I also recommend the Draft EIS/EIR be revised to provide information from local and regional agencies on the conditions of wells within their jurisdictions covering at least the last 10 years. This local information should include, if available, replacement well permits issued for dry wells, complaints or treatment systems installed because of poor water quality, and damage to infrastructure from subsidence or settlement. I recommend this information be mapped and compared to areas of past groundwater substitution transfer pumping, areas of known groundwater level depression, and the pumping area for the proposed 10-year project.

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List of Exhibits

- 1.1 – Figure 16 from Barlow and Leake, 2012
- 1.2 – Figure 29 from Barlow and Leake, 2012
- 2.1 – Composite map of domestic wells, < 150 ft. bgs depth summary maps for northern Sacramento Valley (DWR, 2014a) and traced shallow zone, well depths < 200 ft. bgs., 2004 to 2014 changes in groundwater elevation (DWR, 2014b)
- 3.1 – Composite plot of DWR’s spring 2004 to spring 2014 groundwater elevation change maps for shallow aquifer zone, well depths less than 200 feet bgs, and Draft EIS/EIR SACFEM2013-1990 hydrologic conditions simulations shown in Figures 3.3-29, aquifer depth approximately 35 feet
- 3.2 – Composite plot of DWR’s spring 2004 to spring 2014 groundwater elevation change maps for intermediate aquifer zone, well depths greater than 200 feet and less than 600 feet bgs, and Draft EIS/EIR SACFEM2013-1990 hydrologic conditions simulations shown in Figures 3.3-30, aquifer depth approximately 200 to 300 feet
- 3.3 – Composite plot of DWR’s spring 2004 to spring 2014 groundwater elevation change maps for deep aquifer zone, well depths greater than 600 feet bgs, and Draft EIS/EIR SACFEM2013-1990 hydrologic conditions simulations shown in Figures 3.3-31, aquifer depth approximately 700 to 900 feet
- 4.1 – Summary Table of Sacramento Valley Groundwater Model Parameters
- 4.2 – Table 5, Brush and others, 2013a, C2VSim model parameter ranges
- 4.3 – Table C8, Faut, ed., 2009, CVHM model, measured and simulated hydraulic properties
- 4.4 – Figure 3, Brush and others, 2013a, C2VSim model subregions and hydrologic regions
- 4.5 – Table A1, Faut, ed., 2009, CVHM Water-balance subregions within the Central Valley, California
- 4.6 – Appendix 16.D, Driscoll, 1986, Empirical equations used to estimate specific capacity and transmissivity
- 4.7a to k – Figures A10A and B (a, b), A12A to E (c to g), A13 (h), A14 (i), C14 (j) and A15 (k) from Faut, ed., 2009, CVHM model parameters
- 4.8 a to f – Figures 34A to C (a, b, c), 35A to C (d, e, f), 37A to C (g, h, i), 38A and B(j, k), 39A and B (l, m), page 92 (n) from Brush and others, 2013a, and page 154 (o) from Faut, ed., 2009
- 5.1 – Page 100 from Brush and others, 2013a
- 5.2 – Figure 40, River-bed conductance from Brush and others, 2013a
- 5.3 – Figure C26, Distribution of cells used for streams, streambed hydraulic conductivity values from Faut, ed., 2009
- 5.4a, b – Figure C19A and B (a, b), Distribution of stream gain/loss segments used for model calibration, measured and simulated from Faut, ed., 2009
- 6.1a to c – Figure 81A to C (a, b, c), Simulated average annual subsurface flows between subregions from Brush and others, 2013a
- 6.2 – Figure 39, Simulated net annual subsurface flow between hydrologic regions for water years 2000-2009 from Brush and others, 2013b
- 6.3a to d – Tables 10 to 13 (a, b, c, d), Central Valley basin flows from the C2VSim model from Brush and others, 2013a
- 7.1 – Table summarizing the range of the number of wells in that lie within the spring 2004 to spring 2014 shallow aquifer zone drawdown contours in northern Sacramento Valley from DWR, 2014a and DWR, 2014b (see Exhibit 2.1 for composite map)

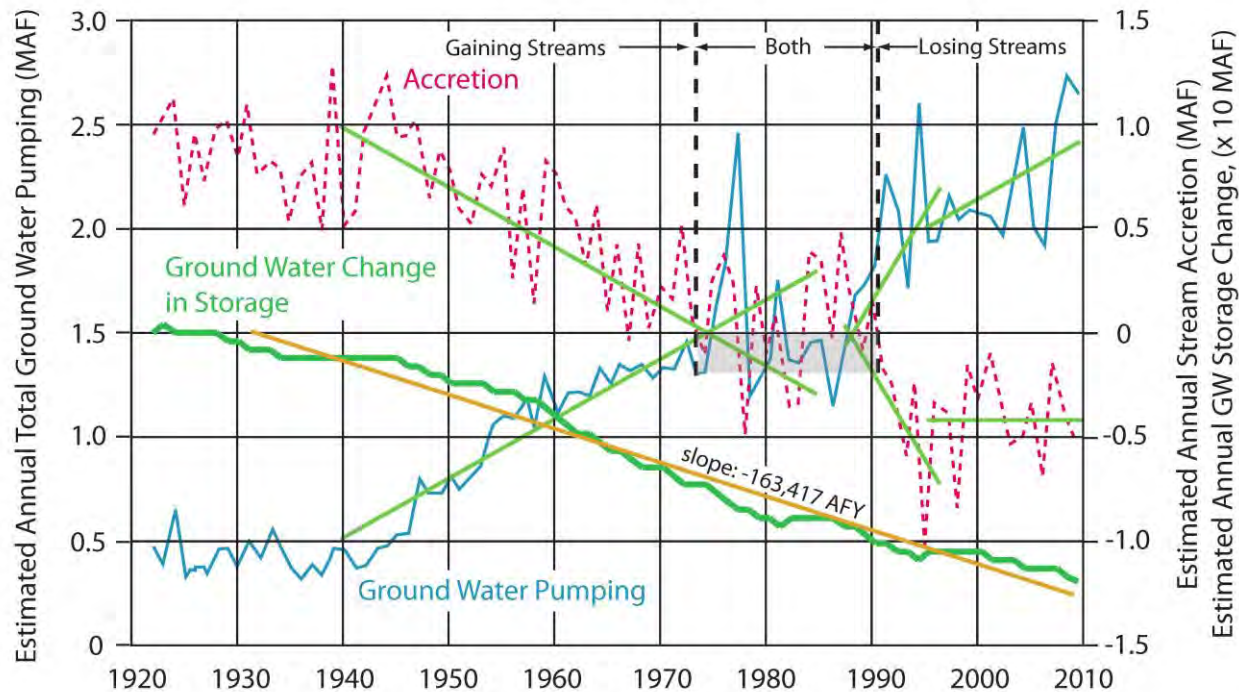
- 8.1a to c – Shallow (a), intermediate (b) and deep (c) composite maps of spring 2004 to spring 2014 groundwater elevation changes in northern Sacramento Valley (DWR, 2014b) with California natural gas pipelines map by California Energy Commission (Exhibit 8.6)
- 8.2 – Intermediate spring 2004 to spring 2014 groundwater elevation changes in northern Sacramento Valley (DWR, 2014b) with DWR's GPS subsidence grid (DWR, 2008)
- 8.3 – Figure B15A, Areal extent of land subsidence in the Central Valley from Faunt, ed., 2009
- 8.4 – Figure 6, Extensometer and GPS survey locations in the Sacramento Valley from DWR, 2008
- 8.5 – Energy Map of California, Map S-2, 2000, California Department of Conservation, Division of Oil, Gas and Geothermal Resources
- 8.6 – California Natural Gas Pipelines map by California Energy Commission
- 8.7 – California Natural Gas Pipelines and Storage Facilities map by California Energy Commission
- 8.8 – California Oil Refineries and Terminals map by California Energy Commission
- 8.9 – California Natural Gas Pipelines – Oil Refineries and Terminals map by California Energy Commission
- 8.10 – California Power Plants map by California Energy Commission
- 8.11 – Electric Generation Facilities and Projects Reviewed by the California Energy Commission, 1976 to July, 2014 map by California Energy Commission
- 9.1 – Figure C1-A, Central Valley Hydrologic Model grid, with horizontal flow barrier from Faunt, ed., 2009
- 9.2 – Page 160 from Faunt, ed., 2009
- 9.3a, b – Pages 203 (a) and 204 (b) from Faunt, ed., 2009
- 9.4a to d – Four screen prints of CGS's 2010 Fault Activity Map of California web site, accessed October 31, 2014
- 9.5 – Explanation for 2010 Fault Activity Map of California
- 9.6 – An Explanatory Text to Accompany the Fault Activity Map of California, first 12 pages
- 10.1 – Table B3 from Faunt, ed., 2009
- 10.2a to c – Figures B9 (a), B10-A (b) and B10-B (c) from Faunt, ed., 2009
- 10.3 – Figure 83 from Brush and others, 2013a
- 10.4 – Figure 35 from Brush and others, 2013b
- 10.5a to c – Tables 3-6 (a), 3-7 (b) and 3-8 (c) from NCWA, 2014b
- 10.6a to g – Figures 3-19 (a), 3-20 (b), 3-22 (c), 3-24 (d), 3-26 (e), 3-27 (f), and 3-29 (g) from NCWA, 2014b
- 10.7 – Composite of Figures 3-22, 3-24 from NCWA, 2014b, and Figure 35 from Brush and others, 2013b
- 10.8 – Figure 2-4 from Brush and others, 2013b
- 10.9 – Figure 2-5 Brush and others, 2013b
- 11.1 – Figure 1 from Miller and Durnford, 2005
- 11.2 – Table 3 from Wallace and others, 1990
- 11.3a to c – Figures 4 (a), 5 (b) and 6 (c) from CH2MHill, 2010
- 12.1 – Annotated bibliography of reports relevant to groundwater resource assessment in the Sacramento Valley provided by Nora and Jim, researchers with AquAlliance, 11 pages
- 12.2 – List of permits to replace dry wells in Shasta County provided by B. Smith, researcher with AquAlliance, 2 pages

AQUALLIANCE

DEFENDING NORTHERN CALIFORNIA WATERS

Exhibit 10.7

Comparison of Ground Water Pumping and Accretion
Sacramento Valley
1920's to 2009



Changes in Accretion, Ground Water Pumping and Ground Water Storage

1. 1920's: ~+953 TAFY accretion with ~+451 TAFY gw pumping = ~ 1,400 TAFY loss in gw storage
2. Late 1960's to Early 1970's: first zero accretion occurs with ~1,300 to ~1,500 TAFY gw pumping
3. 1920' to 2009: ~ +953 TAFY accretion to ~ -445 TAFY accretion = ~ 1,400 TAFY difference
4. Slope of Accretion 1940 to mid-1970's ~ -27,000 AFY; late 1980's to mid-1990's ~ - 85,000 AFY; ratio ~ 3X
5. 1940 to mid-1970's and late 1980's to mid 1990's slopes of ground water pumping increases are mirror images of slopes of accretion losses
6. Mid -1990's to 2010 groundwater pumping slope is similar to 1940 to mid-1970's, but accretion slope is flat.
7. Ground water change in storage ~ 12 to 14 MAF 1922 to 2009 (Figure 35, C2VSim User's Manual v. 3.02-CG, v. R374, June 2013, and Table 10 C2VSim Final Report 3.02-CG, v. R374, June 2013)

Kit Custis, certified Geologist and Hydrogeologist for AquAlliance, 2014

AQUALLIANCE

DEFENDING NORTHERN CALIFORNIA WATERS

July 29, 2014

BDCP Comments
Ryan Wulff, NMFS
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814
Via Email to: BDCP.Comments@noaa.gov

Subject: Comments on the Draft BDCP and Draft BDCP EIS/EIR

Dear Mr. Wulff:

AquAlliance represents groundwater dependent communities, farms, and ecosystems in the northern Sacramento Valley and foothills and submits the following comments and questions regarding the Draft Bay Delta Conservation Plan (“Draft Plan”) and the Draft BDCP EIS/EIR (“EIS/EIR”) (“Project”). The Draft Plan has been developed as a habitat conservation plan (“HCP”) pursuant to the federal Endangered Species Act and a natural community conservation plan (“NCCP”) pursuant to the California Natural Community Conservation Planning Act for the Sacramento–San Joaquin River Delta. The California Department of Water Resources (“DWR”), the US Bureau of Reclamation (“Bureau”) (“Agencies”) and many of their contractors¹ are the proponents of the Draft Plan. DWR acts as the lead agency for the purposes of the California Environmental Quality Act (“CEQA”) and the Bureau, the U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service serve as the lead agencies for the National Environmental Policy Act (“NEPA”).

AquAlliance supports the possibilities found in HCP and NCCP planning processes, but this effort has at its heart a perverse incentive: to drain as much water as possible from the Sacramento River Watershed and the Delta to continue some of the most destructive forms of desert agriculture, urban sprawl, and industrial extraction. The EIS/EIR attempts to disclose impacts as required by CEQA and NEPA, but simultaneously obfuscates many of the direct and indirect impacts. AquAlliance seeks to bring to light some of these hidden impacts and to highlight the absurdity of referring to the Twin Tunnels project, which creates the infrastructure to drain the Sacramento River Watershed and the Delta of essential fresh water, as “Conservation Measure 1.”

¹ “ The BDCP proponents include the following state and federal water contractors under either the SWP or CVP: Alameda County Flood Control and Water Conservation District, Zone 7; Kern County Water Agency; Metropolitan Water District of Southern California; San Luis & Delta-Mendota Water Authority; Santa Clara Valley Water District; and Westlands Water District. Additional water contractors may become BDCP proponents in the future through the BDCP process.” (EIR/EIS p. 1-1)

We incorporate by reference the comments submitted by our coalition of C-WIN, CSPA, and AquAlliance and the two comment letters submitted by the Environmental Water Caucus. We also submit the Project modeling analysis prepared for AquAlliance by Professor Kyran Mish. AquAlliance's previous comments on the Bureau's Environmental Assessments for the 2010/2011 Water Transfer Program, the 2013 Water Transfer Program, the 2014 Water Transfer Program, and scoping comments on the Bureau and San Luis Delta Mendota Water Authority's Ten-Year Water Transfer Plan are attached, as well. These four comment letters all pertain to water transfer programs that illustrate the history of Sacramento Valley water transfers to south of the Delta, contain valuable background and impact information for the area of origin, and present AquAlliance's opposition to the water transfers that will expand under BDCP.

Hydrology

1. **The EIS/EIR fails to adequately disclose the planned increase in water transfers from the Sacramento River Watershed to south of the Delta.**

If the Twin Tunnels (the facilities identified in "Conservation Measure 1") are built as planned with the capacity to take 15,000 cubic feet per second ("cfs") from the Sacramento River, they will have the capacity to drain almost two-thirds of the Sacramento River's average annual flow of 23,490 cfs at Freeport² (north of the planned Twin Tunnels). As proposed, the Twin Tunnels will also increase water transfers when the infrastructure for the Project has capacity. This will occur during dry years when State Water Project ("SWP") contractor allocations drop to 50 percent of Table A amounts or below or when Central Valley Project ("CVP") agricultural allocations are 40 percent or below, or when both projects' allocations are at or below these levels (EIS/EIR Chapter 5). With this Project, North to South water transfers will be in demand and feasible.

For an understanding of water transfers, it would be valuable to know how much is currently exported from the Delta. The EIS/EIR even fails at this task by explaining the current export regime from the Delta thusly, "Some water flowing through the Delta is exported by the SWP/CVP to areas outside the Delta (see Chapter 5, *Water Supply*)..." (p. 7-1) How is the reader to know that "some water" is an immense number on the order of 5-7 million acre-feet ("MAF")? It would be immensely helpful to the reader of a 40,000+ page document to have a better understanding of the magnitude of water being discussed with it presented openly and clearly at every opportunity, such as page one of Chapter seven.

The EIS/EIR also fails to reveal that the current Project is part of many more programs, plans and projects to develop groundwater in the Sacramento Valley, to develop a "conjunctive" system for the region, and to place water districts in a position to integrate the groundwater into the state water supply. These are plans that the Bureau, together with DWR, water districts, and others have been pursuing and developing for many years.

² USGS 2009. <http://wdr.water.usgs.gov/wy2009/pdfs/11447650.2009.pdf>

An environmental impact statement should consider “[c]onnected actions.” 40 C.F.R. §1508.25(a)(1). Actions are connected where they “[a]re interdependent parts of a larger action and depend on the larger action for their justification.” *Id.* §1508.25(a)(1)(iii). Further, an environmental impact statement should consider “[s]imilar actions, which when viewed together with other *reasonably foreseeable or proposed agency actions*, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography.” *Id.* §1508.25(a)(3). The Bureau’s participation in planning, attempting to execute, and frequently executing the programs, plans and projects has circumvented the requirements of NEPA. DWR’s failure to conduct project level CEQA review for water transfers and comprehensive environmental review for the *Sacramento Valley Water Management Agreement* has segmented a known, programmatic project for decades, which means that the Bureau is also failing to comply with state law as the CVPIA mandates. A list of connected actions and similar actions is found in the Cumulative Impacts section below.

2. The EIS/EIR fails to adequately disclose the existing geology that is the foundation of the Sacramento River’s hydrology and the Sacramento Valley’s groundwater basins.

Page 7-1 fails to note a significant geographic feature in the Sacramento River hydrologic region: the Cascade Range. The Cascade Range is the genesis of the Sacramento River and some of its most significant tributaries: the Pit and the McCloud Rivers. This serious omission continues throughout Chapter 7. The enormous influence of the Cascade Mountain Range on not only the Sacramento River, but also the geology, soils, and hydrology of the Sacramento Valley’s ground water basin is completely missing. The California Department of Conservation describes the Range thusly: “The Cascade Range, a chain of volcanic cones, extends through Washington and Oregon into California. It is dominated by Mt. Shasta, a glacier-mantled volcanic cone, rising 14,162 feet above sea level. The southern termination is Lassen Peak, which last erupted in the early 1900s. The Cascade Range is transected by deep canyons of the Pit River. The river flows through the range between these two major volcanic cones, after winding across interior Modoc Plateau on its way to the Sacramento River.”³ The Sacramento River Watershed Program provides another simple, adequate description of its namesake: “The Sacramento River is the largest river and watershed system in California (by discharge, it is the second largest U.S. river draining into the Pacific, after the Columbia River). This 27,000–square mile basin drains the eastern slopes of the Coast Range, Mount Shasta, the western slopes of the southernmost region of the Cascades, and the northern portion of the Sierra Nevada. The Sacramento River carries 31% of the state’s total surface water runoff.”⁴

Without describing the structural attributes of the Sacramento Valley groundwater basin that supports the rivers, streams, communities, and orchards of the region, the EIS/EIR states that, “The Sacramento Valley *groundwater basin* is extremely productive and provides much of the water supply for California’s agricultural and urban water needs,” (page 7-2). [emphasis added] The EIS/EIR fails to disclose to what extent it is productive, what limitations exist to its

³ California Department of Conservation, California Geological Survey, 2002. *California Geomorphic Provinces*. [sic]

⁴ <http://www.sacriver.org/aboutwatershed/roadmap/sacramento-river-basin>

productivity, or how it provides so much water for the State when one considers that groundwater is usually used at a local level. These grandiose claims that lack supporting material lead AquAlliance to ask the following questions:

- Have the agencies conflated a watershed with a groundwater basin?
- Is this a Freudian slip that discloses the intent of the agencies to incorporate the Sacramento Valley groundwater basin into the State's water supply as presented in numerous plans and programs over two decades (see list in Cumulative Impacts)?
- If the lead agencies truly believe that the Sacramento Valley groundwater basin has been and is this important to California's agricultural and urban water needs, why has the EIS/EIR failed to identify it in Figures 7-3, *Groundwater Subbasins Underlying the Central Valley*, and 7-4, *Groundwater Model Domains in the Central Valley*, while both figures name the San Joaquin and Tulare basins?

The repeated absence of some of the most basic geologic, geographic and hydrologic information in the EIS/EIR on which the entire Project is dependent causes the reader to wonder what else has been ignored or purposely omitted in the document.

3. The EIS/EIR fails to disclose the over appropriation of water rights in the Sacramento River Watershed

The public is presented with inadequate baseline data with which to consider the consequences of the Project. One such area is the comparison of the average unimpaired flow of the Sacramento River Watershed stacked against the claims that have been made for water. The average annual unimpaired flow in the Sacramento River basin is 21.6 MAF, but the consumptive use claims are an extraordinary 120.6 MAF!⁵

4. The EIS/EIR fails to disclose the existing conditions of the Sacramento Valley groundwater.

There is an absence of accurate and detailed information that describes the Sacramento Valley groundwater conditions. The EIS/EIR instead states, "A portion of this applied water, and the remaining 13.9 MAF of runoff, is potentially available to recharge the basin and replenish groundwater storage depleted by groundwater pumping. Therefore, except during drought, the Sacramento Valley groundwater basin is "full," and groundwater levels recover to pre-irrigation season levels each spring. Historical groundwater level hydrographs suggest that even after extended droughts, groundwater levels in this basin recovered to pre-drought levels within 1 or 2 years following the return of normal rainfall quantities." (p. 7-13)

The conclusory statements fail to provide decision-makers and the public with important factual data. For example, a summary of conditions in the Durham area of Butte County find that while water levels may recover after dry to drought periods with intense use, wells aren't returning to previous levels, but moving steadily in a downward trajectory.⁶ Additionally, even the Yuba River area, often touted by state and federal agencies as a successful conjunctive use program,

⁵ California Water Impact Network, AquAlliance, and California Sportfishing Protection Alliance 2012. *Testimony on Water Availability Analysis for Trinity, Sacramento, and San Joaquin River Basins Tributary to the Bay-Delta Estuary.*

⁶ Buck, Christina 2014. *Groundwater Conditions in Butte County.*

takes 3-4 years to recover from groundwater substitution in the south sub-basin⁷ although the Yuba County Water Agency analysis fails to determine how much river water is sacrificed to achieve the multi-year recharge rate.

More examples that contradict long-term predictions of “full” and “recovered” groundwater basins are found in the most current DWR maps.⁸ Presented below are tables that illustrate maximum and average groundwater elevation decreases for Butte, Colusa, Glenn, and Tehama counties at three aquifer levels in the Sacramento Valley between the Fall of 2004 and 2013.

County Fall '04 - '13	Deep Wells (Max decrease gwe)	Deep Wells (Avg. decrease gwe)
Butte	-11.4	-8.8
Colusa	-31.2	-20.4
Glenn	-60.7	-37.7
Tehama	-19.5	-6.6

County Fall '04 - '13	Intermediate Wells (Max decrease gwe)	Intermediate Wells (Avg. decrease gwe)
Butte	-21.8	-6.5
Colusa	-39.1	-16.0
Glenn	-40.2	-14.5
Tehama	-20.1	-7.9

County Fall '04 - '13	Shallow Wells (Max decrease gwe)	Shallow Wells (Avg. decrease gwe)
Butte	-13.3	-3.2
Colusa	-20.9	-3.8
Glenn	-44.4	-8.1
Tehama	-15.7	-6.6

Below are the results from DWR’s spring monitoring for Sacramento Valley groundwater basin from 2004 to 2014.

County Spring '04 - '14	Deep Wells (Max decrease gwe)	Deep Wells (Avg. decrease gwe)
Butte	-20.8	-14.6
Colusa	-26.9	-12.6
Glenn	-49.4	-29.2
Tehama	-6.1	-5.3

⁷ 2012. *The Yuba Accord, GW Substitutions and the Yuba Basin*. Presentation to the Accord Technical Committee.

⁸ http://www.water.ca.gov/groundwater/data_and_monitoring/northern_region/GroundwaterLevel/gw_level_monitoring.cfm

County Spring '04 - '14	Intermediate Wells (Max decrease gwe)	Intermediate Wells (Avg. decrease gwe)
Butte	-25.6	-12.8
Colusa	-49.9	-15.4
Glenn	-54.5	-21.7
Tehama	-16.2	-7.9

County Spring '04 - '14	Shallow Wells (Max decrease gwe)	Shallow Wells (Avg. decrease gwe)
Butte	-23.8	-7.6
Colusa	-25.3	-12.9
Glenn	-46.5	-12.6
Tehama	-38.6	-10.8

The DWR data clearly present a different picture of the condition of the Sacramento Valley groundwater basin over time than what is provided in the EIS/EIR. This must be corrected and considered in the NEPA and CEQA process.

5. The EIS/EIR fails to disclose direct and indirect groundwater impacts to the Sacramento Valley that would result from expanded cross-Delta water transfers

Internal BDCP communication from the Department of the Interior indicates that the purchase of approximately 1.3 MAF of water is being planned as a means to make up for flows that would be removed from the Sacramento River by the BDCP tunnels.⁹ As provided above, it is possible that the Twin Tunnels may extract almost two-thirds of the average annual flow from the Sacramento River, which is what creates the need for the 1.3 MAF. The source of the additional water that is integral to the Project is not disclosed or analyzed in the EIS/EIR. If Sacramento Valley groundwater is the intended target, this must be disclosed and analyzed in a re-circulated Draft EIS/EIR.

6. The EIS/EIR vastly understates the extent of groundwater depletion in the San Joaquin Valley.

In regards to the San Joaquin groundwater basin, the DEIS/DEIR states that, “Long-term groundwater production throughout this basin has lowered groundwater levels beyond what natural recharge can replenish.” (p. 7-4) It is no surprise that the relentless extraction of groundwater in the San Joaquin Valley has halted natural recharge, but this mild under-statement of fact masks the tremendous devastation that has occurred there. “Mining” would provide a more accurate depiction of what has transpired over 80+ years instead of “production.” The USGS exposes this form of groundwater exploitation in the San Joaquin and Santa Clara Valleys (1999) in Circular 1182 entitled Part I, “Mining Ground Water.” Current research by Michelle Sneed expands on the impacts from groundwater mining in the San Joaquin by disclosing the extent of historic and current subsidence levels.¹⁰

⁹ Belin, Lety Summary of Assurances Email, dated 2/25/13.

¹⁰ Sneed, Michelle et al. 2013. *Land Subsidence along the Delta-Mendota Canal in the Northern Part of the San Joaquin Valley, California*. <http://pubs.usgs.gov/sir/2013/5142/>

Without explanation or apology, the EIS/EIR omits this current analysis, mentions “overall subsidence” in the Mendota area of 28 feet (without a citation or timeframe), and then recounts older research: “Most San Joaquin Valley subsidence is thought to have been caused primarily by deep aquifer system pumping during the 1950s and 1960s, but is considered to have largely abated since 1974 because of the development of more reliable agricultural surface water supplies from the Delta-Mendota Canal and Friant-Kern Canal (U.S. Geological Survey 1999).” The absence of current scientific research in the EIS/EIR regarding groundwater mining and subsidence leaves the document exceedingly deficient under CEQA and NEPA and the agencies exposed to charges of ineptitude.

Economics of the Draft Plan

The University of the Pacific Eberhardt School of Business concluded in 2012:

This report updates an initial benefit-cost analysis of the water conveyance tunnels at the center of the Bay Delta Conservation Plan (BDCP). Primarily using the results of the BDCP’s own economic benefit and cost studies, we find a benefit-cost ratios ranging from 0.3 to 0.5, meaning that there are between \$1.90 and \$3.36 of costs for every \$1 in economic benefits. To put this in perspective, this benefit-cost ratio is 80% lower than those estimated for the State’s high-speed rail project.

When these very low benefit-cost ratios are considered alongside the inconsistent and incomplete financial plans, it is clear that the Delta water conveyance tunnels proposed in the draft BDCP are not justified on an economic or financial basis.

How has the Project responded and adjusted to such a stinging rebuke by such a reputable source or has it been shunted aside as an illegitimate critique that is contrary to the outcome sought by the agencies?

Modeling

1. The EIS/EIR hinges on models and modeling that are seriously deficient.

The agencies had opportunities to advance both water and environmental planning once again through the Bay Delta Conservation Plan. Like a journeyman in any trade, the tools one has and the skills in using them are what distinguish a journeyman from an apprentice or an imposter. DWR and the Bureau have had ample feedback on the Draft Plan to know, as a journeyman should, that their toolbox is wanting and their use of the tools they selected is inadequate. Among all the areas where this proves to be the case (see referenced June 11, 2014 EWC comments), nowhere is it more glaring than in the model and modeling that are the foundation for the entire Project.

Kyran Mish, Ph.D., provides a succinct review of the Project model and modeling and finds serious deficiencies and concludes:

The technical risks associated with this ambitious project, and the immense budget required for its construction and operation, clearly mandate that the best-

available scientific principles be deployed and documented in all project artifacts, including the Draft EIS/EIR. It is technically indefensible that these principles (including all fundamental physical assumptions) are not readily available in the tens of thousands of pages of the Draft EIS/EIR, and the omission of the particulars of the science used to estimate these environmental effects precludes both accurate prediction of the environmental effects of this project, as well as independent technical verification of the claims made in the plan. Since independent verification is a fundamental hallmark of scientific investigation, the current version of the BDCP Draft EIS/EIR fails even this most basic test of science.

He continues his review with concerns regarding seismic risks, liquefaction, and the model, CalSim II:

- “The plan promises that seismic risks will be addressed during the design and construction phases of the project, but also explicitly admits that no substantial efforts toward accurate identification of seismic risks yet exist within the plan’s scope. Thus the costs of mitigating these risks is unknown from the outset, and any estimate of project cost must thus be considered to be a substantial underestimate of actual project lifespan costs.”
- “One of the worst cases of poor risk assessment in seismic sections of the report is the discussion of possible liquefaction effects. After a good introductory discussion of the natural phenomenon of liquefaction, the Draft EIS/EIR provides little in the way of realistic mitigation plans to handle the very-real risk that liquefaction could destroy the project once it is built (or even damage components of the system during construction).”
- “In the interest of simplicity, only a few key concerns about the suitability of the current version of CalSim will be presented here, but these should be sufficient to indicate that CalSim II does not yet warrant sufficient trust to justify its use for analysis of the alternatives that lie at the heart the water-transfer plan.”

AquAlliance includes Dr. Mish’s entire analysis of the Project model and modeling with our comments.

Cumulative Impacts

The Ninth Circuit has made clear that NEPA mandates “a useful analysis of the cumulative impacts of past, present and future projects.” *Muckleshoot Indian Tribe v. U.S. Forest Service*, 177 F.3d 800, 810 (9th Cir. 1999). Indeed, “[d]etail is required in describing the cumulative effects of a proposed action with other proposed actions.” *Id.* The very cursory cumulative effects discussion contained in the EIS/EIR regarding groundwater plainly fails to meet this standard.

In assessing the significance of a project’s impact, the Bureau must consider “[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.” 40 C.F.R. §1508.25(a)(2). A “cumulative impact” includes “the impact on the environment which results from the incremental impact of the action when added to *other past, present and reasonably foreseeable future actions*

regardless of what agency (Federal or non-Federal) or person undertakes such other actions.” *Id.* §1508.7. The regulations warn that “[s]ignificance cannot be avoided by terming an action temporary or by breaking it down into small component parts.” *Id.* §1508.27(b)(7).

As discussed above, the Project is dependent on the hydrology of the Delta watershed to implement the Draft Plan. The EIS/EIR blatantly fails to consider other past, present and reasonably foreseeable future actions in the Delta watersheds by deferring analysis to a future day. To illustrate the omissions in the EIS/EIR, AquAlliance submits a partial list of Sacramento River Watershed programs, plans, and projects in which the agencies have participated or funded, that, at a minimum, should have been presented in the EIS/EIR for cumulative impact discussion, and better yet, analyzed to comply with CEQA and NEPA:

- The *Sacramento Valley Water Management Agreement* was signed in 2002 and the need for a programmatic EIS/EIR was clear to both the Bureau and DWR. The process was initiated, but never completed.¹¹ Indeed, even the short-term phase of the Sacramento Valley Water Management Program is the subject of an ongoing scoping process for a Programmatic EIS that has not yet been completed (*id.*)
- The *Sacramento Valley Integrated Regional Water Management Plan* (2006).
- The *Sacramento Valley Water Management Plan*. (2007)
- The Stony Creek Fan Partnership Orland Project Regulating Reservoir Feasibility Investigation.
- The Glenn Colusa Irrigation District (“GCID”) *Stony Creek Fan Aquifer Performance Testing Plan* to install seven production wells in 2009 that extracted 26,530 AF of groundwater as an experiment.
- GCID’s Lower Tuscan Conjunctive Water Management Program (Bureau provided funding).
- GCID’s water transfers in 2008 and in 2010, 2013, and 2014.
- The Drought Water Bank for 2009.
- The Bureau of Reclamation’s 2010/2011 Water Transfer Program of 395,910 af of CVP and non-CVP water with 154,237 AF of groundwater substitution (EA/FONSI p. 2-4 and 3-107).
- The Bureau’s planned 2012 water transfers of 76,000 af of CVP water all through ground water substitution.
- The Bureau’s 2013 Water Transfer Program
- The Bureau and San Luis Delta Mendota’s 2014 Water Transfer Program.
- The Bureau of Reclamation’s 600,000 AF, North-to-South Water Transfer Program. EIS/EIR pending since scoping in January 2011.

¹¹ *The Bureau actually began its own Programmatic EIS to facilitate water transfers from the Sacramento Valley, and the interconnected actions that are integrally related to it, but never completed that EIS and has impermissibly broken out segments of the overall Program for piecemeal review for water transfers for GCID’s 2008 Forbearance Transfer, the 2009 Drought Water Bank, 2010/2011, 2012, 2013, and 2014.. See 68 Federal Register 46218 (Aug 5, 2003) (promising a Programmatic EIS on these related activities, “includ[ing] groundwater substitution in lieu of surface water supplies, conjunctive use of groundwater and surface water, refurbish existing groundwater extraction wells, install groundwater monitoring stations, install new groundwater extraction wells...” *Id.* At 46219. See also http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=788 (current Bureau website on “Short-term Sacramento Valley Water Management Program EIS/EIR”).*

The Bureau Has Failed to Consider the Cumulative Impact of Other Groundwater Development and Surface Water Diversions Affecting the Sacramento Valley

In addition to the improper segmentation evident in the draft EIS/EIR, the assessment of environmental impacts is further deficient because the Bureau has failed to consider the cumulative impacts of the planned groundwater extraction when taken in conjunction with other projects proposed for the development of groundwater and surface water. The General Plans of the counties and cities in the Sacramento Valley must be considered as well as the agricultural crop and land use changes that have taken and are taking place. Lastly, we must emphasize again that existing conditions in the Sacramento River Watershed, that is so crucial to California's population, economy, and environment, and therefore the Project, must be more accurately understood and described, so that impacts may be more accurately assessed from the Project.

Conclusion

The Draft EIS/EIR is seriously deficient as noted here, in the coalition comments of C-WIN, CSPA, and AquAlliance, the CSPA comments, and the EWC comments. AquAlliance requests that you incorporate these comments into a new and re-circulated Draft EIS/EIR.

Sincerely,



Barbara Vlamis
AquAlliance's Executive Director

AQUALLIANCE

DEFENDING NORTHERN CALIFORNIA WATERS



December 1, 2014

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Subject: Comments on the *Draft Environmental Impact Statement/Environmental Impact Report Long Term North-to-South 2015-2024 Water Transfer Program*

Dear Mr. Hubbard and Ms. Mizuno:

AquAlliance, California Sportfishing Protection Alliance (“CSPA”), and Aqua Terra Aeris submit the following comments and questions for the Bureau of Reclamation (“Bureau”) and the San Luis Delta Mendota Water Authority’s (“SLDMWA”) (“Lead Agencies”) *Draft Environmental Impact Statement (“EIS”)* and *Environmental Impact Report (“EIR”)* (“EIS/EIR”), for the 2015-2024 *Long Term North-to-South Water Transfer Program* (“Project” or “2015-2024 Water Transfer Program”).

AquAlliance exists to sustain and defend northern California waters. We have participated in past water transfer processes, commented on past transfer documents, and sued the Bureau twice in the last five years. In doing so we seek to protect the Sacramento River’s watershed in order to sustain family farms and communities, enhance Delta water quality, protect creeks and rivers, native flora and fauna, vernal pools and recreational opportunities, and to participate in planning locally and regionally for the watershed’s long-term future. The *2015-2024 Water Transfer Program* is seriously deficient and should be withdrawn. If the Bureau and DWR are determined to pursue water transfers from the Sacramento Valley, AquAlliance requests that the agencies regroup and prepare an adequate programmatic EIS/EIR.

This letter relies significantly on, references, and incorporates by reference as though fully stated herein, for which we expressly request that a response to each comment contained therein be provided, the following comments submitted on behalf of AquAlliance:

- Custis, Kit H., 2014. Comments and recommendations on U.S. Bureau of Reclamation and San Luis & Delta-Mendota Water Authority Draft Long-Term Water Transfer DRAFT EIS/EIR, Prepared for AquAlliance. (“Custis,” Exhibit A)
- ECONorthwest, 2014. Critique of Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report Public Draft, Prepared for AquAlliance. (“EcoNorthwest,” Exhibit B)
- Mish, Kyran D., 2014. Comments for AquAlliance on Long-Term Water Transfers Draft EIR/EIS. (“Mish,” Exhibit C)
- Cannon, Tom, Comments on Long Term Transfers EIR/EIS, Review of Effects on Special Status Fish. Prepared for California Sportfishing Protection Association. (“Cannon,” Exhibit D)

In addition, we renew the following comments previously submitted, attached hereto, as fully bearing upon the presently proposed project and request:

- *2009 Drought Water Bank* (“DWB”). (Exhibit F)
- *2010-2011 Water Transfer Program*. (Exhibit G)
- *2013 Water Transfer Program*. (Exhibit G)
- *2014 Water Transfer Program*. (Exhibit G)
- C-WIN, CSPA, AquAlliance Comments and Attachments for the Bay Delta Conservation Plan’s EIS/EIR. (Exhibit H)
- AquAlliance’s comments on the Bay Delta Conservation Plan’s EIS/EIR. (Exhibit H)
- CSPA’s comments on the Bay Delta Conservation Plan’s EIS/EIR. (Exhibit H)

I. The EIS/EIR Contains an Inadequate Project Description.

A “finite project description is indispensable to an informative, legally adequate EIR.” *County of Inyo v. City of Los Angeles* (1977) 71 Cal.App.3d 185, 192. CEQA defines a “project” to include “the whole of an action” that may result in adverse environmental change. CEQA Guidelines § 15378. A project may not be split into component parts each subject to separate environmental review. *See, e.g., Orinda Ass’n v. Board of Supervisors* (1986) 182 Cal.App.3d 1145, 1171; *Riverwatch v. County of San Diego* (1999) 76 Cal.App.4th 1428. Without a complete and accurate description of the project and all of its components, an accurate environmental analysis is not possible. *See, e.g., Santiago County Water Dist. v. County of Orange* (1981) 118 Cal.App.3d 818, 829; *Sierra Club v. City of Orange* (2008) 163 Cal.App.4th 523, 533; *City of Santee v. County of San Diego* (1989) 214 Cal.App.3d 1438, 1450; *Blue Mountains Biodiversity Project v. United States Forest Service*, 161 F.3d 1208, 1215 (9th Cir. 2008).

As discussed, below, and in the expert reports submitted by *Custis*, *EcoNorthwest*, *Cannon*, and *Mish* on behalf of AquAlliance, the EIS/EIR fails to comport with these standards.

- a. The Project / Proposed Action Alternative Description Lacks Detail Necessary for Full Environmental Analysis.
 - i. Actual transfer buyers, sellers, modes, amounts, criteria, market demands, availability, and timing, are undisclosed.

The Proposed Action Alternative is poorly specified and needs additional clarity before decision-makers and the public can understand its human and environmental consequences. The Lead Agencies tacitly admit that they have no idea how many acre-feet of water may be made available, by what mechanism the water may be made available (fallowing, groundwater substitution, or crop changes), or to what ultimate use (public health, urban, agricultural) the water may be put.

Glenn Colusa Irrigation District is listed as the largest potential seller, but its General Manager, Thad Bettner, asserted publicly on October 7, 2014 that the district hadn't committed to the 91,000 AF found in Table ES-2 (Potential Sellers). GCID subsequently sent the Bureau a letter that states that GCID plans to pursue its own Groundwater Supplemental Supply Program and that, "It is important for Reclamation to understand that GCID has not approved the operation of any District facilities attributed to the LTWTP Action/Project that is presented in the draft EIR/EIS."¹ The letters continues stating that, "It is important to underscore that GCID would prioritize pumping during dry and critically dry water years for use in the Groundwater Supplemental Supply Program, and thus wells used under that program would not otherwise be available for the USBR's LTWTP." First, these public and written comments contradict the EIS/EIR on page 3.8-37 where it states that, "The availability of supplies in the seller service area was determined based on data provided by the potential sellers." Second, the largest potential seller in the *2015-2024 Water Transfer Program* is seemingly unable or unwilling to participate in the groundwater substitution component during dry and critically dry years. In addition, GCID has stated that "it will not participate in a groundwater substitution transfer, and for land idling reduce the acreage from 20,000 acres to no more than 10,000 acres."² Similarly, the Sacramento Suburban Water District received \$2 million from the Governor's Water Action Plan to move groundwater to member agencies that have been "[h]eavily dependent on Folsom reservoir," according to John Woodling of the Sacramento Regional Water Authority.³ Woodling continues that, "During these dry times, the groundwater basin really is our insurance

¹ GCID October 14, 2014.

² GCID November 6, 2014 Board Meeting Item #6.

³ Ortiz, Edward 2014. *Region's water districts split \$14 million for drought relief*. Sacramento Bee November 7, 2014.

policy,” (*Id*). Knowing that smart water managers are very aware of this fact, why would Sacramento Suburban Water District turn around and propose to sell 30,000 AF of water to the out-of-region buyers through groundwater substitution transfers during the Project’s “[d]ry and critically dry years”? In short, the EIS/EIR has no way of knowing what transfers may occur, and when.

It is also not possible to determine with confidence just how much water is requested by potential urban and agricultural buyers and how firm the requests are. What are SLDMWA’s specific requests for agricultural or urban uses of Project water? What are the SLDMWA’s present agricultural water demands for the 850,000 acres that it serves? Left to guess at the possible requests for water, we look at the 2009 DWB where there were between 400,000 and 500,000 AF of presumably urban buyer requests alone (which had priority over agricultural purchases, according to the 2009 DWB priorities) and a cumulative total of less than 400,000 AF from willing sellers. It is highly possible, based on the example during the 2009 DWB, that many buyers are not likely to have their needs addressed by the *2015-2024 Water Transfer Program*. How would this affect the project objectives and purpose? How would this affect variable circumstances for other proposed transfers?

The EIS/EIR also fails to address the ability and willingness of potential buyers to pay for Project water given the supplies that may be available. Complaints from agricultural water districts were registered in the comments on the Draft Environmental Water Account EIS/EIR and reported in the Final EIS/EIR in January 2004 indicating that they could not compete on price with urban areas buying water from the EWA. Given the absence of priority criteria, will agricultural water buyers identified in Table ES-1 have the ability to buy water when competing with urban districts? Moreover, since buyers are not disclosed in the EIS/EIR for non-CVP river water, these further effects on water market conditions and competition between agricultural and urban sectors is impossible to evaluate. Who are the buyers that may request non-CVP river water, and what are their maximum requests? That DWR is not the CEQA lead agency further complicates the evaluation of competition for water in the EIS/EIR.

Nor does the *2015-2024 Water Transfer Program* prevent rice growers (or other farmers) from “double-dipping,” but actually encourages it. Districts and their growers have opted to turn back their surface supplies from the CVP and the State Water Project and substitute groundwater to cultivate their rice crop—thereby receiving premiums on both their CVP contract surface water as well as their rice crop each fall when it goes to market. There appear to be no caps on water sale prices to prevent windfall profits to sellers of Sacramento Valley water — especially for crops with high market prices, such as rice.

The EIS/EIR is inadequate because it fails to identify and analyze the market context for crops as well as water that would ultimately influence the size and scope of the *2015-2024 Water*

*Transfer Program.*⁴ The Project's sellers and buyers are highly sensitive to the influences of prices—prices for water as well as crops such as rice, orchard and vineyard commodities, and other field crops. It is plausible that crop idling would occur more in field crops, while groundwater substitution would be more likely for orchard and vineyard crops. However, high prices for rice—the Sacramento Valley's largest field crop— undermines this logic and leads to substantial groundwater substitution. These potential issues and impacts should be recognized in the EIS/EIR because crop prices are key factors in choices potential water sellers would weigh in deciding whether to idle crops, substitute groundwater, or decline to participate in the Project altogether.

To enable a more complete and discrete project description, the EIS/EIR should propose criteria other than price alone to manage allocation of state water resources. The EIS/EIR should consider some priority criteria as was included in the 2009 Drought Water Bank EA/FONSI (p. 3-88). Do both authorizing agencies, the Bureau and DWR, lack criteria to prioritize water transfers? Are transfers approved on a first-come first-serve basis, as generated by market conditions alone? What is the legal or policy basis to act without providing priority criteria? A lack of criteria fails to encourage regions to develop their own water supplies more efficiently and cost-effectively without damage to resources of other regions. If criteria will be applied, these need to be disclosed and analyzed in the EIS/EIR.

Additional uncertainty caused by the incomplete project description includes:

- How many of the proposed transfers would be one year in duration, multi-year, or permanent. How will the duration of any agreement be determined? The duration of a transfer agreement will have dramatic effects on the water market as well as the environmental impact analysis.
- The EIS/EIR purports to be a 10 year project, but is there an actual sunset date, since it continues serially in multiple years? Could any transfer be approved in the next 10 years that would extend beyond 2024?
- The proposed program provides no way to know what ultimate use transferred water will be put to; nor does the EIS/EIR provide any way to know what activities may occur on idled cropland. The EIS/EIR assumptions on these points are inherently incomplete and fail to support any discrete environmental analysis.

In sum, the proposed program provides no way to know which transfers may or may not occur, individually or cumulatively. The lack of a stable and finite project description undermines the entire EIS/EIR. As discussed further, below, description of the environmental setting, evaluation of potentially significant impacts, and formulation of mitigation measures, among other issues, all are rendered unduly imprecise, deferred, and incomplete, subject to the theoretical transfers taking shape at some, unknown, future time.

⁴ EcoNorthwest (Exhibit B).

ii. Historic transfer data is excluded.

Absent from the DEIS/EIR are any of the required monitoring reports from previous transfer projects. *See, e.g., Citizens for East Shore Parks v. State Lands Commission* (2010) 48 Cal.App.4th 549; *Communities for a Better Environment v. South Coast Air Quality Mgmt. Dist.* (2010) 48 Cal.App.4th 310. Without the required monitoring reports, the public is left in the dark regarding this new proposal to sell up to 600,000 AF annually over a 10 year period. No information is provided regarding the impacts to downstream users, wells near production wells, the Sacramento River and its tributaries, refuges, water quality, special status species and the San Francisco Bay Delta Estuary from past CVP transfers or cumulatively including non-CVP water transfers in the area of origin. For example, groundwater substitution transfers and transfers that result in reduced flows in combination with below normal water years are known to have to have the potential for significant impacts on water quality, fish, wildlife and the flows in the Sacramento River and its tributaries. Providing all such documentation of the terms, conditions, effects, and outcomes of prior transfers is integral to understanding the proposed Project.

b. The Proposed Project is in Fact a Proposed Program.

The lack of any stable, discrete, project description, at best, renders the proposed project a “program,” rather than any specific project itself. “[A] *program* EIR is distinct from a *project* EIR, which is prepared for a specific project and must examine in detail site-specific considerations.” *Center for Sierra Nevada Conservation v. County of El Dorado* (2012) 202 Cal.App.4th 1156, 1184. As discussed further, below, this EIS/EIR does not and cannot complete site-specific and project-specific analysis of unknown transfers at unknown times. Buyers and sellers have “expressed interest,” but no specific transfers or combination of transfers are proposed, and we don’t know which may be proposed or ultimately approved.

Put differently, the EIS/EIR project description is not simply inadequate: the EIS/EIR fails to propose or approve any project at all. Instead, the EIS/EIR should be recharacterized and revised as a program EIS/EIR. Indeed, agency documents have referred to this program, as such, for years. (E.g., Federal Register /Vol. 75, No. 248 /Tuesday, December 28, 2010 /Notices *Long-Term North to South Water Transfer Program, Sacramento County, CA*; Final EA/FONSI for 2010-2011 Water Transfer Program.⁵) And other external sources also support the proposition that this EIS/EIR does not and cannot review and approve specific transfers:

“Each transfer is unique and must be evaluated individually to determine the quantity and timing of real water made available.” (BDCP DEIR at 1E-2.)

“Although this document seeks to identify in the best and most complete way possible the information needed for transfer approval, to both expedite that approval and to

⁵ <http://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=31781>

reduce participant uncertainty, each transfer is unique and must be considered on its individual factual merits, using all the information that is available at the time of transfer approval and execution of the conveyance or letter of agreement with the respective Project Agency in accordance with the applicable legal requirements. This document does not pre-determine those needs or those facts and does not foreclose the requirement and consideration of additional information.” (Draft Technical Information for Preparing Water Transfer Proposals (“DTIPWTP”) 2014.)

Indeed, the Bureau and DWR have known for over a decade that programmatic environmental review was and is necessary for water transfers from the Sacramento Valley. The following examples highlight the Bureau and DWR’s deficiencies in complying with NEPA and CEQA.

- a. The Sacramento Valley Water Management Agreement was signed in 2002, and the need for a programmatic EIS/EIR was clear at that time it was initiated but never completed.
- b. In 2000, the Governor’s Advisory Drought Planning Panel report, *Critical Water Shortage Contingency Plan* promised a program EIR on a drought-response water transfer program, but was never undertaken.
- c. Sacramento Valley Integrated Regional Water Management Plan (2006).
- d. The Sacramento Valley Water Management Plan (2007).
- e. The CVPIA mandates the Bureau contribute to the State of California’s *long-term* efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, among other things. (EIS/EIR 1-10.)

Accordingly, the EIS/EIR should be revised to state that it does not and cannot constitute sufficient environmental review of any particular, as-of-yet-unknown, water transfer proposal; and instead be revised, restructured, and recirculated to provide programmatic policies, criteria, and first-tier environmental review.

- c. The EIS/EIR Improperly Segments Environmental Review of the Whole of this Program.

As discussed throughout these comments, the proposed Project does not exist in a vacuum, but rather is another transfer program in a series of many that have been termed either “temporary,” “short term,” “emergency,” or “one-time” water transfers, and is cumulative to numerous broad programs or plans to develop regional groundwater resources and a conjunctive use system. The *2015-2024 Water Transfer Program* is also only one of several proposed and existing projects that affect the regional aquifers.

For example, the proposed Project is, in fact, just one project piece required to implement the Sacramento Valley Water Management Agreement (“SVWMA”). The Bureau has publically

stated the need to prepare programmatic environmental review for the SVWMA for over a decade, and the present EIS/EIR covers a significant portion of the program agreed to under the SVWMA. In 2003, the Bureau published an NOI/NOP for a “Short-term Sacramento Valley Water Management Program EIS/EIR.” (68 Federal Register 46218 (Aug 5, 2003).) As summarized on the Bureau’s current website:

The Short-term phase of the SVWM Program resolves water quality and water rights issues arising from the need to meet the flow-related water quality objectives of the 1995 Bay-Delta Water Quality Control Plan and the State Water Resources Control Board's Phase 8 Water Rights Hearing process, and would promote better water management in the Sacramento Valley and develop additional water supplies through a cooperative water management partnership. Program participants include Reclamation, DWR, Northern California Water Association, San Luis & Delta-Mendota Water Authority, some Sacramento Valley water users, and Central Valley Project and State Water Project contractors. SVWM Program actions would be locally-proposed projects and actions that include the development of groundwater to substitute for surface water supplies, conjunctive use of groundwater and surface water, refurbish existing groundwater extraction wells, install groundwater monitoring stations, install new groundwater extraction wells, reservoir re-operation, system improvements such as canal lining, tailwater recovery, and improved operations, or surface and groundwater planning studies. These short-term projects and actions would be implemented for a period of 10 years in areas of Shasta, Butte, Sutter, Glenn, Tehama, Colusa, Sacramento, Placer, and Yolo counties.⁶

The resounding parallels between the SVWMA NOI/NOP and the presently proposed project are not merely coincidence: they are a piece of the same program. In fact, the SVWMA continues to require the Bureau and SLDMWA to facilitate water transfers through crop idling or groundwater substitution:

Management Tools for this Agreement. A key to accomplishing the goals of this Agreement will be the identification and implementation of a “palette” of voluntary water management measures (including cost and yield data) that could be implemented to develop increased water supply, reliability, and operational flexibility. Some of the measures that may be included in the palette are:

...

(v) Transfers and exchanges among Upstream Water Users and with the CVP and SWP water contractors, either for water from specific reservoirs, or by substituting groundwater for surface water . . . ⁷

⁶ http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=788

⁷ http://www.norcalwater.org/wp-content/uploads/2010/12/sac_valley_water_mgmt_agrmt_new.pdf

It is abundantly clear that the Bureau and SLDMWA are proposing a program through the present draft EIS/EIR to implement this management tool, as required by the SVWMA. But neither CEQA nor NEPA permit this approach of segmenting and piecemealing review of the whole of a project down to its component parts. The water transfers proposed for this project will directly advance SVWMA implementation, and the Bureau and DWR must complete environmental review of the whole of the program, as first proposed in 2003 but since abandoned. For example, the draft EIS/EIR does not reveal that the current Project is part of a much larger set of plans to develop groundwater in the region, to develop a “conjunctive” system for the region, and to integrate northern California’s groundwater into the state’s water supply.

In this vein the U.S. Department of Interior, 2006. Grant Assistance Agreement, *Stony Creek Fan Conjunctive Water Management Program and Regional Integration of the lower Tuscan Groundwater formation* laid bare the intentions of the Bureau and its largest Sacramento Valley water district partner, Glenn Colusa Irrigation District, to take over the Tuscan groundwater basin to further the implementation of the SVWMA, stating:

GCID shall define three hypothetical water delivery systems from the State Water Project (Oroville), the Central Valley Project (Shasta) and the Orland Project reservoirs sufficient to provide full and reliable surface water delivery to parties now pumping from the Lower Tuscan Formation. The purpose of this activity is to describe and compare the performance of three alternative ways of furnishing a substitute surface water supply to the current Lower Tuscan Formation groundwater users to eliminate the risks to them of more aggressive pumping from the Formation and to optimize conjunctive management of the Sacramento Valley water resources.

d. The Project Description Contains an Inadequate Statement of Objectives, Purpose, and Need.

The lack of a stable project description/proposed alternative, as discussed, above, further obfuscates the need for the Project. Further, without programmatic criteria to prioritize certain transfers, the public is not provided with even a basic understanding of the need for the Project. The importance of this section in a NEPA document can’t be overstated. “It establishes why the agency is proposing to spend large amounts of taxpayers' money while at the same time causing significant environmental impacts... As importantly, the project purpose and need drives the process for alternatives consideration, in-depth analysis, and ultimate selection. The Council on Environmental Quality (CEQ) regulations require that the EIS address the "no-action" alternative and "rigorously explore and objectively evaluate all reasonable alternatives." Furthermore, a well-justified purpose and need is vital to meeting the requirements of Section 4(f) (49 U.S.C. 303) and the Executive Orders on Wetlands (E.O. 11990) and Floodplains (E.O. 11988) and the Section 404(b)(1) Guidelines. Without a well-defined, well-established and well-

justified purpose and need, it will be difficult to determine which alternatives are reasonable, prudent and practicable, and it may be impossible to dismiss the no-build alternative”⁸

With the importance of a Purpose and Need statement revealed above, the Project’s version for purposes of NEPA states that, “The purpose of the Proposed Action is to facilitate and approve voluntary water transfers from willing sellers upstream of the Delta to water users south of the Delta and in the San Francisco Bay Area. Water users have the need for immediately implementable and flexible supplemental water supplies to alleviate shortages,” (p. 1-2). Noticeably missing from this section of the EIS/EIR is a statement about the Bureau’s purpose and need, not the buyers’ purpose and need. The omission of *any* need on the Bureau’s part for this Project highlights the conflicts in the Bureau’s mission, deficiencies in planning for both the short and long term, and the inadequacy of the EIS/EIR that should provide the public with the basis for the development of the range of reasonable alternatives and the identification and eventual selection of a preferred alternative. The *Reclamation’s NEPA Handbook* (2012) stresses that, “The need for an accurate (and adequate) purpose and need statement early in the NEPA process cannot be overstated. This statement gives direction to the entire process and ensures alternatives are designed to address project goals.” (p.11-1)

For purposes of CEQA, the Project Objectives (p. 1-2) go on to state that,

SLDMWA has developed the following objectives for long-term water transfers through 2024:

- Develop supplemental water supply for member agencies during times of CVP shortages to meet existing demands.
- Meet the need of member agencies for a water supply that is immediately implementable and flexible and can respond to changes in hydrologic conditions and CVP allocations.

Because shortages are expected due to hydrologic conditions, climatic variability, and regulatory requirements, transfers are needed to meet water demands.

But merely asserting that there are “demands” from their member lacks context, specificity, and rigor. It also fails to mention the need of the non-member buying agencies involved in the Project.

Some context for the policy failures that lead to the stated need for the Project must be presented. First, the hydrologic conditions described on pages ES-1, 1-1, and 1-2 almost always

⁸ Federal Transportation and Highway Administration, 1990. *NEPA and Transportation Decisionmaking: The Importance of Purpose and Need in Environmental Documents*.
<http://www.environment.fhwa.dot.gov/projdev/tmneed.asp>

apply to the entire state, including the region where sellers are sought, not just the areas served by SLDMWA and non-member buyers as presented here. Second, SLDMWA has chronic water shortages due to its contractors’ junior position in water rights, risks taken by growers to plant permanent crops, and serious long-term overdraft in its service area. Where is this divulged? Third, SLDMWA or its member agencies have sought to buy and actually procured water in many past water years to make up for poor planning and risky business decisions, which violates CEQA’s prohibition against segmenting a project to evade proper environmental review.⁹ The habitual nature of the transfers is acknowledged on pages ES-1 and 1-1 stating, “In the past decades, water entities have been implementing water transfers to supplement available water supplies to serve existing demands, and such transfers have become a common tool in water resource planning.” (See Table 1 for an attempt at documenting transfers since actual numbers are not disclosed in the EIS/EIR).

The Bureau and DWR’s facilitation of so-called “temporary” annual transfers in 12 of the last 14 years is illustrated in Table 1 (2014 transfer totals have not been tallied to date).

Table 1. The table is based on one from Western Canal Water District’s Negative Declaration for a 2010 water transfer.

Past Water Transfers from the Sacramento Valley Through the Delta in TAF Annually*													
Water Year Type **	Dry	Dry	AN	BN	BN	Wet	Dry	Critical	Dry	BN	Wet	BN	Dry
Program	2001	2002	2003	2004	2005	2006	2007	2008 ¹⁰	2009	2010	2011	2012	2013
DWR Drought Water Bank/Dry Year Programs	138	22	11	0.5	0	0	0	0	74	0	0	0	0
Enviro Water Acct	80	145	70	120	5	0	147	60	60	60	0	60	60
Others (CVP, SWP, Yuba, inter alia)	160	5	125	0	0	0	0	173	140	243	0	190	210
Totals	378	172	206	120.5	5	0	147	233	274* **	303	0	250	270

*Table reflects gross AF purchased prior to 20% Delta carriage loss (i.e., actual amounts pumped at Delta are 20% less)
 ** Based on DWR’s measured unimpaired runoff (in million acre-feet)
 Abbreviations: AN - Above normal year type and BN - Below normal year type (<http://cdec.water.ca.gov/cgi-progs/iodir/wsihist>)
 *** The 2015-2024 Water Transfer Program’s EIS/EIR contradicts the 274,000 AF total for 2009 on EIS/EIR page 1-16 that states that the CVP portion alone during 2009 was 390,000 AF.

The Project has become an extension of the so-called “temporary” annual transfers based on the demands of junior water rights holders who expect to receive little contract water during dry years. The low priority of their junior water service contracts within the Central Valley Project leaves their imported surface supplies in question year-to-year. It is the normal and appropriate function of California’s system of water rights law that makes it so. Yet the efforts

⁹ Laurel Heights Improvement Association v. Regents of the University of California, 1988, 47 Cal.3d 376
¹⁰ The Environmental Water Account ended in 2007 (Bay Delta Conservation Plan Draft EIS/EIR 2013). The figures that continue in this row are based on a long-term contract with the Yuba County Water Agency to sell water.-

of the Bureau and DWR to oversee, approve, and facilitate water sales from the Sacramento, Feather, and Yuba rivers with fallowing and groundwater substitution are only intended to benefit the few western San Joaquin Valley farmers whose contractual surface water rights have always been less reliable than most—and whose lands are the most problematic for irrigation. These growers have chosen to harden demand by planting permanent crops, a very questionable business decision, but the Bureau fails to explain why this “tail” in water rights is wagging the dog.

e. The Project Description does Not Include all Project Components.

i. Carriage water.

The EIS/EIR’s description of and reliance on “carriage water” is completely uncertain, undefined, and provides no meaningful information to the public. The EIS/EIR states that “Outflows would generally increase during the transfer period because carriage water would become additional Delta outflow.” (EIS/EIR 3.2-39.) The EIS/EIR also asserts that, “Carriage water (a portion of the transfer that is not diverted in the Delta and becomes Delta outflow) will be used to maintain water quality in the Delta.” (EIS/EIR 2-29.) Elsewhere the EIS/EIR references 20% carriage losses for CCWD and SLDMWA in the EIS/EIR (3.2-39, 3.2-57-58, and B-6), while prior documents have used higher estimates:

Historically, approximately 20-30% of the water transferred through the Delta would be necessary to enable the maintenance of water quality standards, which are based largely upon the total amount of water moving through the Bay-Delta system. This water, which is not available for delivery to Buyers, is known as “carriage water.” Given historically dry conditions prevailing in 2014, DWR estimates that carriage losses could be higher.

(Biggs West Gridley 2014 Water Transfer Neg Dec, p. 4)(Exhibit I). A Bureau spreadsheet that documents the final transfer numbers for 2013 clearly demonstrates that the 30% figure was used for carriage losses.¹¹ The spreadsheet further reveals that there are additional water deductions that were made prior to delivery in 2013 for DWR Conveyance Loss (2%) and Warren Act Conveyance Loss (3%). When all the water deductions are tallied for stream depletion, carriage losses, and the two conveyance losses, the actual water available for delivery when groundwater substitution is used is 53%. This is not presented in the EIS/EIR, which allows the Lead Agencies to overestimate the amount of water that is delivered through the Delta to Buyers and therefore the economic benefits of the *2015-2024 Water Transfer Program*. What is lacking is any meaningful discussion of the need for, role, availability, and effect of carriage water and conveyance losses in any transfer in the EIS/EIR. Without such information it is not possible to determine the water quality and supply effects of the program.

¹¹ Bureau of Reclamation, 2013-12-17 2013 Total Pumpage (FINAL) nlw.xlsx (Exhibit J)

ii. Monitoring and production wells.

The identity and locations of all wells that will be used to monitor groundwater substitution transfer pumping impacts are unknown. The EIS/EIR must include proposed transfer well locations that are sufficiently accurate to allow for determination of distances between the wells and areas of potential impact. These are integral project features that must be disclosed in detail prior to any meaningful effects analysis.

In 2009, GCID installed four production wells to extract 26,530 AF of groundwater as part of its *Stony Creek Fan Aquifer Performance Testing Plan*. Other districts have also installed production wells, most with public funds, that have been used for past transfers such as Anderson/Cottonwood Irrigation District, Butte Water District, and RD-108. To the extent those wells and any others would be used in this project, they must be considered to be part of the whole of the action, and disclosed and analyzed herein.

i. "Other" transfers.

The EIS/EIR states that, "Other transfers not included in this EIS/EIR could occur during the same time period, subject to their own environmental review (as necessary)." (EIS/EIR 1-2.) In other words, not only is the EIS/EIR unclear precisely about which transfers are likely to occur and are analyzed in this EIR/EIR, it also leaves open-ended the prospect of some transfers not being covered by the EIS/EIR. This apparent piecemealing of transfer projects short-circuits comprehensive environmental review.

f. The Project Description Fails to Include Sufficient Locations, Maps, and Boundaries.

The project description must show the location of the project, its component parts, and the affected environmental features. CEQA Guidelines § 15124(a).

Maps are needed of each seller service area at a scale that allows for reasonably accurate measurement of distances between the groundwater substitution transfer wells and surface water features, other non-participating wells, proposed monitoring wells, fisheries, vegetation and wildlife areas, critical surface structures, and regional economic features. Maps with rates and times of stream depletion by longitudinal channel section are needed to allow for an adequate review of the Draft EIR/EIS conclusion of less than significant and reasonable impacts with no injury. These maps are also needed to evaluate the specific locations for monitoring potential impacts. Thus, detailed maps that show the locations of the monitoring wells and the areas of potential impact along with the rates and seasons of anticipated stream depletion are needed for each seller service area. These maps are also needed to allow for evaluation of the cumulative effects whenever pumping by multiple sellers can impact the same resource. The only maps provided by the Draft EIS/EIR that show the location of the groundwater substitution transfer wells, and the rivers and streams potentially impacted are the simulated drawdown Figures 3.3-26 to 3.3-31, which are at a scale of approximately 1 inch to 18 miles. The lack of maps with sufficient detail to see the relationship between the wells and the surface water

features prevents adequate review of the Draft EIS/EIR analysis to determine groundwater and surface water impacts.

Furthermore, figure 3.1-1, mapping the project area, is impossible to read and determine where each seller and buyer service area actually lies. Nor does the figure itself actually include many geographic points of reference used throughout the EIS/EIR. The EIS/EIR, for example, states that “Pelger MCW is located on the east side of the Sacramento River near Robbins (Figure 3.1-1.)” (EIS/EIR at 3.1-7.) But Robbins is not on the map, and the Pelger MCW is virtually impossible to locate on Figure 3.1-1. Similarly, the EIS/EIR states that the Sacramento River is impaired from Keswick dam to the Delta, but the EIS/EIR contains no description or map showing where Keswick dam is located, or any map enabling an understanding of the geographic scope of this water quality impairment. This problem repeats for literally dozens of existing environmental features described in the EIS/EIR. And, this problem is compounded by the unstable nature of the project description itself, leaving the EIS/EIR to string together multiple combinations of place names where transfers may or may not be imported or exported, and leaving the reader to continually search out secondary information to attempt to follow the EIS/EIR’s terse and convoluted descriptions. A clear explanation, with visual aids, of the affected environment, including all local creeks and streams, and transfer water routes, is necessary to enable any member of the general public to grasp the potential types and locations of environmental impacts caused by the proposed program.

II. The EIS/EIR State Lead Agency Should be DWR, Not SLDMWA.

SLDMWA is not the proper Lead Agency for the Project. California Environmental Quality Act (“CEQA”) Guidelines sections 15367 and 15051 require that the California Department of Water Resources (“DWR”), as the operator of the California Aqueduct and who has responsibility to protect the public health and safety and the financial security of bondholders with respect to the aqueduct, is the more appropriate lead agency. In *PCL v DWR*, the court found that DWR’s attempt to delegate lead agency authority impermissibly insulated the department from “public awareness and possible reaction to the individual members’ environmental and economic values.”¹²

Pursuant to CEQA, ““lead agency” means the public agency which has the principal responsibility for carrying out or approving a project which may have a significant effect upon the environment.” (Public Res. Code § 21067.) As such, the lead agency must have authority to require imposition of alternatives and mitigation measures to reduce or avoid significant project effects, and must have the authority to disapprove of the project altogether. Here, the DWR clearly fits this description. As the EIS/EIR states, “[t]hese transfers require approval from Reclamation and/or Department of Water Resources (DWR).” (EIS/EIR 1-2.) Additionally, the

¹² *Planning and Conservation League et al. v Department of Water Resources* (2000) 83 Cal.App.4th 892, 907, citing *Kleist v. City of Glendale* (1976) 56 Cal. App. 3d 770, 779.

EIS/EIR reveals the obvious and long-standing relationship between the Bureau and DWR in facilitating surface water transfers. The Bureau and DWR have collaborated on each DTIWT publication, which provides specific environmental considerations for transfer proposals; are said to have “sponsored drought-related programs” together; have created the joint EIS/EIR for the Environmental Water Account (“EWA”); and “cooperatively implemented the 2009 Drought Water Bank.”

SLDMWA should not serve as the lead agency. The *2015-2024 Water Transfer Program* has the potential to impact the long-term water supplies, environment, and economies in many California counties far removed from the SLDMWA geographic boundaries. With SLDMWA designated as the lead agency, and no potential sellers or source counties designated as responsible agencies, the process is unreasonably biased toward the narrow functional interests of SLDMWA and its member agencies. According to the EIS/EIR, the SLDMWA’s role is to “[h]elp negotiate transfers in years when the member agencies could experience shortages.” (EIS/EIR 1-1.) Helping to negotiate a transfer is a wholly different role than that of a lead agency with approval authority over a project. All of SLDMWA’s purposes and powers are centered on providing benefit to member organizations,¹³ and do not implement the Sustainable Groundwater Management Act.¹⁴ Not only would SLDMWA be advocating on behalf of its members in this process, but nothing provided in the EIS/EIR suggests that it has authority to require mitigation measures or alternatives to reduce or avoid significant project impacts, for example, to groundwater resources in the seller service area, as such limitations would clearly be contrary to the specific interests of the SLDMWA members.

Importantly, DWR not only has jurisdiction over the SLDMWA transfers in ways that SLDMWA does not, but also DWR has review and approval authority over potential transfers outside of the SLDMWA altogether, including, for example, the East Bay Municipal Utilities District, as well as “[o]ther transfers not included in this EIS/EIR [that] could occur during the same time period, subject to their own environmental review (as necessary).” (EIS/EIR 1-2.) Environmental review of transfers should be unified and comprehensive, and cumulative across both geography and over time in a way that DWR and not SLDMWA can provide.

III. The EIS/EIR Fails to Completely and Accurately Describe the Affected Environmental Setting and Baseline Conditions.

A complete and accurate description of the existing and affected environmental setting is critical for an adequate evaluation of impacts to it. See *e.g. San Joaquin Raptor/Wildlife Rescue Ctr. v. County of Stanislaus* (1994) 27 Cal.App.4th 713; *Galante Vineyards v. Monterey Peninsula Water Mgmt. Dist.* (1997) 60 Cal.App.4th 1109, 1122; *County of Amador v. El Dorado County*

¹³ SLDMWA JPA, para. 6, pp. 4-7.

¹⁴ StAmant 2014. Letter to Bureau of Reclamation and SLDMWA re the 2015-2024 Water Transfer Program.

Water Agency (1999) 76 Cal.App.4th 931, 955; *Cadiz Land Co. v. Rail Cycle* (2000) 83 Cal.App.4th 74, 94.

As discussed, below, and in the expert reports submitted by *Custis*, *EcoNorthwest*, *Cannon*, and *Mish* on behalf of AquAlliance, the EIS/EIR fails to comport with these standards.

a. The EIS/EIR Fails to Describe Existing Physical Conditions.

i. Groundwater Supply

The EIS/EIR fails to provide a comprehensive assessment of the historic change in groundwater storage in the Sacramento Valley groundwater basin, and other seller sources areas within the proposed 10-year groundwater substitution transfer project. Historic change and current groundwater contour maps are critical to establishing an environmental baseline for the groundwater substitution transfers. The EIS/EIR uses SACFEM2013 simulations of groundwater substitution transfer pumping effects for WY 1970 to WY 2003, but the discussion of the simulation didn't provide specifics on how the model simulated the current conditions of the Sacramento Valley groundwater system or the potential impacts from the 10-year groundwater substitution transfer project based on current conditions. Again, The EIS/EIR relies on only modeling to consider impacts from the Project when it should disclose the results from actual monitoring and reporting for water transfer conducted in 12 of the last 14 years.

The EIS/EIR concludes that the Sacramento Valley basin's groundwater storage has been relatively constant over the long term, decreasing during dry years and increasing during wetter periods, but the EIR/EIS ignores more recent information and study (e.g. Brush 2013a and 2013b, NCWA, 2014a and 2014b). According to the BDCP EIS/EIR:

Some locales show the early signs of persistent drawdown, including the northern Sacramento County area, areas near Chico, and on the far west side of the Sacramento Valley in Glenn County where water demands are met primarily, and in some locales exclusively, by groundwater. These could be early signs that the limits of sustainable groundwater use have been reached in these areas."

(BDCP EIS/EIR at 7-13.) The Draft EIS/EIR provides only one groundwater elevation map of the Sacramento Valley groundwater basin, Figure 3.3-4, which shows contours only from selected wells that omit many depths and areas. The Draft EIS/EIR doesn't provide maps showing groundwater elevations, or depth to groundwater, for groundwater substitution transfer seller areas in Sutter, Yolo, Yuba, and Sacramento counties. The DWR provides on a web site a number of additional groundwater level and depth to groundwater maps that the EIS/EIR should use to help complete its description of the affected environment.¹⁵

¹⁵http://www.water.ca.gov/groundwater/data_and_monitoring/northern_region/GroundwaterLevel/gw_level_monitoring.cfm#Well%20Depth%20Summary%20Maps

Presented below are tables that illustrate maximum and average groundwater elevation decreases for Butte, Colusa, Glenn, and Tehama counties at three aquifer levels in the Sacramento Valley between the fall of 2004 and 2013. (Id).

County Fall '04 - '13	Deep Wells (Max decrease gwe)	Deep Wells (Avg. decrease gwe)
Butte	-11.4	-8.8
Colusa	-31.2	-20.4
Glenn	-60.7	-37.7
Tehama	-19.5	-6.6

County Fall '04 - '13	Intermediate Wells (Max decrease gwe)	Intermediate Wells (Avg. decrease gwe)
Butte	-21.8	-6.5
Colusa	-39.1	-16.0
Glenn	-40.2	-14.5
Tehama	-20.1	-7.9

County Fall '04 - '13	Shallow Wells (Max decrease gwe)	Shallow Wells (Avg. decrease gwe)
Butte	-13.3	-3.2
Colusa	-20.9	-3.8
Glenn	-44.4	-8.1
Tehama	-15.7	-6.6

Below are the results from DWR's spring monitoring for Sacramento Valley groundwater basin from 2004 to 2014.

County Spring '04 - '14	Deep Wells (Max decrease gwe)	Deep Wells (Avg. decrease gwe)
Butte	-20.8	-14.6
Colusa	-26.9	-12.6
Glenn	-49.4	-29.2
Tehama	-6.1	-5.3

County Spring '04 - '14	Intermediate Wells (Max decrease gwe)	Intermediate Wells (Avg. decrease gwe)
Butte	-25.6	-12.8
Colusa	-49.9	-15.4
Glenn	-54.5	-21.7
Tehama	-16.2	-7.9

County Spring '04 - '14	Shallow Wells (Max decrease gwe)	Shallow Wells (Avg. decrease gwe)
Butte	-23.8	-7.6
Colusa	-25.3	-12.9
Glenn	-46.5	-12.6
Tehama	-38.6	-10.8

The DWR data clearly present a different picture of the condition of the Sacramento Valley groundwater basin over time than what is provided in the EIS/EIR. This must be corrected and considered in the NEPA and CEQA process.

The EIS/EIR omits other critical information needed to understand the project’s impacts to area groundwater, including but not limited to:

- the distances between the transfer well(s) and surface water features;
- the number of non-participating wells in the vicinity of the transfer wells that may be impacted by the pumping; and,
- the distance between the transfer wells and non-participant wells that may be impacted by the transfer pumping, including domestic, public water supply and agricultural wells.

The EIS/EIR assumes that, “The groundwater modeling results indicate that shallow groundwater is typically deeper than 15 feet in most locations under existing conditions, and often substantially deeper.” (3.8-32.) However, existing hydrologic condition documents clearly show Depth to Groundwater levels in shallow portions of the aquifer system that are <15’ from the surface.

- The Chart titled **Depth to Water by Sub-Inventory Unit (SIU) on 2014_10_Summary_Table.PDF** page 2/2 shows the Average Depth to Water (feet) in March through October 2014. 7 of 16 Sub-Inventory Units (“SIUs”) in Butte County show average groundwater levels <15’ from the surface at some time of the year.¹⁶
- November 2014 Adobe spreadsheets show numerous monitoring wells with water levels closer than 10’ to the surface. The wells are located in Butte County SIUs designated under the county Basin Management Objective (“BMO”) program. While some of the SIUs are corresponding to an Irrigation District primarily served by surface water, the Butte Sink, Cherokee, North Yuba, Angel Slough, Llano Seco and M&T SIUs have naturally occurring water levels <10’. All 3 pages show ground surface to water surface (feet).¹⁷

¹⁶https://www.buttecounty.net/wrcdocs/Programs/Monitoring/GWLevels/2014/2014_10_Summary_Table.pdf
https://www.buttecounty.net/wrcdocs/Programs/Monitoring/GWLevels/2014/2014_10_Data_Summary_Update.pdf (Exhibit K)

¹⁷ 2014 Monthly Groundwater Depth to Water- CASGEM:
https://www.buttecounty.net/wrcdocs/Programs/Monitoring/GWLevels/2014/2014_10_Data_Summary_Update.pdf (Exhibit K)

- The January 2014 *BUTTE COUNTY DOMESTIC WELL DEPTH SUMMARY* shows the 10' Depth to Groundwater Contour lines in the lower portion of the map.¹⁸
- The January 2014 *COLUSA COUNTY DOMESTIC WELL DEPTH SUMMARY* shows the 10' Depth to Groundwater Contour lines in large portions of the county.¹⁹
- The January 2014 *GLENN COUNTY DOMESTIC WELL DEPTH SUMMARY* shows the 10' Depth to Groundwater Contour lines in the lower portion of the map.²⁰

Dan Wendell of The Nature Conservancy, a panelist at a workshop held by the California Natural Resources Agency, the California Department of Food and Agriculture, and California EPA on March 24, 2014, presented a similar picture as the county summaries above, but also raised the alarm about the existing, significant streamflow losses from groundwater pumping and, even more significantly, how long it takes for those losses to appear:

“The Sacramento Valley still has water levels that are fairly shallow,” he said. “There are numerous perennial streams and healthy ecosystems, and the basin is largely within a reasonable definition of sustainable groundwater yield. However, since the 1940s, groundwater discharge to streams in this area has decreased by about 600,000 acre-feet per year due to groundwater pumping, and it’s going to decrease an additional 600,000 acre-feet in coming years under 2009 status quo conditions due to the time it takes effects of groundwater pumping to reach streams. It takes years to decades, our work is showing.”²¹

What areas in the Sellers’ region were used to reach the EIS/EIR conclusion that “[i]ndicate that shallow groundwater is typically deeper than 15 feet”? What prevented the analysis from disclosing the many miles of riparian habitat in the Sacramento Valley that indicate that riparian forest vegetation remains healthy with groundwater levels shallower than 15 feet? As we presented above, there are many areas in the Sellers’ region that have groundwater higher than 15 feet below ground surface.

In addition, the EIS/EIR fails to provide recharge data for the aquifers. Professor Karin Hoover, Assistant Professor of hydrology, hydrogeology, and surficial processes from CSU Chico, found

¹⁸ Butte County shallow Groundwater Contours:

www.water.ca.gov/groundwater/data_and_monitoring/northern_region/GroundwaterLevel/WellDepthSummaryMaps/Domestic_BUTTE.pdf (Exhibit L)

¹⁹ Colusa County shallow Groundwater Contours:

www.water.ca.gov/groundwater/data_and_monitoring/northern_region/GroundwaterLevel/WellDepthSummaryMaps/Domestic_COLUSA.pdf (Exhibit M)

²⁰ Glenn County shallow Groundwater Contours:

www.water.ca.gov/groundwater/data_and_monitoring/northern_region/GroundwaterLevel/WellDepthSummaryMaps/Domestic_GLENN.pdf (Exhibit N)

²¹ <http://mavensnotebook.com/2014/04/28/groundwater-management-workshop-part-1-sustainable-groundwater-management-panel/> (Exhibit O)

in 2008 that, “Although regional measured groundwater levels are purported to ‘recover’ during the winter months (Technical Memorandum 3), data from Spangler (2002) indicate that recovery levels are somewhat less than levels of drawdown, suggesting that, in general, water levels are declining.” According to Dudley, “Test results indicate that the ‘age’ of the groundwater samples ranges from less than 100 years to tens of thousands of years. In general, the more shallow wells in the Lower Tuscan Formation along the eastern margin of the valley have the ‘youngest’ water and the deeper wells in the western and southern portions of the valley have the ‘oldest’ water,” adding that “the youngest groundwater in the Lower Tuscan Formation is probably nearest to recharge areas.” (2005). “This implies that there is currently no active recharge to the Lower Tuscan aquifer system (M.D. Sullivan, personal communication, 2004),” explains Dr. Hoover. “If this is the case, then water in the Lower Tuscan system may constitute fossil water with no known modern recharge mechanism, and, once it is extracted, it is gone as a resource,” (Hoover 2008).²²

ii. Groundwater Quality

The Draft EIS/EIR discusses the potential for impacts to groundwater quality by migration of contaminants as a result of groundwater substitution pumping, but provides only a general description of the current condition of groundwater quality. No maps are provided that show the baseline groundwater quality and known areas of poor or contaminated groundwater, or from all areas where groundwater pumping may occur. Groundwater quality information on the Sacramento Valley area is available from existing reports by the USGS (1984, 2008b, 2010, and 2011) and Northern California Water Association (NCWA, 2014c). Determination of groundwater quality prior to pumping is critical to avoiding significant adverse impacts, both to adjacent groundwater users impacted by migrating contaminants, as well as surface water potentially impaired by contaminated runoff from irrigated agriculture or other uses.

There are numerous hazardous waste plumes in Butte County, which could easily migrate with the potential increased groundwater pumping proposed for the Project. The State Department of Toxics Control and the Regional Water Resources Control Boards have a great deal of information readily available for all counties involved with the proposed Project. Fluctuating domestic wells can lead to serious contamination from heavy metals and non-aqueous fluids. Because the Bureau fails to disclose basic standards for the mitigation and monitoring requirements, it is unknown if hazardous plumes in the areas of origin will be monitored or not.

²² Spangler, Deborah L. 2002. *The Characterization of the Butte Basin Aquifer System, Butte County, California*. Thesis submitted to California State University, Chico; Dudley, Toccoy et al. 2005. *Seeking an Understanding of the Groundwater Aquifer Systems in the Northern Sacramento Valley: An Update*; Hoover, Karin A. 2008. *Concerns Regarding the Plan for Aquifer Performance Testing of Geologic Formations Underlying Glenn-Colusa Irrigation District, Orland Artois Water District, and Orland Unit Water Users Association Service Areas, Glenn County, California*. White Paper. California State University, Chico.

Please note the attached map from the State Water Resources Control Board (2008) that highlights areas vulnerable to groundwater contamination throughout the state. A significant portion of both the areas of origin and the receiving areas are highlighted. When the potential for serious health and safety impacts exists, NEPA and CEQA require that this must be disclosed and analyzed.

iii. Surface Water Flows

The EIS/EIR asserts that, under the no action/no project alternative, “Surface water supplies would not change relative to existing conditions. Water users would continue to experience shortages under certain hydrologic conditions, requiring them to use supplemental water supplies.” (3.1-15.) It would be most helpful if the lead agencies would explain the geographic scope of this statement since the shortages could be experienced throughout the areas of origin, transmission, and delivery – as well as the entire State of California. The section continues with, “Under the No Action/No Project Alternative, some agricultural and urban water users may face potential shortages under dry and critical hydrologic conditions.” Again, to what geographic areas is the EIS/EIR referring? The final sentence in the section reads, “Impacts to surface water supplies would be the same as the existing conditions.” Without further elaboration or a reference that would further explain what exactly are the “existing conditions, mentioned” this is merely a conclusory assertion without the benefit of factual data. For example, existing conditions vary wildly in California weather patterns and agency allocations can as well. For example, in 2014 CVP Settlement Contractors were threatened with an unprecedented 40 percent allocation, which later became 75 percent when they cooperated with water transfers. Failing to disclose the wide range of natural and agency decisions that comprise the No Action/No Project alternative must be corrected and re-circulated in another draft EIS/EIR.

The EIS/EIR states that “[b]ecause of the interaction of surface flows and groundwater flows in riparian systems, including associated wetlands, enables faster recharge of groundwater, these systems are less likely to be impacted by groundwater drawdown as a result of the action alternatives;” therefore, “[t]hese systems are less likely to be impacted by groundwater drawdown as a result of the action alternatives.” (EIS/EIR 3.8-32.) This flawed assumption has been readily discredited by USGS:

There is more of an interaction between the water in lakes and rivers and groundwater than most people think. Some, and often a great deal, of the water flowing in rivers comes from seepage of groundwater into the streambed. Groundwater contributes to streams in most physiographic and climatic settings... Groundwater pumping can alter how water moves between an aquifer and a stream, lake, or wetland by either intercepting groundwater flow that discharges into the surface-water body under natural conditions, or by

increasing the rate of water movement from the surface-water body into an aquifer. A related effect of groundwater pumping is the lowering of groundwater levels below the depth that streamside or wetland vegetation needs to survive. The overall effect is a loss of riparian vegetation and wildlife habitat.²³

Lastly, the EIR/EIS presents the rivers and streams analyzed for impacts from the Proposed Action alternative with numerous omissions and conclusory remarks that are not supported. (3.8-49 – 3.8-51.) Examples include:

- *Table 3.8.3 Screening Evaluation Results for Smaller Streams in the Sacramento River Watershed for Detailed Vegetation and Wildlife Impact Analysis for the Proposed Action* fails to designate the counties of origin except for Deer and Mill creeks. Even readers familiar with the region need this basic information.
- Creeks with groundwater/surface water connections, but omitted from Tehama and Butte counties in Table 3.8.3 include, but are not limited to: Clear, Cottonwood, Battle, Singer, Pine, Zimmershed, Rock, Mud, and Big Chico.
- The modeling that is used to omit streams from analysis and to select and analyze other streams is completely inadequate to the task. Page D-3 has information about model resolution. It is normal to have five to ten nodes to resolve a feature of interest, but the nodal spacing is listed as ranging from 125 to 1000 meters, with stream node spacing around 500 meters (EIS/EIR p. D-3). This implies that spatial features smaller than about 2 kilometers cannot be resolved with this model. With the physical response of interest below the threshold of resolution even under the best of circumstances, then you have 100% margin of error, because the model cannot "see" that response.²⁴

iv. Surface Water Quality

The baseline water quality data presented in the EIS/EIR is insufficient to accomplish any meaningful understanding of existing water quality levels throughout the project area. The EIS/EIR fails to show where each affected water body is, or disclose its existing beneficial uses, or numeric water quality objectives. Data that are presented is scattered, inconsistent, incomplete, often severely out of date, and often misleading. Further, the EIS/EIR fails to explain exactly where much of the presented water quality data comes from – indeed, failing to explain exactly where the affected environment is at all.

Many waterways are left out of this section entirely. The biological and vegetation effects of the program are discussed elsewhere in the EIS/EIR, and show that most would be impacted by the proposed program, but these waterways are not discussed in the EIS/EIR water quality section. Diminished flows can affect water quality in a variety of way, for example, causing

²³ The USGS Water Science School. <http://ga.water.usgs.gov/edu/gwdepletion.html>

²⁴ Mish, p. 8. (Exhibit C)

higher temperatures, lower dissolved oxygen, or high sediment contamination or turbidity. Therefore, these affected waterways should be described and analyzed in the EIS/EIR water quality chapter.

In addition, the EIS/EIR only names the California Aqueduct, the Delta-Mendota Canal, and the San Luis Reservoir as affected waters within the buyer areas. Later, the EIS/EIR admits that increased irrigation in the buyers' areas may adversely impact stream water quality, but none of these rivers, streams, creeks, or any other potentially affected waterway of any kind, are described in the buyer project areas. (EIS/EIR 3.2-26.)

The EIS/EIR also fails to meaningfully describe the existing water quality in the affected environment. The EIS/EIR repeatedly misleads the public and decision-makers regarding the baseline conditions of waters within the project area by labeling them as "generally high quality." For example, the EIS/EIR states that "certain segments of the Sacramento River contain several constituents of concern, including Chlordane, dichlorodiphenyltrichloroethane, Dieldrin, mercury, polychlorinated biphenyls (PCBs), and unknown toxicity (see Table 3.2-1); however, the water quality in the Sacramento River is generally of high quality." What is the basis for this non-sequitur used here, and repeated throughout the existing environmental descriptions in the EIS/EIR? How do constituents of concern and unknown toxicity translate to generally high quality?

The remaining baseline information presented in the EIS/EIR contains significant gaps that preclude a meaningful understanding of the existing environmental conditions. In order to attempt to characterize the water quality in the affected environmental area, the EIS/EIR lists out beneficial uses, 303(d) impairments, and a variety of water quality monitoring data. The EIS/EIR presents almost no reference to existing numeric water quality objectives, and evaluation of potential breaches of those standards is therefore impossible.

Table 3.2-1 lists 303(d) impairments within the area of analysis. The table states the approximate mileage or acreage of the portion of each water body that is impaired, but fails to inform the public exactly where these stretches are located. For example, table 3.2-1 states that, within the Delta, approximately 43,614 acres are impaired for unknown toxicity, 20,819 acres are impaired for electrical conductivity, and 8,398 acres are impaired for PCBs; but without knowing which acres within the Delta this table describes, it is impossible to know whether transfer water will affect those particular areas. This problem repeats for all impairments listed in table 3.2-1.

The baseline environmental condition of the Delta is poorly described. The EIS/EIR states that:

[e]xisting water quality constituents of concern in the Delta can be categorized broadly as metals, pesticides, nutrient enrichment and associated eutrophication, constituents associated with suspended sediments and turbidity, salinity, bromide, and organic

carbon. Salinity is a water quality constituent that is of specific concern and is described below.

(EIS/EIR at 3.2-21.) The EIS/EIR provides no further information about “metals, pesticides, nutrient enrichment and associated eutrophication, constituents associated with suspended sediments and turbidity.” These contaminants are each the focus of intensive regulation and controversy, and could cause significant adverse impacts if contaminated surface waters are transferred, but no meaningful baseline data of existing conditions is provided to facilitate an evaluation of the effects of the incremental changes caused by the proposed program.

The EIS/EIR provides scattered and essentially useless monitoring data to attempt to describe the existing water quality conditions in the program area. First, the EIS/EIR is unclear exactly what year or years it uses to constitute the baseline environmental conditions. Then, Tables 3.2-4 through 3.2-20 provide data from 1980 through 2014. Some tables average data, some use median data, some present isolated data, and none provide a comparison to existing numeric water quality objectives. Of all of the existing environmental baseline data provided, only table 3.2-15 provides any data regarding contamination caused by metals in the water column, and only for Lake Natoma from April to September of 2008. As a result, any contamination relating to any metals in any transfer water is essentially ignored by the EIS/EIR. Moreover, the scattershot data provided in the EIS/EIR does not provide the public with any information about the actual water quality of transfer water that may be used in any future project.

Table 3.2-21 presents mean data from “selected” monitoring stations throughout the Delta. The EIS/EIR states that “[s]ampling period varies, depending on location and constituent, but generally is between 2006-2012.” (EIS/EIR 3.2-22.) EIS/EIR readers simply have no way to know what these data actually represent. Columns are labeled “mean TDS,” “mean electrical conductivity,” and “mean chloride, dissolved.” Are these data averaged for the approximate period of 2006-2012? Were any data excluded? The EIS/EIR lists these monitoring stations, but doesn’t explain where each is actually located, which should be mapped for ease of reference. Nor does the EIS/EIR state what the applicable water quality objective is at each monitoring point for each parameter; nor how often these water quality objectives were breached.

Figure 3.2-2 presents the monthly median chloride concentrations at selected monitoring sites, and misleadingly states that these median concentrations do not exceed the secondary MCL for chloride of 250 mg/L; but that comparison is irrelevant as the Bay-Delta Plan sets water quality objectives for chloride at 250 mg/day, not monthly mean.

Figures 3.2-3 through 3.2-5 show average electrical conductivity at selected monitoring stations, but the EIS/EIR fails to state the relevant water quality standard against which to compare these data, and fails to report the frequency and magnitude of exceedances, which

are numerous and great. When do exceedances occur, and how can the proposed program avoid transferring water from or into waterways with elevated EC?

The EIS/EIR fails to provide any discussion or analysis of how SWRCB Decision 1641 would be implemented. The EIS/EIR states that Decision 1641 “requires Response Plans for water quality and water levels to protect diverters in the south Delta that may affect the opportunity to export transfers.” (EIS/EIR at 2-32.) Later, the EIS/EIR adds that Decision 1641 “require[s] that the Central Valley Project (CVP) and State Water Project (SWP) be operated to protect water quality, and that DWR and/or Reclamation ensure that the flow dependent water quality objectives are met in the Delta (SWRCB 2000).” (EIS/EIR 3.2-10.) Nowhere does the EIS/EIR actually identify what these requirements entail, nor analyze when they would or would not be met by any portion of the proposed program. D-1641 is among the most critical of water quality regulations controlling the proposed program, and the EIS/EIR must provide significantly more analysis of how it would propose to comply with these State Water Board standards. As discussed, below, compliance with D-1641 standards is far from certain.

Similarly, the EIS/EIR notes that “DWR has developed acceptance criteria to govern the water quality of non-Project water that may be conveyed through the California Aqueduct. These criteria dictate that a pump-in entity of any non-project water program must demonstrate that the water is of consistent, predictable, and acceptable quality prior to pumping the local groundwater into the SWP.” (EIS/EIR at 3.2-10.) Again, however, the EIS/EIR fails to explain what these criteria require, and fails to provide any discussion of whether, when, or how these criteria could be met for each transfer contemplated by the program. This lack of information and analysis is insufficient to support informed public and agency environmental decision-making.

IV. The EIS/EIR Fails to Evaluate Inconsistency with Applicable Laws, Plans, and Policies.

a. State Water Policies.

The EIS/EIR should fully disclose the consolidated places of use for DWR and the Bureau, and what criteria might be applied for greater flexibility claimed for the consolidated place of use necessary for any given year's water transfer program, and what project alternatives could avoid this shift. Could the transfers be facilitated through transfer provisions of the Central Valley Project Improvement Act? Would the consolidation be a permanent or temporary request, and would the consolidation be limited to the duration of just the *2015-2024 Water Transfer Program*? How would the consolidated places of use permit amendments to the SWP and CVP permits relate to their joint point of diversion? Would simply having the joint point of diversion in place under D-1641 suffice for the purpose of the Project?

The EIS/EIR should better describe existing water right claims of sellers, buyers, the Bureau, and DWR. In response to inquiries from the Governor's Delta Vision Task Force, the SWRCB

acknowledged that while average runoff in the Delta watershed between 1921 and 2003 was 29 million acre-feet annually, the 6,300 active water right permits issued by the SWRCB is approximately 245 million acre-feet²⁵ (pp. 2-3). In other words, **water rights on paper are 8.4 times greater than the real water in California's Central Valley rivers and streams diverted to supply those rights on an average annual basis.** And the SWRCB acknowledges that this 'water bubble' does not even take account of the higher priority rights to divert held by pre-1914 appropriators and riparian water right holders (*Id.* p. 1). More current research reveals that the average annual unimpaired flow in the Sacramento River basin is 21.6 MAF, but the consumptive use claims are an extraordinary 120.6 MAF – 5.6 times more claims than there is available water.²⁶ Informing the public about water rights claims would necessarily show that buyers and the Agencies clearly possess junior water rights as compared with those of many willing sellers. Full disclosure of these disparate water right claims and their priority is needed to help explain the actions and motivations of buyers and sellers in the *2015-2024 Water Transfer Program*. Otherwise the public and decision makers have insufficient information on which to support and make informed choices.

To establish a proper legal context for these water rights, the EIS/EIR should also describe more extensively the applicable California Water Code sections about the treatment of water rights involved in water transfers.

Like federal financial regulators failing to regulate the shadow financial sector, subprime mortgages, Ponzi schemes, and toxic assets of our recent economic history, the state of California has been derelict in its management of scarce water resources. As we mentioned above we are supplementing these comments on this matter of wasteful use and diversion of water by incorporating by reference and attaching the 2011 complaint to the State Water Resources Control Board of the California Water Impact Network the California Sportfishing Protection Alliance, and AquAlliance on public trust, waste and unreasonable use and method of diversion as additional evidence of a systemic failure of governance by the State Water Resources Control Board, the Department of Water Resources and the U.S. Bureau of Reclamation, filed with the Board on April 21, 2011. (Exhibit Q)

b. Public Trust Doctrine.

The State of California has the duty to protect the people's common heritage in streams, lakes, marshlands, and tidelands through the Public Trust Doctrine.²⁷ The Sacramento, Feather, and Yuba rivers and the Delta are common pool resources. DWR acknowledges this legal reality in

²⁵ SWRCB, 2008. Water Rights Within the Bay Delta Watershed (Exhibit P.)

²⁶ California Water Impact Network, AquAlliance, and California Sportfishing Protection Alliance 2012. *Testimony on Water Availability Analysis for Trinity, Sacramento, and San Joaquin River Basins Tributary to the Bay-Delta Estuary.* (Exhibit Q)

²⁷ *National Audubon Society v. Superior Court* (1983) 33 Cal 3d, 419, 441.

its publication, *Water Transfer Approval: Assuring Responsible Transfers*.²⁸ The application of the Public Trust Doctrine requires an analysis of the public trust values of competing alternatives, as was directed by the State Water Board in the Mono Lake Case. Its applicability to alternatives for the water transfers planned from the Sacramento, Feather, and Yuba rivers and through the Delta, where species recovery, ecosystem restoration, recreation and navigation are pitted against damage from water exports, is exactly the kind of situation suited to a Public Trust analysis, which should be required by the 2015-2024 Water Transfer Program. The act of appropriating water—whether for a new use or for a new method of diversion or of use—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. Groundwater pumping with adverse effects to public trust surface waters must also be considered.

c. Local General Plans and Ordinances.

The Draft EIS/EIR discusses only two county ordinances, the Colusa Ordinance No. 615 and Yolo Export Ordinance No. 1617, one agreement, the Water Forum Agreement in Sacramento County, and one conjunctive use program, the American River Basin Regional Conjunctive Use Program. Except for the brief discussion of the two ordinances, one agreement, and one conjunctive use program listed above, the Draft EIS/EIR doesn’t describe the requirements of local GMPs, ordinances, and agreements listed in Tables 3.3-1 (page 3.3-8) and Table 3-1 (page 27). Thus, the actual groundwater substitution transfer project permit requirements, restrictions, conditions, or exemptions required for each seller service area by the Bureau, DWR, and one or more County GMP or groundwater ordinance will apparently be determined at a future date.

Additional information is needed on what the local regulations require for exporting groundwater out of each seller’s groundwater basin. The Draft EIS/EIR needs to discuss how the local regulations ensure that the project complies with Water Code Sections 1220, 1745.10, 1810, 10750, 10753.7, 10920-10936, and 12924 (for more detailed discussion of these Water Codes see Draft EIS/EIR Section 3.3.1.2.2). Although the Draft EIS/EIR doesn’t document, compare or evaluate the requirements of all local agencies that have authority over groundwater substitution transfers in each seller service area, the Draft EIS/EIR concludes that the environmental impacts from groundwater substitution transfer pumping by each of the sellers will either be less than significant and cause no injury, or be mitigated to less than significant through mitigation measures WS-1, and GW-1 with its reliance on compliance with local regulations.

²⁸ California Department of Water Resources, *Water Transfer Approval: Assuring Responsible Transfers*, July 2012, page 3. Accessible online 16 February 2014 at http://www.water.ca.gov/watertransfers/docs/responsible_water_transfers_2012.pdf. In addition, the Delta Protection Act of 1959 also acknowledges this reality, California Water Code Sections 12200-12205. (Exhibit R)

As noted above, this conclusions is derived from information absent from the EIS/EIR and, even if there was information considered by the Lead Agencies, without any apparent analysis. Butte, Glenn, and Shasta counties represent counties with Sellers and all of them have the potential to be heavily impacted by activities in or adjacent to their jurisdictions. AquAlliance has examined their ordinances and found them insufficient to protect other users and the environment (Exhibits U, V, X). Sincere efforts at monitoring for groundwater levels and subsidence become meaningless if the monitoring infrastructure is scant and enforcement absent. The Butte County Department of Water and Resource Conservation also explains that local plans are simply not up to the task of managing a regional resource:

Each of the four counties that overlie the Lower Tuscan aquifer system has their own and separate regulatory structure relating to groundwater management. Tehama County, Colusa, and Butte Counties each have their own version of an export ordinance to protect the citizens from transfer-related third party impacts. Glenn County does not have an export ordinance because it relies on Basin Management Objectives (BMOs) to manage the groundwater resource, and subsequently to protect third parties from transfer related impacts. Recently, Butte County also adopted a BMO type of groundwater management ordinance. Butte County, Tehama County and several irrigation districts in each of the four counties have adopted AB3030 groundwater management plans. All of these groundwater management activities were initiated prior to recognizing that a regional aquifer system exists that extends over more than one county and that certain activities in one county could adversely impact another. Clearly the current ordinances, AB3030 plans, and local BMO activities, which were intended for localized groundwater management, are not well suited for management of a regional groundwater resource like that theorized of the Lower Tuscan aquifer system.²⁹

There is a possibility that a seller's groundwater substitution area of impact will occur in multiple local jurisdictions, which should results in project requirements coming from multiple local as well as state and federal agencies. The Draft EIS/EIR doesn't discuss the obstacles from cross jurisdictional impacts that are immense because groundwater basins cross county lines thereby eliminating authority. (*Id*) One obvious example is found with productions wells placed in Glenn County in the lower end of the Tuscan Aquifer Basin that may affect the up-gradient part of the aquifer in Butte and Tehama counties.

If the Project proceeds, each seller's project analysis should identify what future analyses, ordinances, project conditions, exemptions, monitoring and mitigation measures are required to ensure that each of the seller's project meets or exceed the goals of the Draft EIS/EIR.

V. The EIS/EIR Fails to Adequately Analyze Numerous Environmental Effects.

²⁹ Butte County Department of Water and Resource Conservation, *Needs Assessment Tuscan Aquifer Monitoring, Recharge, and Data Management Project*, 2007. (Exhibit S)

The EIS/EIR fails to include numerous required elements to support a meaningful analysis of the project's significant adverse impacts. First, the deficiencies in the incomplete and undefined project description, and incomplete description of existing environmental conditions, render any true impact analysis, or hard look at the project effects, impossible. *See, e.g., Santiago County Water Dist. v. County of Orange* (1981) 118 Cal.App.3d 818; *San Joaquin Raptor Rescue Ctr. v. County of Merced* (2007) 149 Cal.App.4th 645. Even the analysis provided, however, employs unsupported and inapplicable standards of significance. (CEQA Guidelines § 15064(b); *see, e.g., Oakland Heritage Alliance v. City of Oakland* (2011) 195 Cal.App.4th 884, 896; *Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1111). The EIS/EIR fails to completely analyze the project's significant adverse impacts, and fails to support its conclusions with substantial evidence, failing to characterize the project effects in the proper context and intensity. (*Id.*; 40 C.F.R. § 1508.27(a); *City of Maywood v. Los Angeles Unified School Dist.* (2012) 208 Cal.App.4th 362, 391; *Laurel Heights Improvement Association v. Regents of Univ. of Cal.* (1988) 47 Cal.3d 376, 393; *Madera Oversight Coalition, Inc. v. County of Madera* (2011) 199 Cal.App.4th 48, 102 ("whether an EIR is sufficient as an informational document is a question of law subject to independent review by the courts."))

As discussed, below, and in the expert reports submitted by *Custis*, *EcoNorthwest*, *Cannon*, and *Mish* on behalf of AquAlliance, the EIS/EIR fails to comport with these standards.

a. Surface Water Flows.

The EIS/EIR fails to adequately analyze changes to all surface water flows as a result of the proposed project. While the EIS/EIR presents some level of streamflow drawdown analysis in its vegetation and biological resources section, that analysis is not taken into consideration with respect to affects to other water supply rights. This raises the specter of injury to senior water rights holders, and the EIS/EIR fails to provide sufficient information regarding where such rights are held and in what amounts, and where proposed transfers may interfere.

Streamflow depletion in the EIS/EIR is evaluated through modeling, but a closer look at the models employed shows significant omissions. First, because the rate of stream depletion is scaled to pumping rate and because the model documentation doesn't indicate the pumping locations, rates, volumes, times or durations that produced the pumped volumes shown in Figure 3.3-25, or the stream depletions shown in Figures B-5 and B-6 in Appendix B, it appears that the SACFEM2013 modeling did not simulate the maximum rate of stream depletion for the proposed 10-year project. Second, the available Delta export capacity was determined from CalSim II model results using only conditions through WY 2003, which fails to account for

current conditions, climate change conditions, and future conditions. (EIS/EIR 3.7-18.) The adequacy of CalSIM II has also been called into question.³⁰

In addition, the Bay-Delta Conservation Plan establishes flow limits for the Delta that the EIS/EIR fails to consider. Instead, the EIS/EIR states that the proposed projects could decrease outflows by 0.3 percent in winter and spring, and provides a bare conclusion that this impact is less than significant. (EIS/EIR 3.2-39.) Just this year the Bureau of Reclamation and DWR requested a Temporary Urgency Change from the SWRCB, a modification to Delta flow objectives that were not being met, and D-1641 standards, in order to attempt to manage species protection.³¹

The EIS/EIR attempts to consider changes in available supplies for project participants, but fails to review what other water rights holders may be affected by diminished flows. This is especially important given the EIS/EIR's conclusion that transfers would be most needed in times of critical shortage.

The EIS/EIR also fails to disclose changes in flows as a result of tailwater and ag drainage, which could lead to significant streamflow impacts.

b. Water Quality.

- i. The EIS/EIR improperly excludes substantial amounts of water from any meaningful impact evaluation.

The EIS/EIR fails to provide any evidence to support its proposition that "if the change in flow is less than ten cubic feet per second (cfs), it is assumed that there would be no water quality impacts as this is within the error margins of the model." (EIS/EIR 3.2-27.) First, the margin of error of the model has no bearing on actual water quality. Second, NPDES permits regularly regulate flows of less than 10 cfs. According to USGS, 10 cfs equals 6.46 million gallons per day (MGD). The EIS/EIR's assumption that a change in reservoir elevation of less than 1,000 acre feet could not possibly have significant impacts to water quality is similarly baseless. (EIS/EIR 3.2-27.) This amounts to approximately 325,800 gallons of water, more than enough to result in a noticeable difference in water quality. The Federal Clean Water Act is a strict liability statute providing no de minimis exceptions. By way of comparison, the City of Galt Wastewater Treatment Plant maintains flows at 4.5 MGD (NPDES Permit No. CA0081434), the City of Colusa Wastewater Treatment Plant maintains flows of approximately 0.7 MGD (NPDES Permit No. CA0078999), and each of these facilities has been assessed penalties for effluent exceedances by the Regional Water Board in recent years. The EIS/EIR's conclusion that flows equivalent to entire municipal wastewater treatment plants have no ability to compromise water quality standards is simply wrong.

³⁰ Close, A., et al, 2003. A Strategic Review of CALSIM II and its Use for Water Planning, Management, and Operations in Central California (Exhibit T)

³¹ Letter from Mark W. Cowin to Tom Howard, April 9, 2014 (Exhibit U)

Similarly, the EIS/EIR provides the bare conclusion that:

CVP and SWP reservoirs within the Seller Service Area would experience only small changes in storage, which would not be of sufficient magnitude and frequency to result in substantive changes to water quality. Any small changes to water quality would not adversely affect designated beneficial uses, violate existing water quality standards, or substantially degrade water quality. Consequently, potential effects on reservoir water quality would be less than significant.

(EIS/EIR 3.2-31.) The EIS/EIR simply provides no evidence or analysis in making this conclusion.

Lastly, the EIS/EIR provides no actual analysis of potential impacts to San Luis Reservoir as a result of lowering water levels in response to transfers. The EIS/EIR admits that “storage under the Proposed Action would be less than the No Action/No Project Alternative for all months of the year,” and asserts that water levels would be lowered between 3%-6% as a result of the Project. (EIS/EIR 3.2-41.) The EIS/EIR then presents the bare conclusion that “These small changes in storage are not sufficient to adversely affect designated beneficial uses, violate existing water quality standards, or substantially degrade water quality.” The EIS/EIR provides no basis for this determination, including no comparison of baseline environmental conditions to changes in contaminated runoff as a result of any particular water transfer.

- ii. The EIS/EIR fails to provide any information with which to evaluate impacts from idled crop fields, or farmlands in buyers’ areas.

The EIS/EIR assumes certain agricultural practices will occur at idle rice fields, when in reality, property owners would be free to re-purpose idled fields in countless and creative ways. (EIS/EIR 3-2.30.) For idled alfalfa, corn, or tomato cropland, the EIS/EIR assumes that property owners will put in place erosion control measures to conserve soil. While this may be a reasonable assumption for some farms, others, who may prefer to pursue multi-year water transfers, may not have an interest in investing in soil conservation. In addition, the EIS/EIR fails to provide analysis of the degree of effectiveness of soil conservation measures where no groundcover is in place. (EIS/EIR 3.2-29.) If proven to be effective, the EIS/EIR should require the Lead Agencies to condition water transfers on these necessary mitigation measures, and provide monitoring and reporting to ensure their continued implementation. We recommend that the Bureau and DWR require, at a minimum, that local governments select independent third-party monitors, who are funded by surcharges on Project transfers paid by the buyers, to oversee the monitoring that is proposed in lieu of Bureau and DWR staff, and that peer-reviewed methods for monitoring be required. If this is not done, the Project’s proposed monitoring and mitigation outline is insufficient and cannot justify the significant risk of adverse environmental impacts.

The EIS/EIR also states that increased erosion would not be of concern in Butte, Colusa, Glenn, Solano, Sutter, and Yolo counties, due to the prevalence of clay and clay loam soils. (EIS/EIR 3.2-29.) This bare conclusion does not provide any meaningful evaluation of the proposed program's impacts. Does the EIS/EIR really mean to assert that nowhere across six entire counties does soil erosion adversely impact water quality?

The EIS/EIR contradicts itself, stating:

In cases of crop shifting, farmers may alter the application of pesticides and other chemicals which negatively affect water quality if allowed to enter area waterways. Since crop shifting would only affect currently utilized farmland, a significant increase in agricultural constituents of concern is not expected.

(EIS/EIR 3.2-30.) Would applications be altered, or remain the same? The EIS/EIR says both. In truth, due to the programmatic nature of this EIS/EIR, although it is a "project" not a "programmatic" document, one cannot know. This level of impact must be evaluated on a project-by-project basis, yet the Lead Agencies assertion that this is a "project" level EIS/EIR precludes additional CEQA and NEPA review.

The EIS/EIR concludes that water quality impacts in the buyer area would be less than significant, but provides no evidence or assurances whatsoever regarding the ultimate use of the purchased water would be. (EIS/EIR 3.2-41.) The EIS/EIR then considers only impacts resulting from increased crop irrigation, acknowledging that "[i]f this water were used to irrigate drainage impaired lands, increased irrigation could cause water to accumulate in the shallow root zone and could leach pollutants into the groundwater and potentially drain into the neighboring surface water bodies." (EIS/EIR 3.2-41.) The EIS/EIR then dismisses this possibility, assuming that buyers would only use water for "prime or important farmlands." Missing from this section is any analysis of water quality. What does the EIS/EIR consider to be prime or important farm lands? Do all such actual farms exhibit the same water quality in irrigated runoff? The EIS/EIR provides no assurances its assumptions will be met, and moreover, fails to explain what its assumptions actually are.

The EIS/EIR then again relies on an improper ratio comparison of the amount of transfer water potentially used in buyer areas, to the total amount of all water used in the buyers' areas. The EIS/EIR adds:

The small incremental supply within the drainage-impaired service areas would not be sufficient to change drainage patterns or existing water quality, particularly given drainage management, water conservation actions and existing regulatory compliance efforts already implemented in that area.

(EIS/EIR 3.2-41.) Again, however, any comparison ratio of transferred water to other irrigation simply provides no analysis of what water quality impacts any individual transfer would have

after application on any individual farm. Moreover, if indeed a transfer is responding to a shortage, the transfer amount could actually constitute all or a majority of water usage for a particular site. Allusion to “existing regulatory compliance efforts” only suggests that regulatory compliance is not already maintained in each and every potential buyer farmland. There is no reasonable dispute that return flows from irrigated agriculture can often compromise water quality standards, but the EIS/EIR simply brushes this impact aside.

The EIS/EIR assumes that transfers may only occur during times of shortage (EIS/EIR 3.2-41), yet the proposed project itself is not so narrowly defined, and nothing in the Water Code limits transfers to circumstances where there has been a demonstrated shortfall in the buyer’s area. As a result of this open-ended project description, the true water quality impacts in the buyers’ areas are completely unknown.

- iii. The EIS/EIR ignores numerous potentially significant sources of contamination to surface waters.

The EIS/EIR describes the existing environmental conditions of most of the water bodies within the potential seller areas to be impaired for numerous contaminants; and also provides sampling and monitoring data to show that in-stream exceedances of water quality objectives regularly occur. Yet, the EIS/EIR fails to ever discuss the impact of moving contaminated water from one source to another. For example, where a seller’s water is listed as impaired for certain contaminants, any movement of that water to another waterbody will simply spread this impairment. The EIS/EIR provides no information with which to determine the actual water quality of the seller’s water for any particular transfer, nor any evaluation or monitoring to determine whether moving these contaminants from one water to another would harm beneficial uses or exceed receiving water limits. The EIS/EIR should provide a more particularized review of potential contaminants and their impacts under the proposed project. For example, the EIS/EIR does not analyze water quality impacts from boron, but the BDCP EIS/EIR states, “large-scale, out-of-basin water transfers have reduced the assimilative capacity of the river, thereby exacerbating the water quality issues associated with boron.” (BDCP EIS/EIR at 8-40.) Similarly, dissolved oxygen, among other forms of contamination, pose regular problems pursuant to D-1641. These potentially significant impacts must be disclosed for public and agency review.

What selenium and boron loads in Mud Slough and other tributaries to the San Joaquin River may be expected from application of this water to western San Joaquin Valley lands?

The EIS/EIR fails to disclose whether changes in specific conductivity as a result of the program would result in significant impacts to water quality. First, as noted above, the EIS/EIR presents scattered baseline data, much of which appears to show ongoing EC exceedances, but the EIS/EIR fails to disclose what Bay-Delta EC standards are, and the frequency and magnitude of baseline exceedances. Against this backdrop, the EIS/EIR then admits that program transfers would increase EC by as much as 4.3 percent. (EIS/EIR 3.2-39.) The EIS/EIR fails to disclose

whether these regular EC increases would exacerbate baseline violation conditions. In addition, the EIS/EIR only presents analysis for one monitoring location, whereas the Bay-Delta plan contains EC limits for over a dozen monitoring locations.

The EIS/EIR fails to disclose the extent to which program transfers could harm water quality by moving the "X2" location through the Delta. D-1641 specifies that, from February through June, the location of X2 must be west of Collinsville and additionally must be west of Chipps Island or Port Chicago for a certain number of days each month, depending on the previous month's Eight River Index. D-1641 specifies that compliance with the X2 standard may occur in one of three ways: (1) the daily average EC at the compliance point is less than or equal to 2.64 millimhos/cm; (2) the 14-day average EC is less than or equal to 2.64 millimhos/cm; or (3) the 3-day average Delta outflow is greater than or equal to the corresponding minimum outflow.

The EIS/EIR relies on an improper ratio approach to its impact evaluation of increased EC concentrations in the Delta Mendota Canal as a result of San Joaquin River diversions. (EIS/EIR 3.2-40.) The EIS/EIR admits that EC in the canal would increase as a result of these diversions, but fails to disclose by how much, or against what existing environmental conditions. Instead, the EIS/EIR compares the transfer amount, approximately 250 cfs, to the total capacity of the canal, about 4,000 cfs, to conclude that EC changes would not be significant. A comparison of the transfer amount to the total canal capacity simply provides no analysis of or information about EC concentrations.

The EIS/EIR fails to meaningfully evaluate potentially significant impacts to surface water quality as a result of groundwater substitution. First, the EIS/EIR provides an improper and misleading comparison, stating that

The amount of groundwater substituted for surface water under the Proposed Action would be relatively small compared to the amount of surface water used to irrigate agricultural fields in the Seller Service Area. Groundwater would mix with surface water in agricultural drainages prior to irrigation return flow reaching the rivers. Constituents of concern that may be present in the groundwater could enter the surface water as a result of mixing with irrigation return flows. Any constituents of concern, however, would be greatly diluted when mixed with the existing surface waters applied because a much higher volume of surface water is used for irrigation purposes in the Seller Service Area. Additionally, groundwater quality in the area is generally good and sufficient for municipal, agricultural, domestic, and industrial uses.

(EIS/EIR at 3.2-21.) The EIS/EIR's threshold of significance asks whether any water quality objective will be violated, and this must be measured at each discharge point. In turn, any farm that substitutes surface water irrigation for groundwater irrigation must be evaluated against this threshold. The EIS/EIR fails to provide any evidence to support its conclusion that the dilution of the groundwater runoff into surface waters would avoid any significant water quality

impacts. On one hand the EIS/EIR asserts that groundwater is of good quality, and on the other hand, asserts that the overall quality would improve as it is mixed with surface water irrigation runoff: *which* source provides the better water quality in this arrangement? It is widely recognized that irrigated agricultural return flows can transport significant contaminants to receiving water bodies. In addition, the EIS/EIR simply assumes that contaminated groundwater would not be pumped and applied to agricultural lands, despite the fact that groundwater extractions may mobilize PCE, TCE, and nitrate plumes under the City of Chico,³² and fails to disclose the existence of all hazardous waste plumes in the area of origin where groundwater substitution may occur. The assertion that “groundwater is generally good” throughout 6-10 counties is insufficient to provide any meaningful information against which to evaluate any particular transfer.

For “non-Project” reservoirs, the EIS/EIR provides one piece of additional information: modeling projections showing various rates of drawdown in table 3.2-24. The EIS/EIR then concludes that because water quality in these reservoirs is generally good, the reductions would not result in any significant water quality impacts. Again, the EIS/EIR provides no evidence or analysis to support this bare conclusion. Nor does the EIS/EIR present the beneficial uses of Collins Lake, nor Dry Creek, downstream of Collins Lake (see Table 3.2-2). The EIS/EIR does note that Lake McClure, Hell Hole Reservoir, and Camp Far West Reservoir maintain beneficial uses for cold water habitat and wildlife habitat, but fails to evaluate whether these beneficial uses would be impacted. Dissolved oxygen rates will decrease with lower water levels, and any sediment-based contaminant concentration, will increase. And the fact that drawdowns increase in already-critical years only heightens the water quality concerns.

The EIS/EIR repeatedly relies on dilution as the solution, with no actual analysis or receiving water assimilative capacity, and no regulatory authority. It is well-established law that a discharger may receive a mixing zone of dilution to determine compliance with receiving water objectives if and only if the permittee has conducted a mixing zone study, submitted to a Regional Board or the State Board for approval. (See, e.g., *Waterkeepers N. Cal. v. AG Indus. Mfg.*, 2005 U.S. Dist. LEXIS 43006 [“A dilution credit is a limited regulatory exception that must be preceded by a site specific mixing zone study”]; Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, 65 Fed. Reg. 31682 (May 18, 2000), 31701 [“All waters . . . are subject to the criteria promulgated today. Such criteria will need to be attained at the end of the discharge pipe, unless the State authorizes a mixing zone.”]) The EIS/EIR entirely ignores Clean Water Act requirements for obtaining dilution credits, and, with no supporting evidence whatsoever, effectively and illegally grants dilution credits across the board. (See, EIS/EIR 3.2-31, 3.2-35, 3.2-36, 3.2-42, 3.2-59). For each instance in which the EIR/EIS wishes to apply dilution credit to its determination of whether water quality impacts will be significant, it must perform – with the approval of the State or Regional

³² http://www.ci.chico.ca.us/capital_project_services/NitrateArea2NPh3U1-3.asp

Water Board – a mixing zone study considering the impacted waterbody and the specific types and quantities of the proposed pollutant discharge(s). Short of that, each time the EIS/EIR relies on dilution as the solution, it fails to analyze whether any contaminant in any waterbody in any amount could protect beneficial uses or exceed receiving water standards. The more Project water goes to south-of-Delta agricultural users than to urban users, the higher would be their groundwater levels, the more contaminated the groundwater would be in the western San Joaquin Valley and the more the San Joaquin River would be negatively affected from contaminated seepage and tailwater by operation of the Project.

c. Groundwater Resources.

The modeling efforts presented by the EIS/EIR fail to accurately capture the project's groundwater impacts. First, the SACFEM2013 simulations didn't evaluate the impacts of pumping the maximum annual amount proposed for each of the 10 years of the project. Second, because the groundwater modeling effort didn't include the most recent 11 years record, it appears to have missed simulating the most recent periods of groundwater substitution transfer pumping and other groundwater impacting events, such as recent changes in groundwater elevations and groundwater storage (DWR, 2014b), and the reduced recharge due to the recent periods of drought. Without taking the hydrologic conditions during the recent 11 years into account, the results of the SACFEM2013 model simulation may not accurately depict the current conditions or predict the effects from the proposed groundwater substitution transfer pumping during the next 10 years.

The Lead Agencies are making gross assumptions about the number, size, and behavior of all the surface water resources in the state, just to be able to coerce those assumptions into data that fits into the SACFEM2013 model. The assumptions are driving the modeling instead of the model (and science) driving accurate results. Appendix D is full of inaccurate statements and clear indications that this model is deficient. For example, it's advertised as a 3D model, but it's actually a collection of linked 2D models, and those are driven not by science, but by assumptions, e.g., the model can't calculate the location of the phreatic surface: it relies on assumptions and observations for that data, and that makes the model incapable of prediction.³³

The Draft EIS/EIR should provide the time-drawdown and distance-drawdown hydraulic characteristics for each groundwater substitution transfer well so that non-participant well owners can estimate and evaluate the potential impacts to their well(s) from well interference due to the pumping the groundwater substitution transfer well(s). This analysis is not present in the EIS/EIR.

³³ Mish (Exhibit C) pp. 3 and 4).

The EIS/EIR wrongly assumes that stream depletion impacts from pumping occur only downstream from the point on the stream closest to the pumping well.³⁴ Any monitoring of the effects of groundwater substitution pumping on surface or ground water levels, rates and areas of stream depletion, fisheries, vegetation and wildlife impacts, and other critical structures needs to cover a much wider area than what is needed for a direct surface water diversion.

The EIS/EIR doesn't compare the known groundwater quality problem areas with the SACFEM2013 simulated drawdowns to demonstrate that the proposed projects won't draw in or expand the areas of known poor water quality. The EIS/EIR analysis doesn't appear to consider the impacts to private well owners. Pumping done as part of the groundwater substitution transfer may cause water quality impacts from geochemical changes resulting from a lowering the water table below historic elevations, which exposes aquifer material to different redox conditions and can alter the mixing ratio of different quality aquifer zones being pumped. Changes in groundwater level can also alter the direction and/or rate of movement of contaminated groundwater plumes both horizontally and vertically, which may expose non-participating wells to contaminants they would not otherwise encounter.

The EIS/EIR fails to evaluate any changes in the rate and direction of inter-basin groundwater flow. Inter-basin groundwater flow may become a hidden long-term impact that increases the time needed for recovery of groundwater levels from groundwater substitution transfer pumping, and can extend the impact from groundwater substitution transfer pumping to areas outside of the groundwater substitution transfer seller's boundary.

Finally, the EIS/EIR should evaluate how Project transfers could add to the already high water table in the western San Joaquin Valley? Impacts from a higher water table could include increased groundwater contamination, lower flood resistance, greater erosion, and loss of suitability of certain parcels to particular land uses.

d. The SACFEM 2013 and CALSIM II Models are Inadequate.

The comments herein are based largely on the attached work of Dr. Custis (Exhibit A) and Dr. Mish (Exhibit C), and we request specific responses to these attached works. The EIR/EIS fails to accurately estimate environmental effects likely to occur during water transfers. The SACFEM2013 model used to predict groundwater resources is flawed by being based on poor technology that is simply not up to the task of accurate large-scale modeling.

The SACFEM2013 model is only partially predictive, in that key aquifer responses are entered as input data instead of being computed as predictive quantities. The model requires considerable data manipulation to be used, and these manipulations are necessarily subject to interpretation. The model description in the EIR/EIS presents no validation results that can be used to provide basic quality-assurance for the analyses used in the EIR/EIS. The model is not

³⁴ Custis (Exhibit A)

predictive in many important responses (as mentioned above), so its results are a reflection of past data (e.g., streamflows, phreatic surface location, etc.) instead of providing a predictive capability for future events. As described in previous sections, both the model and the input data contain gross over-simplifications that compromise the ability to provide accurate estimates of real-world responses of water resources. On page 19 of Appendix B, the reader is promised that model uncertainty will be described in Appendix D, but that promise is never delivered. This lack of any formal measure of uncertainty is not an unimportant detail, as it is impossible to provide accurate estimates of margin of error without some formal treatment of uncertainty. Any physical response asserted by the model's results has a margin of error of 100% if that response involves spatial scales smaller than a kilometer or more.

The EIR/EIS makes little connection between groundwater extraction process modeled by SACFEM2013 and the all-too-real potential for surface subsidence, and the attendant irreversible loss of aquifer capacity. The problem is especially important during drought years, when groundwater substitution is most likely to occur. In a drought, the aquifer already entrains less groundwater than normal, so that additional stresses due to pumping are visited upon the aquifer skeleton. This is exactly the conditions required to cause loss of capacity and the risk of subsidence. Yet the EIR/EIS makes scant mention of these all-too-real problems, and no serious modeling effort is presented in the EIR/EIS to assess the risk of such environmental degradation.

In contrast to the shortcomings of the model, the Bureau/DWR's DTIPWT seeks information on interactions between groundwater pumping and groundwater/surface water supplies at various increments of less than one and two miles. (DTIPWT at Appendix B.) Where the EIS/EIR fails to provide information at a level of detail required by BOR and DWR to determine whether significant impacts to water supplies may occur, the EIS/EIR fails to provide information needed to support a full analysis of groundwater and surface water impacts, and fails to support its conclusions with evidence.

CalSim II is a highly complex simulation model of a complex system that requires significant expertise to run and understand. Consequently, only a few individuals concentrated in the Department of Water Resources, U.S. Bureau of Reclamation and several consulting firms understand the details and capabilities of the model. State Water Resources Control Board (SWRCB) staff cannot run the model. To the extent CalSim II is relied upon, the EIR/EIS must be transparent and clearly explain and justify all assumptions made in model runs. It must explicitly state when findings are based on post processing and when findings are based on direct model results. And results must include error bars to account for uncertainty and margin of safety.

As an optimization model, CalSim II is hardwired to assume perfect supply and perfect demand. The notion of perfect supply is predicated on the erroneous assumption that groundwater can always be obtained to augment upstream supply. However, the state and federal projects have

no right to groundwater in the unadjudicated Sacramento River basin. Operating under this assumption risks causing impacts to ecosystems dependent upon groundwater basins in the areas of origin. The notion of perfect demand is also problematic, as it cannot account for the myriad of flow, habitat and water quality requirements mandated by state and federal statutes. Perfect demand assumes water deliveries constrained only by environmental constraints included in the code. In other words, CalSim II never truly measures environmental harm beyond simply projecting how to maximize deliveries without violating the incorporated environmental constraints. As a monthly time-step model, CalSim II cannot determine weekly, daily or instantaneous effects; i.e., it cannot accurately simulate actual instantaneous or even weekly flows. It follows that CalSim II cannot identify real-time impacts to objectives or requirements. Indeed, DWR admits, "CalSim II modeling should only be used in 'comparative mode,' that is when comparing the results of alternate CalSim II model runs and that 'great caution should be taken when comparing actual data to modeled data."³⁵

The Department of Civil Engineering University of California at Davis conducted a comprehensive survey of members of California's technical and policy-oriented water management community regarding the use and development of CalSim II in California. Detailed interviews were conducted with individuals from California's water community, including staff from both DWR and USBR (the agencies that created, own, and manage the model) and individuals affiliated with consulting firms, water districts, environmental groups, and universities.

The results of the survey, which was funded by the CalFed Science Program and peer-reviewed, should serve as a cautionary note to those who make decisions based on CalSim II. The report cites that in interviewing DWR and USBR management and modeling technical staff: "*Many interviewees acknowledge that using CALSIM II in a predictive manner is risky and/or inappropriate, but without any other agency-supported alternative they have no other option.*"

The report continues that: "All users agree that CalSim II needs better documentation of the model, data, inputs, and results. CalSim II is data-driven, and so it requires numerous input files, many of which lack documentation," and "There is considerable debate about the current and desirable state of CalSim II's calibration and verification," and "Its representation of the SWP and CVP includes many simplifications that raise concerns regarding the accuracy of results." "The model's inability to capture within-month variations sometimes results in overestimates of the volume of water the projects can export from the Sacramento- San Joaquin Bay-Delta and makes it seem easier to meet environmental standards than it is in real operations." The study concluded by observing, "CalSim II is being used, and will continue to be used, for many other types of analyses for which it may be ill-suited, including in absolute mode."

³⁵ Answering Brief for Plaintiff-Intervenor-Appellee California Department of Water Resources, Appeal from the United States District Court for the Eastern District of California, No. 1:09-cv-407, Case: 11-15871, 02/10/2012, ID: 8065113, page 15

In sum, the relied-upon models fail to accurately characterize the existing and future environment, fail to assess project-related impacts at a level of detail required for the EIS/EIR, and fail to support the EIS/EIR's conclusions regarding significance of impacts.

e. Seismicity.

The EIS/EIR reasoning that because the projects don't involve new construction or modification of existing structures that there are no potential seismic impacts from the activity undertaken during the transfers is incorrect. The project area has numerous existing structures that could be affected by the groundwater substitution transfer pumping, specifically settlement induced by subsidence. Although the seismicity in the Sacramento Valley is lower than many areas of California, it's not insignificant. There is a potential for the groundwater substitution transfer projects to increase the impacts of seismic shaking because of subsidence causing additional stress on existing structures.

The EIS/EIR fails to inform the public through any analysis of the potential effects excessive groundwater pumping in the seller area may have on the numerous known earthquake faults running through and about the north Delta area, and into other regions of Northern California. As recently detailed in a paper published by a well-respected British scientific journal, "[u]plift and seismicity driven by groundwater depletion in central California," excessive pumping of groundwater from the Central Valley might be affecting the frequency of earthquakes along the San Andreas Fault, and raising the elevation of local mountain belts. The research posits that removal of groundwater lessens the weight and pressure on the Earth's upper crust, which allows the crust to move upward, releasing pressure on faults, and rendering them closure to failure. Long-Term Water Transfer Agreements have impacted the volume of groundwater extracted as farmers are able to pump and then forego surface water in exchange for money. The drought has exacerbated the need for water in buyer areas, and depleted the natural regeneration of groundwater supply due to the scarcity of rain.

Detailed analyses of this seismicity and focal mechanisms indicate that active geologic structures include blind thrust and reverse faults and associated folds (e.g., Dunnigan Hills) within the Coast Ranges-Sierran Block ("CRSB") boundary zone on the western margin of the Sacramento Valley, the Willows and Corning faults in the valley interior, and reactivated portions of the Foothill fault system. Other possibly seismogenic faults include the Chico monocline fault in the Sierran foothills and the Paskenta, Elder Creek and Cold Fork faults on the northwestern margin of the Sacramento Valley.³⁶

f. Climate Change.

³⁶ http://archives.datapages.com/data/pacific/data/088/088001/5_ps0880005.htm (Custis, Exhibit A)

The gross omissions and errors within the climate change analysis of the EIS/EIR fail to accurately describe the existing climatological conditions into which the project may be approved, fail to accurately describe the diminution of water and natural resources over recent and future years as a result of climate change, fail to integrate these changing circumstances into any future baseline or cumulative conditions, and fail to completely analyze or support the EIS/EIR conclusions regarding the project's potentially significant impacts.

i. The EIS/EIR Completely Fails to Incorporate Any Climate Change Information into its Analysis.

The EIS/EIR provides no analysis whatsoever of the extent to which climate change will affect the EIS/EIR assumptions regarding water supply, water quality, groundwater, or fisheries. Despite providing an overview of extant literature and study, all agreeing that California temperatures have been, are, and will continue to be rising, the entire EIS/EIR analysis of climate change interactions with the proposed project states:

As described in the Section 3.6.1.3, changes to annual temperatures, extreme heat, precipitation, sea level rise and storm surge, and snowpack and streamflow are expected to occur in the future because of climate change. Because of the short-term duration of the Proposed Action (10 years), any effects of climate change on this alternative are expected to be minimal. Impacts to the Proposed Action from climate change would be less than significant.

(EIS/EIR 3.6-21 to 3.6-22; similarly, the EIS/EIR Fisheries chapter at 3.7-23 states: "Future climate change is not expected to alter conditions in any reservoir under the No Action/No Project Alternative because there will be limited climate change predicted over the ten year project duration (see Section 3.6, Climate Change/Greenhouse Gas).")

First, this "analysis" seriously misstates extant science by claiming that climate change impacts "are expected to occur in the future." The effects of climate change are affecting California's water resources at present, and have been for years. A 2007 DWR fact sheet, for example, states that "[c]limate change is already impacting California's water resources."³⁷ A more recent 2013 report issued by the California Office of Environmental Health Hazard Assessment states that "[m]any indicators reveal already discernible impacts of climate change, highlighting the urgency for the state, local government and others to undertake mitigation and adaptation strategies."³⁸ The report states that:

³⁷ <http://www.water.ca.gov/climatechange/docs/062807factsheet.pdf> (Exhibit AA)

³⁸ <http://oehha.ca.gov/multimedia/epic/pdf/ClimateChangeIndicatorsSummaryAugust2013.pdf> (Exhibit BB)

Climate is a key factor affecting snow, ice and frozen ground, streams, rivers, lakes and the ocean. Regional climate change, particularly warming temperatures, have affected these natural physical systems.

From October to March, snow accumulates in the Sierra Nevada. This snowpack stores much of the year's water supply. Spring warming releases the water as snowmelt runoff. Over the past century, spring runoff to the Sacramento River has decreased by 9 percent. Lower runoff volumes from April to July may indicate: (1) warmer winters, during which precipitation falls as rain instead of snow; and (2) earlier springtime warming.

Glaciers are important indicators of climate change. They respond to the combination of winter snowfall and spring and summer temperatures. Like spring snowmelt, the melting of glaciers supplies water to sustain flora and fauna during the warmer months. Glacier shrinkage results in earlier peak runoff and drier summer conditions—changes with ecological impacts—and contributes to sea level rise.

With warming temperatures over the past century, the surface area of glaciers in the Sierra Nevada has been decreasing. Losses have ranged from 20 to 70 percent.

...

Over the last century, sea levels have risen by an average of 7 inches along the California coast.

...

Lake waters have been warming at Lake Tahoe, Lake Almanor, Clear Lake and Mono Lake since the 1990s. Changes in water temperature can alter the chemical, physical and biological characteristics of a lake, leading to changes in the composition and abundance of organisms that inhabit it.

...

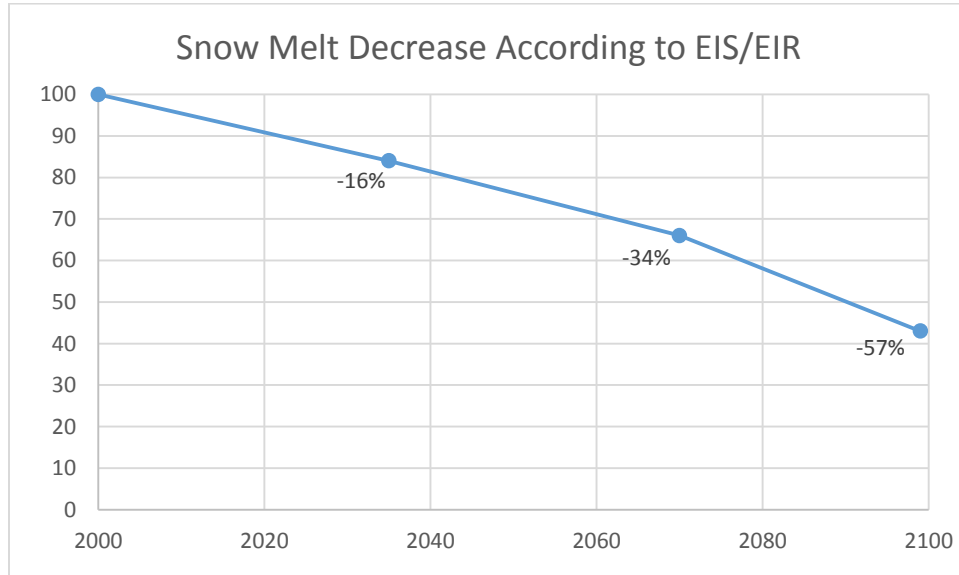
Snow-water content—the amount of water stored in the snowpack—has declined in the northern Sierra Nevada and increased in the southern Sierra Nevada, likely reflecting differences in precipitation patterns.

Reduced runoff means less water to meet the state's domestic, agricultural, hydroelectric power generation, recreation and other needs. Cold water fish habitat, alpine forest growth and wildfire conditions are also impacted.

In addition, climate change threatens to reduce the size of cold water pools in upstream reservoirs and raise temperatures in upstream river reaches for Chinook, and climate change will reduce Delta outflows and cause X2 to migrate further east and upstream. (See, BDCP at 5.B-310, "Delta smelt may occur more frequently in the north Delta diversions area under future climate conditions if sea level rise [and reduced Sacramento River inflow below Freeport] induces movement of the spawning population farther upstream than is currently typical.")

And, the EIS/EIR “[f]igure 3.6-1 shows the climate change area of analysis,” excluding all of the Sierra Nevadas except those within Placer County, and excluding all of Sacramento County. (EIS/EIR 3.6-2.)

Instead of accounting for these factors in its environmental analysis, the EIS/EIR takes the obtuse approach of relying only on “mid-century” and year 2100 projections to cast climate change as a “long-term” and “future” problem. (See, e.g., EIS/EIR 3.6-10.) First, the U.S. Department of Interior and the California Resources Agency clearly possess better information regarding past, present, and on-going changes to water supplies as a result of climate change than presented in the EIS/EIR, and such information must be incorporated. Second, even the information presented could be more fully described, and where appropriate, extrapolated, to support any meaningful analysis. Presumably these studies and reports provide more than one or two future data points, and instead show curved projections over time. For example, the EIS/EIR states that “[i]n California, snow water equivalent (the amount of water held in a volume of snow) is projected to decrease by 16 percent by 2035, 34 percent by 2070, and 57 percent by 2099, as compared to measurements between 1971 and 2000.” (EIS/EIR 3.6-11.) Are these the only three data points provided by the study? Unless the EIS/EIR assumes that the entire percent decreases will be felt exclusively in years 2035, 2070, and 2099, these data should be extrapolated, as follows, to approximate the snow melt decrease over the project term:



From this it is apparent that snow melt will decrease over the project term. This provides just one example, but the EIS/EIR itself should include meaningful analysis of climate change effects upon annual temperatures, extreme heat, precipitation, evaporation, sea level rise, storm surge, snowpack, groundwater, stream flow, riparian habitat, fisheries, and local economies over the life of the project.

Nine years ago, in 2005, then California Governor Arnold Schwarzenegger stated “[w]e know the science. We see the threat. And we know the time for action is now.”³⁹ Here, in contrast, the EIS/EIR says, let’s wait another ten years. This is simply unacceptable.

ii. The EIS/EIR Completely Ignores Increased GHG Emission in the Buyer Areas.

The EIS/EIR impact evaluation of increased GHG emissions in the buyer areas consists of a series of incomplete characterizations and unsupported conclusion. First, the EIS/EIR states: “Water transfers to agricultural users . . . could temporarily reduce the amount of land idled relative to the No Action/No Project Alternative.” (EIS/EIR 3.6-22.) This is in part true, but understates the impact, as there is no guarantee that the newly-supported land-uses would either be temporary, or agricultural. Second, the EIS/EIR states that “farmers may also pump less groundwater for irrigation, which would reduce emissions from use of diesel pumps.” This too is entirely speculative, and also contradicts the earlier implication that transfer water would only go to idled cropland. Third, the EIS/EIR summarily concludes that, “[t]he total amount of agricultural activity in the Buyer Service Area relative to GHG emissions would not likely change relative to existing conditions and the impact would be less than significant.” This again contradicts the EIS/EIR earlier statement that a water transfer could result in less idled cropland; and also defies logic and has no support in fact to suggest that increasing provision of a scarce resource would not induce some growth. At a bare minimum, the EIS/EIR should use its own estimated GHG reduction rates achieved as a result of newly idled cropland in the sellers’ service area as means of measuring the estimated GHG emission increases caused by activating idled cropland in the buyers’ service areas.

iii. The EIS/EIR Threshold of Significance for GHG Emissions is Inappropriate.

The EIS/EIR reviews nearly a dozen relevant, agency-adopted, thresholds of significant for GHG emissions, and chooses to select the single threshold that sits a full order of magnitude above all others. The chosen threshold is unsupported in fact or law, and creates internal contradiction within the EIS/EIR. The CEQA Guidelines state that:

A lead agency should consider the following factors, among others, when assessing the significance of impacts from greenhouse gas emissions on the environment:

. . .

Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project.

³⁹ United Nations World Environment Day Conference, June 1, 2005, San Francisco; see also, Executive Order S-3-05.

The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions.

(CEQA Guidelines § 15064.4.) Numerous Air Districts within the affected area have established GHG thresholds of significance that the EIS/EIR improperly chooses not to apply. The EIS/EIR argues that these Air District thresholds are meant to apply to stationary sources, an exercise that “would be overly onerous and is not recommended.” (EIS/EIR 3.6-18.) This must be rejected. The EIS/EIR fails to provide any reason to believe that Air District regulations would not and should not be applied to activities occurring within each respective Air District. The CEQA Guidelines require the lead agency to use “a threshold of significance that the lead agency determines applies to the project;” here, the lead agency has not determined that the local Air District thresholds do not apply to the project activities; rather, it has determined that this evaluation would be too onerous. So instead, the EIS/EIR chooses to apply the threshold of significance adopted by the Antelope Valley Air District and the Mojave Desert Air District, each of which would clearly have latitude to adopt lax air quality thresholds owing to the lack of use intensity within each district. With (hopefully) no transfer water heading to the Mojave Desert, the lead agency has no basis to determine that the Mojave Desert Air District’s thresholds of significance “applies to the project.” The EIS/EIR also notes that the same threshold has been adopted by USEPA for Clean Air Act, Title V permits. But the Title V standard also applies to stationary sources, which the EIS/EIR says are inapplicable. Does any project element require a Title V permit? In short, the EIS/EIR fails to evaluate the project against any threshold of significance that was adopted either (1) for the benefit of an individual air district in which project activities would occur, or (2) for the benefit of regional or statewide GHG emission goals. The EIS/EIR’s unsupported grab of the most lax standard it could find, with no bearing on the project whatsoever, must be rejected.

g. Fisheries.

AquAlliance shares the widely held view that operation of the Delta export pumps is the major factor causing the Pelagic Organism Decline (“POD”) and in the deteriorating populations of fall-run Chinook salmon. In 2012, the State Water Resources Control Board received word in early December that the Fall Midwater Trawl surveys for September and October showed horrendous numbers for the target species. The indices for longfin smelt, splittal, and threadfin shad reveal the lowest in history.⁴⁰ Delta smelt, striped bass, and American shad numbers remain close to their lowest levels (*Id*). The 2013 indices were even worse and the 2014 indices are also abysmal (*Id*). Tom Cannon declared in June 2014 that water transfers have been and will remain devastating to Delta smelt during dry years.⁴¹ “In my opinion, the effect of Delta operations this summer [2014] of confining smelt to the Sacramento Deepwater ship channel

⁴⁰ <http://www.dfg.ca.gov/delta/data/fmwt/Indices/index.asp>. (Exhibit CC)

⁴¹ Cannon 2014. Declaration for Preliminary Injunction in AquAlliance and CSPA v. United State Bureau of Reclamation. (Exhibit DD)

upstream of Rio Vista due to adverse environmental conditions in the LSZ that will be exacerbated by the Transfers, both with and without relaxed outflow standards, with no evidence that they can emerge from the ship channel in the fall to produce another generation of smelt, is significant new information showing that the Transfers will have significant adverse impacts on Delta smelt.” Mr. Cannon’s October report observes that “habitat conditions have been very poor and the Delta smelt population is now much closer to extinction with the lowest summer index on record.”

As Mr. Cannon’s comments highlight, attached and fully incorporated as though stated in their entirety, herein, the EIS/EIR has inaccurately characterized the existing environment, including the assumption that delta smelt are not found in the Delta in the summer transfer season, when in fact during dry and critical years when transfers would occur, most if not all delta smelt are found in the Delta; and fails to fully assess the significant and cumulative effects to listed species in multiyear droughts when listed fish are already under maximum stress, which effects could be avoided by limiting transfers in the second or later years of drought.

The *2015-2024 Water Transfer Program* would exacerbate pumping of fresh water from the Delta, which has already suffered from excessive pumping over the last 12 years. Pumped exports cause reverse flows to occur in Old and Middle Rivers and can result in entrainment of fish and other organisms in the pumps. Pumping can shrink the habitat for Delta smelt (*Hypomesus transpacificus*) as well, since less water flows out past Chipps Island through Suisun Bay, which Delta smelt often prefer.

The EIS/EIR should also evaluate whether Project effects could alter stream flows necessary to maintain compliance with California Fish and Game Code Section 5937. A recent study issued from the University of California, Davis, documents hundreds of dams failing to maintain these required flows.⁴² Both the timing and volumes of transfer water must be considered in conjunction with 5937 flows.

h. Vegetation and Wildlife.

i. The EIS/EIR reaches faulty conclusion for Project and cumulative impacts.

Section 3.8.5, *Potentially Significant Unavoidable Impacts*, declares that, “None of the alternatives would result in potentially significant unavoidable impacts on natural communities, wildlife, or special-status species.” Regarding cumulative biological impacts of the proposed Project (Alternative 2), the EIS/EIR concludes, “Long-term water transfers would not be cumulatively considerable with the other projects because each of the projects would have little or no impact flows [sic] in rivers and creeks in the Sacramento River watershed or the vegetation and wildlife resources that depend on them,” (p. 3.8-92). This is a conclusory

⁴² https://watershed.ucdavis.edu/files/biblio/BioScience-2014-Grantham-biosci_biu159.pdf. (Exhibit EE)

statement without supporting material to justify it, only modeling that has been demonstrated in our comments as extremely deficient.

The EIS/EIR actually discloses there are very likely many significant impacts from the proposed project on terrestrial and aquatic habitat and species. Examples from Chapter 3.8 include:

- “The lacustrine natural communities in the Seller Service Area that would be potentially impacted by the alternatives include the following reservoirs: Shasta, Oroville, New Bullards Bar, Camp Far West, Collins, Folsom, Hell Hole, French Meadows, and McClure,” (p. 3.8-10)
- “The potential impacts of groundwater substitution on natural communities in upland areas was considered potentially significant if it resulted in a consistent, sustained depletion of water levels that were accessible to overlying communities (groundwater depth under existing conditions was 15 feet or less). A sustained depletion would be considered to have occurred if the groundwater basin did not recharge from one year to the next,” (p. 3.8-33).
- “In addition to changing groundwater levels, groundwater substitution transfers could affect stream flows. As groundwater storage refills during and after a transfer, it could result in reduced availability of surface water in nearby streams and wetlands,” (p. 3.8-33).

It should also be noted that the 2008 U.S. Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) biological opinions did not evaluate potential impacts to in-stream flow due to water transfers involving groundwater substitution. How these potential impacts may adversely affect biological resources in the areas where groundwater pumping will occur, including listed species and their habitat, were also not included.⁴³ To reach the conclusion that the Project “would not be cumulatively considerable with the other projects” based only on modeling fails to provide the public with meaningful analysis of probable impacts.

ii. The 2015-2024 Water Transfer Program has potential adverse impacts for the giant garter snake, a threatened species.

As the Lead and Approving Agencies are well aware, the purpose of the ESA is to conserve the ecosystems on which endangered and threatened species depend and to conserve and recover those species so that they no longer require the protections of the Act. 16 U.S.C. § 1531(b), ESA § 2(b); 16 U.S.C. § 1532(3), ESA §3(3) (defining “conservation” as “the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter are no longer necessary”). “[T]he ESA was enacted not merely to forestall the extinction of species (i.e., promote species

⁴³ California Department of Fish and Game. 2013. COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT (2013 DRAFT EA) AND FINDING OF NO SIGNIFICANT IMPACT (FONSI) FOR THE 2013 CENTRAL VALLEY PROJECT (CVP) WATER, p.4. (Exhibit FF)

survival), but to allow a species to recover to the point where it may be delisted.” *Gifford Pinchot Task Force v. U.S. Fish & Wildlife Service*, 378 F.3d 1059, 1069 (9th Cir. 2004). To ensure that the statutory purpose will be carried out, the ESA imposes both substantive and procedural requirements on all federal agencies to carry out programs for the conservation of listed species and to insure that their actions are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. 16 U.S.C. § 1536. See *NRDC v. Houston*, 146 F.3d 1118, 1127 (9th Cir. 1998) (action agencies have an “affirmative duty” to ensure that their actions do not jeopardize listed species and “independent obligations” to ensure that proposed actions are not likely to adversely affect listed species). To accomplish this goal, agencies must consult with the Fish and Wildlife Service whenever their actions “may affect” a listed species. 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14(a). Section 7 consultation is required for “any action [that] may affect listed species or critical habitat.” 50 C.F.R. § 402.14. Agency “action” is defined in the ESA’s implementing regulations to “mean all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States.” 50 C.F.R. § 402.02.

The giant garter snake (“GGS”) is an endemic species to Central Valley California wetlands. (Draft Recovery Plan for the Giant Garter Snake (“DRP”) 1). The giant garter snake, as its name suggests, is the largest of all garter snake species, not to mention one of North America’s largest native snakes, reaching a length of up to 64 inches. Female GGS tend to be larger than males. GGS vary in color, especially depending on the region, from brown to olive, with white, yellow, or orange stripes. The GGS can be distinguished from the common garter snake by its lack of red markings and its larger size. GGS feed primarily on aquatic fish and specialize in ambushing small fish underwater, making aquatic habitat essential to their survival. Females give birth to live young from late July to early September, and brood size can vary from 10 to up to 46 young. Some studies have suggested that the GGS is sensitive to habitat change in that it prefers areas that are familiar and will not typically travel far distances.

If fallowing (idling) occurs, there will be potentially significant impacts to GGS and this is acknowledged on page 3.8-69: “Giant garter snakes have the potential to be affected by the Proposed Action through cropland idling/shifting and the effects of groundwater substitution on small streams and associated wetlands.” The Lead Agencies use language found in a 1997 Programmatic Biological Opinion (as well as the 1999 Draft Recovery Plan) to explain that GGS depend on more than rice fields in the Sacramento Valley. “The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of (1) adequate water during the snake’s active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat; (3)

upland habitat for basking, cover, and retreat sites; and (4) higher elevation uplands for cover and refuge from flood waters.”⁴⁴

Even with the explanation above, that clearly illustrates the importance of upland habitat to GGS, the EIS/EIR concludes that idling or shifting upland crops “[a]re not anticipated to affect giant garter snakes, as they do not provide suitable habitat for this species” (p. 3.8-69). The EIS/EIR is internally contradictory and fails to provide any evidence to support its conclusion that GGS will not be impacted by idling or shifting crops in upland areas. In support of the importance of upland acreage to GGS, a Biological Opinion for Gray Lodge found that, “Giant garter snakes also use burrows as refuge from extreme heat during their active period. The Biological Resources Division (BRD) of the USGS (Wylie et al_ 1997) has documented giant garter snakes using burrows in the summer as much as 165 feet (50. meters) away from the marsh edge. Overwintering snakes have been documented using burrows as far as 820 feet (250 meters) from the edge of marsh habitat,” (1998).⁴⁵

More pertinent background information that is lacking in the EIS/EIR is found in the Bureau’s Biological Assessment for the 2009 DWB that disclosed that one GGS study in Colusa County revealed the “longest average movement distances of 0.62 miles, with the longest being 1.7 miles, for sixteen snakes in 2006, and an average of 0.32 miles, with the longest being 0.6 miles for eight snakes in 2007.” (BA at p.16) However, in response to droughts and other changes in water availability, the GGS has been known to travel up to 5 miles in only a few days, and the EIS/EIR should evaluate impacts to GGS survival and reproduction under such extreme conditions

As the EIS/EIR divulges, flooded rice fields, irrigation canals, streams, and wetlands in the Sacramento Valley can be used by the giant garter snake for foraging, cover and dispersal purposes. The Bureau’s 2009 and 2014 Biological Assessments acknowledge the failure of the Bureau and DWR to complete the Conservation Strategy that was a requirement of the 2004 Biological Opinion (BA at p. 19-20). Research was finally initiated “since 2009,” but is nowhere near the projected 10-year completion date. The unnecessary delay hasn’t daunted the agencies pursuit of transfers that affect GGS despite the absence of the following information that the U.S. Fish and Wildlife Service has explicitly required since the 1990s:

- GGS distribution and abundance.
- Ten years of baseline surveys in the Sacramento Valley
- Five years of rice land idling surveys in the Sacramento Valley Recovery Unit and the Mid-Valley Recovery Unit.

⁴⁴ Programmatic Consultation with the U.S. Army Corps of Engineers
404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo Counties, California

⁴⁵ http://www.usbr.gov/mp/nepa/documentShow.cfm?Doc_ID=15453

This Project and all North-to-South and North-to-North transfers should be delayed until the Bureau and DWR have completed the Conservation Strategy they have known about for at least a decade and a half.

The Bureau and DWR continue to allow an increase in acres fallowed (2013 *Draft Technical Information for Preparing Water Transfer Proposals* (“DTIPWTP”)) since the 2010/2011 *Water Transfer Program* first proposed to delete or modify other mitigation measures previously adopted as a result of the Environmental Water Account (“EWA”) EIR process. The EWA substantially reduced significant impacts for GGS, but without showing that they are infeasible, the Bureau and DWR proposed to delete the 160 acre maximum for “idled block sizes” for rice fields left fallow rather than flooded and to substitute for it a 320 acre maximum. (See 2003 Draft EWA EIS/EIR, p. 10-55; 2004 Final EWA EIS/EIR, Appendix B, p. 18, Conservation Measure # 4.) There was no evidence in 2010 to support this change nor has there been any provided to the present time. In light of the agencies failure to complete the required Conservation Strategy mentioned above and the data gathered in the Colusa County study, how can the EIS/EIR suggest (although it is not presented in the document, but in the agencies *Draft Technical Information for Preparing Water Transfer Proposals* papers) that doubling the fallowing acreage is in any way biologically defensible? The Lead and Approving Agencies additionally propose to delete the EWA mitigation measure excluding Yolo County east of Highway 113 from the areas where rice fields may be left fallow rather than flooded, except in three specific areas.⁴⁶ (See 2004 Final EWA EIS/EIR, Appendix B, p. 18, Conservation Measure # 2.) What is the biological justification for this change and where is it documented? What are the impacts from this change?

Deleting these mitigation measures required by the EWA approval would violate NEPA and CEQA’s requirements that govern whether, when, and how agencies may eliminate mitigation measures previously adopted under NEPA and CEQA.

Additionally, the 2010/2011 *Water Transfer Program* failed to include sufficient safeguards to protect the giant garter snake and its habitat. The EA for that two-year project concluded, “The frequency and magnitude of rice land idling would likely increase through implementation of water transfer programs in the future. Increased rice idling transfers could result in chronic adverse effects to giant garter snake and their habitats and may result in long-term degradation to snake populations in the lower Sacramento Valley. In order to avoid potentially significant adverse impacts for the snake, additional surveys should be conducted prior to any alteration in water regime or landscape,” (p. 3-110). To address this significant impact the Bureau proposed relying on the 2009 Drought Water Bank (“DWB”) Biological Opinion, which was a one-year BO. Both the expired 2009 BO and the 2014 BO highlighted the Bureau and DWR’s avoidance of

⁴⁶ USBR and DWR, 2013. *Draft Technical Information for Preparing Water Transfer Proposals*.

meeting federal and state laws stating, “This office has consulted with Reclamation, both informally and formally, seven times since 2000 on various forbearance agreements and proposed water transfers for which water is made available [“for delivery south of the delta” is omitted in 2014] by fallowing rice (and other crops) or substituting other crops for rice in the Sacramento Valley. Although transfers of this nature were anticipated in our biological opinion on the environmental Water Account, that program expired in 2007 and, to our knowledge, no water was ever made available to EWA from rice fallowing or rice substitution. The need to consult with such frequency on transfers involving water made available from rice fallowing or rice substitution suggests to us a need for programmatic environmental compliance documents, including a programmatic biological opinion that addresses the additive effects on giant garter snakes of repeated fallowing over time, and the long-term effects of potentially large fluctuations and reductions in the amount and distribution of rice habitat upon which giant garter snakes in the Sacramento Valley depend,” (p.1-2). And here we are in late 2014 still without that programmatic environmental compliance that is needed under the Endangered Species Act.

If the Project is or isn’t approved, we propose that the Lead and Approving Agencies commit to the following conservation recommendations from the 2014 Biological Opinion by changing the word “should” to “shall”:

1. Reclamation should [shall] assist the Service in implementing recovery actions identified in the Draft Recovery Plan for the Giant Garter Snake (U.S. Fish and Wildlife Service 1999) as well as the final plan if issued during the term of the proposed action.
2. Reclamation should [shall] work with the Service, Department of Water Resources, and water contractors to investigate the long-term response of giant garter snake individuals and local populations to annual fluctuations in habitat from fallowing rice fields.
3. Reclamation should [shall] support the research goals of the Giant Garter Snake Monitoring and Research Strategy for the Sacramento Valley proposed in the Project Description of this biological opinion.
4. Reclamation should [shall] work with the Service to create and restore additional stable perennial wetland habitat for giant garter snakes in the Sacramento Valley so that they are less vulnerable to market-driven fluctuations in rice production. The CVPIA (b)(1)other and CVPCP conservation grant programs would be appropriate for such work.

- iii. The EIS/EIR fails to accurately describe the uppermost acreage that could impact GGS.

Page 3.8-69 claims that the Proposed Action “[c]ould idle up to a maximum of approximately 51,573 acres of rice fields,” but the Lead and Approving Agencies are well aware that past

transfers have or could have fallowed much more acreage and that 20 percent is allowed per county under the *Draft Technical Information for Preparing Water Transfer Proposals* last written in 2013. Factual numbers for proposed water transfers that included fallowing and groundwater substitution in the last 25 years should be disclosed in a revised and re-circulated draft EIS/EIR. The companion data that should also be presented would disclose how much water was actually transferred each year by seller and delineated by acreage of land fallowed and/or groundwater pumped. This information should not only be disclosed in the EIS/EIR, but it should also be readily available on the Bureau's web site. In addition, the EIS/EIR should cease equivocating with usage of "could" and "approximately" and select and analyze a firm maximum acreage of idled land, which would provide the public with the ability to consider the impacts from a most significant impact scenario.

"In 1992, Congress passed the Central Valley Project Improvement Act (Act, or CVPIA), which amended previous authorizations of the California Central Valley Project (CVP) to include fish and wildlife protection, restoration, enhancement, and mitigation as project purposes having equal priority with power generation, and irrigation and domestic water uses." ⁴⁷ The *2015-2024 Water Transfer Program* fails to take seriously the equal priority for, "[f]ish and wildlife protection, restoration, enhancement, and mitigation."

i. Economics.

Our comments are based largely upon the *EcoNorthwest* report produced for AquAlliance, attached and fully incorporated as though stated in their entirety, herein. Once again, the lack of relevant baseline information and discrete project description thwarts any ability to effectively analyze the project, and the lack of any market analysis of water prices, and prices for agricultural commodities, relegates the EIS/EIR to unsupported conclusions about the likely future frequency and amounts of water transfers and their environmental and economic consequences. The EIS/EIR further relies on obsolete data for certain key variables and ignores other relevant data and information. For example, the analysis assumes a price for water that bears no resemblance to the current reality. Growers and water sellers and buyers react to changing prices and market conditions, but the EIS/EIR is silent on these forces and how they would influence water transfers.

The EIS/EIR underestimates negative impacts on the regional economy in the sellers' area, acknowledging that negative economic impacts would be worse if water transfers happen over consecutive years, but estimating impacts only for single-year transfers, ignoring the data on the frequency of recent consecutive-year transfers.

As discussed, below, the EIS/EIR's inadequate evaluation and avoidance of subsidence will result in additional unaccounted-for economic costs. Injured third parties would bear the costs

⁴⁷ U.S. Department of Interior. *10 Year of Progress: Central Valley Project Improvement Act 1993-2002*. <http://www.waterrights.ca.gov/baydelta/docs/exhibits/SLDM-EXH-03B.pdf> (Exhibit GG)

of bringing to the sellers' attention harm caused by groundwater pumping, and the ability of parties to resolve disputes with compensation is speculative. The EIS/EIR is silent on these and other ripple cost effects of subsidence.

The EIS/EIR ignores the environmental externalities and economic subsidies that water transfers support. The EIS/EIR lists Westlands Water District as one of the CVP contractors expressing interest in purchasing transfer water. The environmental externalities caused by agricultural production in Westlands WD are well documented, as are the economic subsidies that support this production. To the extent that the water transfers at issue in the EIS/EIR facilitate agricultural production in Westlands WD, they also contribute to the environmental externalities and economic subsidies of that production, but the EIS/EIR is silent on these environmental and economic consequences of the water transfers.

j. Cultural Resources.⁴⁸

The EIS/EIR fails to adequately provide evidence that water transfers, which draw down reservoir surface elevations at Central Valley Project (CVP) and State Water Project (SWP) reservoirs beyond historically low levels, could not potentially adversely affect cultural resources. The EIS/EIR states that the potential of adverse impacts to cultural resources does exist:

3.13.2.4 Alternative 2: Full Range of Transfers (Proposed Action)

Transfers that draw down reservoir surface elevations at CVP and SWP reservoirs beyond historically low levels could affect cultural resources. The Proposed Action would affect reservoir elevation in CVP and SWP reservoirs and reservoirs participating in stored reservoir water transfers. Water transfers have the potential to affect cultural resources, if transfers result in changing operations beyond the No Action/No Project Alternative. Reservoir surface water elevation changes could expose previously inundated cultural resources to vandalism and/or increased wave action and erosion (p. 3.13-15).

This passage states that the Long Range Water Transfers undertaking may have the potential to affect cultural resources if the water transfers lowered reservoir elevations enough to expose cultural resources. The first step for analysing this would require conducting research for past studies and reports with site specific data for the CVP and SWP reservoirs. The EIS/EIR states:

3.13.1.3 Existing Conditions

This section describes existing conditions for cultural resources within the area of analysis. *All data regarding existing conditions were collected through an examination of archival and current literature pertinent to the area of analysis.* Because action

⁴⁸ Comments in this section are based on the work of Bill Helmer, prepared for AquAlliance on the 2014 Long-Term Water Transfers EIS/EIR

alternatives associated with the project do not involve physical construction-related impacts to cultural resources, no project specific cultural resource studies were conducted in preparation of this Environmental Impact Statement/Environmental Impact Report (EIS/EIR) (EIS/EIR, p. 3.13-13, emphasis added).

However, there are no references listed for all the data collected which were "pertinent to the area of analysis." Also, the EIS/EIR states on p. 3.13-15 cited above that the lowering of the reservoir water elevations due to water transfers may affect cultural resources. Obviously, such an impact does not need to "[i]nvolve physical construction-related impacts to cultural resources," so this rationale for not conducting specific cultural resource studies contradicts its own assertion.

Instead of conducting a cultural resources study which locates historic resources and traditional cultural properties (with the use of a contemporary Native American ethnological study), and then assesses the amount of project-related water elevation changes which may affect these resources, the EIS/EIR merely stated that their Transfer Operations Model was used to show that the project's "Impacts to cultural resources at Shasta, Oroville and Folsom reservoirs would be less than significant," (3.13-15, 3.13-16). A chart on page 13.3-15 shows that the proposed project is projected to decrease reservoir elevations at the "critical" level in September by 0.5 ft. at Shasta Reservoir, 2.4 ft. at Lake Oroville, and 1.5 ft. at Folsom Reservoir. (There is no source for this chart, and the reader has to guess that it may be from the Transfer Operations Model. The definitions of the various categories in the chart are also unexplained).

Based upon the findings shown on the chart, it is stated:

The reservoir surface elevation changes under the Proposed Action for these reservoirs would be within the normal operations and would not be expected to expose previously inundated cultural resources to vandalism or increased wave action and wind erosion. Impacts to cultural resources at Shasta, Oroville and Folsom reservoirs would be less than significant (p. 3.13-15).

However, there is no evidence to show that a project-related reservoir drop of 2.4 ft. at Lake Oroville will not uncover cultural resources documented in *The Archaeological and Historical Site Inventory at Lake Oroville, Butte County*,⁴⁹ and expose them "to vandalism or increased wave action and wind erosion," thus adversely affecting these resources. This study states that there are 223 archaeological and/or historic sites recorded in the water level fluctuation zone of Lake Oroville (p. 12). Where is the Cultural Study which shows that lowering Lake Oroville 2.4 ft. due to water transfers *will not* expose specific archaeological sites or traditional cultural properties?

⁴⁹ Prepared for the California Department of Water Resources by the Archaeological Research Center, Sacramento, and the Anthropological Studies Center, Rohnert Park, 2004. (Exhibit HH)

Without an inventory of the cultural resources which may be uncovered by the project-related drop in reservoir elevation for all the affected reservoirs, the numbers in the chart on page 13.3-15 mean nothing. The numbers in the chart provide no evidence that the project may or may not have an adverse effect on cultural resources. In contrast, substantial documentation of cultural resources in these areas exists.⁵⁰ The threat of potential project-related impacts to cultural resources triggers a Section 106 analysis of the project under the requirements of the National Historic Preservation Act, which "[r]equires Federal agencies to take into account the effects of their undertakings on historic properties" [36 CFR 800.1(a)].

Although the issue here is the raising of the Shasta Reservoir water levels, cultural impacts related to water levels at the Shasta Reservoir has been an ongoing issue for the Winnemem Wintu Tribe. The Winnemem Wintu Tribe and all tribes within the project area (Area of Potential Effects) need to be consulted by federal and state agencies. A project-specific cultural study under CEQA is also required under 15064.5. *Determining the Significance of Impacts to Archaeological and Historical Resources*. Consultation with federally recognized tribes and California Native American tribes is required for this project.

k. Air Quality.

The EIS/EIR fails to analyze the air quality impacts in all these regions, especially with regard to the Buyers Service Area. Moreover, Appendix F – Air Quality Emissions Calculations exclude portions of the Sellers Service Area in Placer and Merced Counties. Conversely, there was not data supplied in Appendix F concerning the air quality impacts from the water transfers that would affect the Bay Area AQMD counties (Alameda, Contra Costa, Santa Clara), a Monterey Bay Unified APCD county (San Benito) and San Joaquin APCD counties (San Joaquin, Stanislaus, Merced, Fresno and Kings). Consequently, air quality impacts in the Buyers and Sellers Service Areas are unanalyzed and the EIS/EIR conclusions are not supported by evidence.

The EIS/EIR attempts to classify which engines would be subject to the ATCM based on whether an agricultural engine is in an air district designated in attainment for particulate matter and ozone, and is more than a half mile away from any residential area, school or hospital (aka

⁵⁰ Folsom Reservoir: <http://online.wsj.com/articles/SB10001424052702304419104579322631095468744>
Lake Oroville-
<http://www.latimes.com/local/la-me-lake-oroville-artifacts-20140707-story.html#page=1> (Exhibit II)
Shasta Reservoir
<http://www.winnememwintu.us/2014/09/09/press-release-dam-the-indians-anyway-winnememwar-dance-at-shasta-dam/> (Exhibit JJ)

sensitive receptors). (See p. 3.5-14). The EIS/EIR claims that the engines in Colusa, Glenn, Shasta and Tehama (part of Sellers Service Area) are exempt from the ATCM. However, 17 CCCR 93115.3 exempts in-use stationary diesel agricultural emissions not only based on the engines being remote, but all also “provided owners or operators of such engines comply with the registration requirements of section 93115.8, subdivisions (c) and (d), and the applicable recordkeeping and reporting requirement of section 93115.10,” which the EIS/EIR ignores. Furthermore, the EIS/EIR fails to present any data about the “tier” the subject agricultural diesel engines fall into. While the EIS/EIR identifies the tiers and concomitant requirements for replacement or repowering, it fails to provide any analysis or evidence evaluating whether the engines being used to pump water are operating within the permissible timeframes, depending on the tier designation.

The EIS/EIR analyzes the assessment methods based on existing emissions models from the regulation, diesel emissions factors from USEPA Compilation of Air Pollutant Emission Factors (for Natural gas fired reciprocating engines and gasoline/diesel industrial engines) and CARB Emission Inventory Documentation (for land preparation, harvest operations and windblown dust); and CARB size fractions for particulate matter. None of these references is directly on point to diesel powered water pumps and the emissions caused thereby. Moreover, the EIS/EIR provides absolutely no information as to why these models are appropriate to serve as the basis for thresholds of significance.

The analysis provided in the EIS/EIR is less than complete. Here the “Significance Criteria” were only established and considered for the “sellers in the area of analysis where potential air quality impacts from groundwater substitution and crop idling transfers could occur.” (See p. 3.5-25) But that is only half the equation. The unconsidered air quality impacts include what and how increased crop production and vehicle usage would affect the air quality in the Buyers Service Area. Data and evidence of those impacts were not even considered.

In establishing the significance criteria, the EIS/EIR utilized known thresholds of significance from the air districts in the Sellers Service Area that had published them. For the other districts in the Sellers Service Area, the EIS/EIR made the assumption that “[t]he threshold used to define a ‘major source’ in the [Clean Air Act] CAA (100 tons per year [tpy])” could be “used to evaluate significance.” (See p. 3.5-26). There are several flaws with this over broad application of the “major source” threshold. First, agricultural pumps and associated agricultural activity are not typically considered “major sources,” especially when compared to major industrial sources. Second, the application of the major source threshold runs counter to the legal requirement that “[u]pwind APCDs are required to establish and implement emission control programs commensurate with the extent of pollutant transport to downwind districts,” as announced as a requirement of the California Clean Air Act. (See p. 3.5-11). Finally, the 100 tpy threshold is wildly disproportionate to the limits set in nearby or adjoining air district and covering the same air basin. For example, the Butte AQMD considers significance thresholds for

NOx, ROG/VOCs and PM10 to be 137lbs/day (25 tpy); Feather River AQMD considers significance thresholds for NOx and VOCs to be 25lbs/day (4.5 tpy) and 80 lbs/day (14.6 tpy) for PM10; Tehama APCD considers significance thresholds for NOx, ROG/VOCs and PM10 to be 137 lbs/day (25 tpy); Shasta AQMD considers significance thresholds for NOx, ROG/VOCs and PM10 on two levels – Level “B” is 137 lbs/day (25 tpy) and Level “A” is 25lbs/day (4.5 tpy) and 80 lbs/day (14.6 tpy) for PM10; and Yolo AQMD considers significance thresholds for ROG/VOCs and NOx to be 54.8 lbs/day (10 tpy) and 80 lbs/day (14.6 tpy) for PM10. Clearly, there is a proportional relationship between these thresholds of significance. In contrast, the EIS/EIR, with substantial evidence to the contrary, assumes that the threshold of significance for those air districts who have not published a *CEQA Handbook* should be 100 tpy, or an increase by magnitudes of 4 to 20 times more than similarly situated Central Valley air districts.

“When considering a project’s impact on air quality, a lead agency should provide substantial evidence that supports its conclusion in an explicit, quantitative analysis whenever possible.” (See Guide to Air Quality Assessment in Sacramento County, Sacramento Metropolitan Air Quality Management District, 2009, Ch. 2, p. 2-6). Importantly, the EIS/EIR provides no basis, other than an assumption, as to why the major source threshold of significance from the CAA should be used or is appropriate for assessing the significance of the project impacts under CEQA or NEPA. The use of the CAA’s threshold of significance for major sources is erroneous as a matter of law. (See *Endangered Habitats League v. County of Orange* (2005) 131 Cal.App.4th 777, 793 (“The use of an erroneous legal standard [for the threshold of significance in an EIR] is a failure to proceed in the manner required by law that requires reversal.”)) Lead agencies must conduct their own fact-based analysis of the project impacts, regardless of whether the project complies with other regulatory standards. Here, the EIR/EIS uses the CAA threshold without any factual analysis on its own, in violation of CEQA. (*Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1109; citing *CBE v. California Resources Agency* (2002) 103 Cal.App.4th 98, 114; accord *Mejia v. City of Los Angeles* (2005) 130 Cal.App.4th 322, 342 [“A threshold of significance is not conclusive . . . and does not relieve a public agency of the duty to consider the evidence under the fair argument standard.”].) This uncritical application of the CAA’s major source threshold of significance, especially in light of the similarly situated air district lower standards, represents a failure in the exercise of independent judgment in preparing the EIS/EIR.

VI. The EIS/EIR Fails to Adequately Analyze Numerous Cumulative Impacts.

The Ninth Circuit Court makes clear that NEPA mandates “a useful analysis of the cumulative impacts of past, present and future projects.” *Muckleshoot Indian Tribe v. U.S. Forest Service*, 177 F.3d 800, 810 (9th Cir. 1999). “Detail is required in describing the cumulative effects of a proposed action with other proposed actions.” *Id.* CEQA further states that assessment of the

project's incremental effects must be "viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects." (CEQA Guidelines § 15065(a)(3).) "[A] cumulative impact consists of an impact which is created as a result of the combination of the project evaluated in the EIR together with other projects causing related impacts." (CEQA Guidelines § 15065(a)(3).)

An EIR must discuss significant cumulative impacts. CEQA Guidelines §15130(a). Cumulative impacts are defined as two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts. CEQA Guidelines § 15355(a). "[I]ndividual effects may be changes resulting from a single project or a number of separate projects. CEQA Guidelines § 15355(a). A legally adequate cumulative impacts analysis views a particular project over time and in conjunction with other related past, present, and reasonably foreseeable future projects whose impacts might compound or interrelate with those of the project at hand. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time. CEQA Guidelines § 15355(b). The cumulative impacts concept recognizes that "[t]he full environmental impact of a proposed . . . action cannot be gauged in a vacuum." *Whitman v. Board of Supervisors* (1979) 88 Cal. App. 3d 397, 408 (internal quotation omitted).

In assessing the significance of a project's impact, the Bureau must consider "[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." 40 C.F.R. §1508.25(a)(2). A "cumulative impact" includes "the impact on the environment which results from the incremental impact of the action when added to *other past, present and reasonably foreseeable future actions* regardless of what agency (Federal or non-Federal) or person undertakes such other actions." *Id.* §1508.7. The regulations warn that "[s]ignificance cannot be avoided by terming an action temporary or by breaking it down into small component parts." *Id.* §1508.27(b)(7).

An environmental impact statement should also consider "[c]onnected actions." *Id.* §1508.25(a)(1). Actions are connected where they "[a]re interdependent parts of a larger action and depend on the larger action for their justification." *Id.* §1508.25(a)(1)(iii). Further, an environmental impact statement should consider "[s]imilar actions, which when viewed together with other *reasonably foreseeable or proposed agency actions*, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography." *Id.* §1508.25(a)(3) (emphasis added).

As discussed, below, and in the expert reports submitted by *Custis, EcoNorthwest, Cannon, and Mish* on behalf of AquAlliance, the EIS/EIR fails to comport with these standards for cumulative impacts upon surface and groundwater supplies, vegetation, and biological resources; and, the

baseline and modeling data relied upon by the EIS/EIR that does not account for related transfer projects in the last 11 years.

a. Recent Past Transfers.

Because the groundwater modeling effort didn't include the most recent 11 years record (1970-2003), it appears to have missed simulating the most recent periods of groundwater substitution transfer pumping and other groundwater impacting events, such as recent changes in groundwater elevations and groundwater storage (DWR, 2014b), and the reduced recharge due to the recent periods of drought. Without taking the hydrologic conditions during the recent 11 years into account, the results of the SACFEM2013 model simulation may not accurately depict the current conditions or predict the effects from the proposed groundwater substitution transfer pumping during the next 10 years.

- f. In 2009, the Bureau approved a 1 year water transfer program under which a number of transfers were made. Regarding NEPA, the Bureau issued a FONSI based on an EA.
- g. In 2010, the Bureau approved a 2 year water transfer program (for 2010 and 2011). No actual transfers were made under this approval. Regarding NEPA, the Bureau again issued a FONSI based on an EA.
- h. The Bureau planned 2012 water transfers of 76,000 AF of CVP water all through groundwater substitution.⁵¹
- i. In 2013, the Bureau approved a 1 year water transfer program, again issuing a FONSI based on an EA. The EA incorporated by reference the environmental analysis in the 2010-2011 EA.
- j. The Bureau and SLDMWA's 2014 Water Transfer Program proposed transferring up to 91,313 AF under current hydrologic conditions and up to 195,126 under improved conditions. This was straight forward, however, when attempting to determine how much water may come from fallowing or groundwater substitution during two different time periods, April-June and July-September, the reader was left to guess.⁵²

⁵¹ USBR 2012. Memo to the Deputy Assistant Supervisor, Endangered Species Division, Fish and Wildlife Office, Sacramento, California regarding Section 7 Consultation.

⁵² The 2014 Water Transfer Program's EA/MND was deficient in presenting accurate transfer numbers and types of transfers. The numbers in the "totals" row of Table 2-2 presumably should add up to 91,313. Instead, they add up to 110, 789. The numbers in the "totals" row of Table 2-3 presumably should add up to 195,126. Instead, they add up to 249,997. Both Tables 2-2 and 2-3 have a footnote stating: "These totals cannot be added together. Agencies could make water available through groundwater substitution, cropland idling, or a combination of the two; however, they will not make the full quantity available through both methods. Table 2-1 reflects the total upper limit for each agency."

These closely related projects impact the same resources, are not accounted for in the environmental baseline, and must be considered as cumulative impacts.

b. Yuba Accord

The relationship between the Lead Agencies is not found in the EIS/EIR, but is illuminated in a 2013 Environmental Assessment. “The Lower Yuba River Accord (Yuba Accord) provides supplemental dry year water supplies to state and Federal water contractors under a Water Purchase Agreement between the Yuba County Water Agency and the California Department of Water Resources (DWR). Subsequent to the execution of the Yuba Accord Water Purchase Agreement, DWR and The San Luis & Delta- Mendota Water Authority (Authority) entered into an agreement for the supply and conveyance of Yuba Accord water, to benefit nine of the Authority’s member districts (Member Districts) that are SOD [south of Delta] CVP water service contractors.”⁵³

In a Fact Sheet produced by the Bureau, it provides some numerical context and more of DWR’s involvement by stating, “Under the Lower Yuba River Accord, up to 70,000 acre-feet can be purchased by SLDMWA members annually from DWR. This water must be conveyed through the federal and/or state pumping plants in coordination with Reclamation and DWR. Because of conveyance losses, the amount of Yuba Accord water delivered to SLDMWA members is reduced by approximately 25 percent to approximately 52,500 acre-feet. Although Reclamation is not a signatory to the Yuba Accord, water conveyed to CVP contractors is treated as if it were Project water.”⁵⁴ However, the Yuba County Water Agency (“YCWA”) may transfer up to 200,000 under Corrected Order WR 2008-0014 for Long-Term Transfer and, “In any year, up to 120,000 af of the potential 200,000 af transfer total may consist of groundwater substitution. (YCWA-1, Appendix B, p. B-97.)”⁵⁵

Potential cumulative impacts from the Project and the YCWA Long-Term Transfer Program from 2008 - 2025 are not disclosed or analyzed in the EIS/EIR. The *2015-2024 Water Transfer Program* could transfer up to 600,000 AF per year through the same period that the YCWA Long-Term Transfers are potentially sending 200,000 AF into and south of the Delta. How these two projects operate simultaneously could have a very significant impact on the environment and economy of the Feather River and Yuba River’s watersheds and counties as well as the Delta. The involvement of Browns Valley Irrigation District and Cordua Irrigation District in both long-term programs must also be considered. This must be analyzed and presented to the public in a revised draft EIS/EIR.

⁵³ Bureau of Reclamation, 2013. *Storage, Conveyance, or Exchange of Yuba Accord Water in Federal Facilities for South of Delta Central Valley Project Contractors*.

⁵⁴ Bureau of Reclamation, 2013. *Central Valley Project (CVP) Water Transfer Program Fact Sheet*.

⁵⁵ State Water Resources Control Board, 2008. ORDER WR 2008 - 0025

Also not available in the EIS/EIR is disclosure of any issues associated with the YCWA transfers that have usually been touted as a model of success. The YCWA transfers have encountered troubling trends for over a decade that, according to the draft Environmental Water Account (“EWA”) EIS/EIR, are mitigated by deepening domestic wells (2003 p. 6-81). While digging deeper wells is at least a response to an impact, it hardly serves as a proactive measure to avoid impacts. Additional information finds that it may take 3-4 years to recover from groundwater substitution in the south sub-basin⁵⁶ although YCWA’s own analysis fails to determine how much river water is sacrificed to achieve the multi-year recharge rate. None of this is found in the EIS/EIR. What is found in the EIS/EIR is that even the inadequate SACFEM2013 modeling reveals that it could take more than six years in the Cordua ID area to recover from multi-year transfer events, although recovery is not defined (pp, 3.3-69 to 3.3-70). This is a very significant impact that isn’t addressed individually or cumulatively.

c. BDCP

The EIS/EIR fails to include the Bay Delta Conservation Plan (“BDCP”) in the Cumulative Impacts section and in any analysis of the *2015-2024 Water Transfer Program*. Although we acknowledge that BDCP could not possibly be built during the 10-Year Water Transfer Program’s operation, the EIS/EIR misses the point that the *2015-2024 Water Transfer Program* is a prelude to what comes later with BDCP. This connection is entirely absent. If the Twin Tunnels (the facilities identified in “Conservation Measure 1”) are built as planned with the capacity to take 15,000 cubic feet per second (“cfs”) from the Sacramento River, they will have the capacity to drain almost two-thirds of the Sacramento River’s average annual flow of 23,490 cfs at Freeport⁵⁷ (north of the planned Twin Tunnels). As proposed, the Twin Tunnels will also increase water transfers when the infrastructure for the Project has capacity. This will occur during dry years when State Water Project (“SWP”) contractor allocations drop to 50 percent of Table A amounts or below or when Central Valley Project (“CVP”) agricultural allocations are 40 percent or below, or when both projects’ allocations are at or below these levels (EIS/EIR Chapter 5). With BDCP, North to South water transfers would be in demand and feasible.

Communication regarding assurances for BDCP indicates that the purchase of approximately 1.3 million acre-feet of water is being planned as a mechanism to move water into the Delta to make up for flows that would be removed from the Sacramento River by the BDCP tunnels.⁵⁸ There is only one place that this water can come from: the Sacramento Valley’s watersheds. It is well known that the San Joaquin River is so depleted that it will not have any capacity to contribute meaningfully to Delta flows. Additionally, the San Joaquin River doesn’t flow past the proposed north Delta diversions and neither does the Mokelumne River.

⁵⁶ 2012. *The Yuba Accord, GW Substitutions and the Yuba Basin*. Presentation to the Accord Technical Committee. (pp. 21, 22).

⁵⁷ USGS 2009. <http://wdr.water.usgs.gov/wy2009/pdfs/11447650.2009.pdf> Exhibit KK)

⁵⁸ Belin, Lety, 2013. E-mail regarding Summary of Assurances. February 25 (Department of Interior). (Exhibit LL)

As discussed above, the EIS/EIR also fails to reveal that the *2015-2024 Water Transfer Program* is part of many more programs, plans and projects to develop water transfers in the Sacramento Valley, to develop a “conjunctive” system for the region, and to place water districts in a position to integrate the groundwater into the state water supply. BDCP is one of those plans that the federal agencies, together with DWR, SLDMWA, water districts, and others have been pursuing and developing for many years.

d. Biggs-West Gridley

The *Biggs-West Gridley Water District Gray Lodge Wildlife Area Water Supply* Project, a Bureau project, is not mentioned anywhere in the Vegetation and Wildlife or Cumulative Impacts sections.⁵⁹ This water supply project is located in southern Butte County where Western Canal WD, Richvale ID, Biggs-West Gridley WD, and Butte Water District actively sell water on a regular basis, yet impacts to GGS from this project are not disclosed. This is a serious omission that must be remedied in a recirculated draft EIS/EIR.

e. Other Projects

Court settlement discussions between the Bureau and Westlands Water District over provisions of drainage service. Case # CV-F-88-634-LJO/DLB will further strain the already over allocated Central Valley Project with the following conditions:

- k. A permanent CVP contract for 890,000 acre-feet of water a year exempt from acreage limitations.
- l. Minimal land retirement consisting of 100,000 acres; the amount of land Westlands claims it has already retired (115,000 acres) will be credited to this final figure. Worse, the Obama administration has stated it will be satisfied with 100,000 acres of “permanent” land retirement.
- m. Forgiveness of nearly \$400 million owed by Westlands to the federal government for capital repayment of Central Valley Project debt.
- n. Five-Year Warren Act Contracts for Conveyance of Groundwater in the Tehama-Colusa and Corning Canals – Contract Years 2013 through 2017 (March 1, 2013, through February 28, 2018).

Additional projects with cumulative impacts upon groundwater and surface water resources affected by the proposed project:

- a. The DWR Dry Year Purchase Agreement for Yuba County Water Agency water transfers from 2015-2025 to SLDMWA.⁶⁰

⁵⁹ http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=15381

⁶⁰ SLDMWA Resolution # 2014 386

http://www.sldmwa.org/OHTDocs/pdf_documents/Meetings/Board/Prepacket/2014_1106_Board_PrePacket.pdf

- b. GCID's *Stony Creek Fan Aquifer Performance Testing Plan* to install seven production wells in 2009 to extract 26,530 AF of groundwater as an experiment that was subject to litigation due to GCID's use of CEQAs exemption for research.
- c. Installation of numerous production wells by the Sellers in this Project many with the use of public funds such as Butte Water District,⁶¹ GCID, Anderson Cottonwood Irrigation District,⁶² and Yuba County Water Authority⁶³ among others.

VII. The EIS/EIR Fails to Develop Legally Adequate Mitigation Measures.

CEQA requires that the lead agency consider and adopt feasible mitigation measures that could reduce a project's adverse impacts to less than significant levels. Pub. Resources Code §§ 21002, 21002.1(a), 21100(b)(3), 21151, 22081(a). An adequate environmental analysis in the EIS/EIR itself is a prerequisite to evaluating proper mitigation measures: this analysis cannot be deferred to the mitigation measure itself. *See, e.g., Vineyard Area Citizens for Responsible Growth v. City of Rancho Cordova* (2007) 40 Cal.4th 412. Moreover, mitigation measures must A mitigation measure is inadequate if it allows significant impacts to occur before the mitigation measure takes effect. *POET, LLC v. State Air Resources Board* (2013) 218 Cal.App.4th 681, 740. An agency may not propose a list of measures that are "nonexclusive, undefined, untested and of unknown efficacy." *Communities for a Better Environment v. City of Richmond* (2010) 184 Cal.App.4th 70, 95. Formulation of mitigation measure should generally not be deferred. CEQA Guidelines § 15126.4(a)(1)(B). If deferred, however, mitigation measure must offer precise measures, criteria, and performance standards for mitigation measures that have been evaluated as feasible in the EIR, and which can be compared to established thresholds of significance. *E.g., POET, LLC v. State Air Resources Board* (2013) 218 Cal.App.4th 681; *Preserve Wild Santee v. City of Santee* (2012) 210 Cal.App.4th 260; *Sacramento Old City Association v. City Council* (1991) 229 Cal.App.3d 1011; CEQA Guidelines § 15126.4(a)(1)(B); *Defend the Bay v. City of Irvine* (2004) 119 Cal.App.4th 1261, 1275. Economic compensation alone does not mitigate a significant environmental impact. *See* CEQA Guidelines § 15370; *Gray v. County of Madera* (2008) 167 Cal.App.4th 1099, 1122. Where the effectiveness of a mitigation measure is uncertain, the lead agency must conclude the impact will be significant. *Citizens for Open Govt. v. City of Lodi* (2012) 70 Cal.App.4th 296, 322; *Fairview Neighbors v. County of Ventura* (1999) 70

⁶¹ Prop 13. Ground water storage program: 2003-2004 Develop two production wells and a monitoring program to track changes in ground.

⁶² "The ACID Groundwater Production Element Project includes the installation of two groundwater wells to supplement existing district surface water and groundwater supplies."
http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=8081

⁶³ Prop 13. Ground water storage program 2000-2001: Install eight wells in the Yuba-South Basin to improve water supply reliability for in-basin needs and provide greater flexibility in the operation of the surface water management facilities. \$1,500,00;

Cal.App.4th 238, 242. An EIR must not only mitigate direct effects, but also must mitigate cumulative impacts. CEQA Guidelines § 15130(b)(3).

Under NEPA, “all relevant, reasonable mitigation measures that could improve the project are to be identified,” including those outside the agency’s jurisdiction,⁶⁴ and including those for adverse impacts determined to be less-than-significant (40 C.F.R. § 1502.16(h)).

As discussed, below, and in the expert reports submitted by *Custis*, *EcoNorthwest*, *Cannon*, and *Mish* on behalf of AquAlliance, the EIS/EIR fails to comport with these standards.

The EIS/EIR illegally defers the development of and commitment to feasible mitigation measures to reduce or avoid a whole host of potentially significant project impacts. The EIS/EIR relies on mitigation measures WS-1 and GW-1 to reduce or avoid significant project effects through the entire environmental review document, not just for surface and ground water supplies, but also for impacts to vegetation, subsidence, regional economics, . (3.7-26, 3.7-56, 3.10-37, 3.10-51.) Unfortunately, these mitigation measures fail all standards for CEQA compliance, deferring analysis of the impact in question to a future time, including no criteria or performance standards by which to evaluate success, and failing to demonstrate that the measures are feasible or sufficient.

But the precise relationship of these mitigation measures is unclear. For example, the EIS/EIR relies on GW-1 to mitigate impacts to vegetation and wildlife as a result of stream flow loss; why doesn’t the EIS/EIR consider the streamflow mitigation measure for this impact?

a. Streamflow Depletion.

WS-1 requires that a portion of transfer water be held back to offset streamflow depletion caused by groundwater substitution pumping, but fails to include critical information to ensure that any such mitigation measure could work. First, it is not clear that any transfer release and the groundwater substitution pumping would simultaneously occur, in real time. If groundwater pumping causes streamflow depletion at any time other than exactly when the transfer is made, then the transfer deduction amount will not avoid streamflow drawdown. And, indeed, it is well known that streamflow depletion can continue, directly and cumulatively, after the transfer activity ends. (E.g., figures B-4, B-5 and B-6 in Draft EIS/EIR Appendix B).

Next, the EIS/EIR fails to include any meaningful information to determine whether the applicable “streamflow depletion factor” to be applied to any single transfer project will mitigate significant impacts.

The EIS/EIR provides that “The exact percentage of the streamflow depletion factor will be assessed and determined on a regular basis by Reclamation and DWR, in consultation with buyers and sellers, based on the best technical information available at that time.” (EIS/EIR at

⁶⁴ <http://ceq.hss.doe.gov/nepa/regs/40/40p3.htm>

3.1-21.) More information is required. It is unclear whether WS-1 considers the cumulative volume of water pumped for each groundwater substitution transfers, or the instantaneous rate of stream depletion caused by the pumping. Any factor must be the outcome of numerous measured variables, such as the availability of water to capture, the rate and duration of recharge, the streambed sediment permeability, the duration of pumping, the distance between the well and stream, and others; but the EIS/EIR fails to provide any means of evaluating these various factors. How good must the “best technical information available at that time” be? What is the likelihood it will be available, what constraints does this face, and what requirements are in place to ensure that sufficient information is obtained? Why hasn’t this information been analyzed in the EIS/EIR? What roles do the buyers and sellers have in reaching this determination?

Moreover, the EIS/EIR fails to identify the threshold of significance below which significant impacts would not occur. WS-1 purports to avoid “legal injury,” but fails to define any threshold or criteria that will be applied in the performance of WS-1 to clearly determine when legal injury would ever occur.

b. Groundwater Overdraft.

The EIS/EIR illegally defers formulation and evaluation of mitigation measure GW-1 in much the same way as WS-1. In reliance on GW-1, the EIS/EIR goes so far as to defer the environmental impact analysis that should be provided now, as part of the EIS/EIR itself. Moreover, GW-1 fails to include clear performance standards, criteria, thresholds of significance, evaluation of feasibility, analysis of likelihood of success, and even facially permits significant impacts to occur. And importantly, GW-1 does not, in fact, reduce potentially significant impacts to less-than-significant levels, but rather, attempts to monitor for when significant effects occur, then purports to provide measures to slow the impact from worsening.

GW-1 begins by referencing the *DRAFT Technical Information for Preparing Water Transfer Proposals* (“DTIPWTP”)(Reclamation and DWR 2013) and Addendum (Reclamation and DWR 2014). First, it is worth noting that this document is in DRAFT form, as have all such previous iterations of the Technical Information for Preparing Water Transfer Proposals, leaving any guidance for a final mitigation measure uncertain. Second, the DTIPWTP itself requires a project-specific evaluation of then-existing groundwater and surface water conditions to determine potentially significant impacts to water supplies; but this is exactly the type of impact analysis that must occur now in the self-described project EIS/EIR before any consideration of mitigation measures is possible. Even still, the exact scope of future environmental review is unclear as well. “Potential sellers will be required to submit well data,” but the EIS/EIR does not explain what data or why. (EIS/EIR at 3.3-88.)

GW-1 next requires potential sellers “to complete and implement a monitoring program,” but a monitoring program itself cannot prevent significant impacts from occurring. “ The monitoring

program will incorporate a sufficient number of monitoring wells to accurately characterize groundwater levels and response in the area before, during, and after transfer pumping takes place.’ (EIS/EIR 3.3-88.) Again, this should be done now, for public review, to determine the significance of project impacts before the project is approved. Moreover, the EIS/EIR fails to provide any guidance on what constitutes “a sufficient number of monitoring wells.” GW-1 then requires monitoring data no less than on a monthly basis, but common sense suggests that significant groundwater pumping could occur in less than a month’s time. GW-1 requires that “Groundwater level monitoring will include measurements before, during and after transfer-related pumping,” but monitoring after transfer-related pumping can only show whether significant impacts *have* occurred; it cannot prevent them. Yet this is exactly what the EIS/EIR proposes: “The purpose of Mitigation Measure GW-1 is to monitor groundwater levels during transfers to avoid potential effects. If any effects occur despite the monitoring efforts, the mitigation plan will describe how to address those effects.” (EIS/EIR 3.3-91.) Hence, GW-1 only requires elements of the mitigation plan to kick in after monitoring shows significant impacts, which are extremely likely to occur given the fact that monitoring alone amounts to no mitigation or avoidance measure.

Even still, the proposed mitigation plans don’t mitigate significant impacts. The mitigation plan includes the following requirements: “Curtailed pumping until natural recharge corrects the issue.” This, of course, could take years and is acknowledged in the EIS/EIR (p. 3.1-17 and 18), and really amounts to no mitigation of the significant impact at all. “Reimbursement for significant increases in pumping costs due to the additional groundwater pumping to support the transfer.” In what amount, at what time, as decided by who? Monetary compensation is not always sufficient to cover damages to business operations. “Curtailed pumping until water levels raise above historic lows if non-reversible subsidence is detected (based on local data to identify elastic versus inelastic subsidence).” It does not follow that any water level above the *historic lows* avoids or offsets damage from non-reversible subsidence. -only admits that irreversible subsidence may occur. Finally, “[o]ther actions as appropriate” is so vague as to be meaningless. (EIS/EIR 3.3-90.)

The wholesale deferral of these mitigation measures is particularly confusing since the lead agencies should already have monitoring and mitigation plans and evaluation reports based on the requirements of the DTIPWTP for past groundwater substitution transfers, which likely were undertaken by some of the same sellers as the proposed 10-year transfer project. The Draft EIS/EIR should provide these existing Bureau approved monitoring programs and mitigation plans as examples of what level of technical specificity is required to meet the objectives of GW-1.

The DTIPWRP doesn’t add any additional monitoring or mitigation requirements for subsidence, stating that areas that are susceptible to land subsidence may require land surface elevation surveys, and that the Project Agencies will work with the water transfer proponent to develop a mutually agreed upon subsidence monitoring program. The monitoring locations in “strategic” locations are similarly deferred with no guiding criteria.

Lastly, groundwater quality monitoring only appears to be required after a transfer has begun, which again is too late to prevent any significant impact from occurring. (EIS/EIR 3.3-89.)

Mitigation measure GW-1 calls for stopping pumping after significant impacts are detected and then waiting for natural recovery of the water table. This might not be in time for groundwater dependent farms or riparian trees (cottonwoods & willows) to recover from the impact or could greatly extend the time to recovery. In the meantime, riparian-dependent wildlife including Swainson's hawks would be without nesting habitat, migration corridors, and foraging areas. The mitigation measure should require active restoration of important habitat such as riparian and wetland, not natural recovery. Recovery to an arbitrary water level is not necessarily the same as recovery of wildlife habitat and populations of sensitive species.

The water level monitoring in the mitigation measure should give explicit quantitative criteria for significant impact. Stating that a reduction in flow or GW level is "within natural variation" and therefore not significant is deceptive. The natural variation includes extreme cases and the project should not be allowed to add an additional increment to an already extreme condition. The extremes are supposed to be rare, not long-term and chronic. For example, Little Chico Creek may be essentially dry at times but it is not totally dry and that may be all that allows plants and animals to persist until wetter conditions return. If everything dies because the creek becomes totally dry due to the project, then it may never recover.

VIII. The EIS/EIR Fails to Analyze a Reasonable Range of Alternatives.

The EIS/EIR is required to evaluate and implement feasible project alternatives that would lessen or avoid the project's potentially significant impacts. Pub. Resources Code §§ 21002, 21002.1(a), 21100(b)(4), 21150; *Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564. This is true even if the EIS/EIR purports to reduce or avoid any or all environmental impacts to less than significant levels. *Laurel Heights Improvement Assn. v. Regents of Univ. of Cal.* (1988) 47 Cal.3d 376. Alternatives that lessen the project's environmental impacts must be considered even if they do not meet all project objectives. CEQA Guidelines § 15126.6(a)-(b); *Habitat & Watershed Caretakers v City of Santa Cruz* (2013) 213 Cal.App.4th 1277, 1302; *Center for Biological Diversity v. County of San Bernardino* (2010) 185 Cal.App.4th 866. Further, the EIS/EIR must contain an accurate no-project alternative against which to consider the project's impacts. CEQA Guidelines § 15126.6(e)(1); *Mira Mar Mobile Community v. City of Oceanside* (2004) 119 Cal.App.4th 477.

Under NEPA, the alternatives analysis constitutes "the heart of the environmental impact statement" (40 C.F.R. § 1502.14). The agency must "rigorously explore and objectively evaluate all reasonable alternatives" (40 C.F.R. § 1502.14(a), 40 C.F.R. § 1502.14(b)), and to identify the preferred alternative (40 C.F.R. § 1502.14(e)). The agency must consider the no action

alternative, other reasonable courses of action, and mitigation measures that are not an element of the proposed action (40 C.F.R. § 1508.25(b)(1)-(3)).

a. No Environmentally Superior Alternative is Identified.

The EIS/EIR fails to follow the law and significantly misleads the public and agency decision-makers in declaring that none of the proposed alternatives are environmentally superior. (EIS/EIR 2-39.) First, neither CEQA nor NEPA provide the lead agencies with discretion to sidestep this determination. As the Council on Environmental Quality (CEQ) has explained, “[t]hrough the identification of the environmentally preferable alternative, the decision maker is clearly faced with a choice between that alternative and the others, and must consider whether the decision accords with the Congressionally declared polices of the Act.”⁶⁵ CEQA provides that “[i]f the environmentally superior alternative is the “no project” alternative, the EIR shall also identify an environmentally superior alternative among the other alternatives.” (CEQA Guidelines § 15126.6(e)(2).)

First, the EIS/EIR fails to identify whether the “no project” alternative is environmentally superior to each other alternative. If that is the case, the EIS/EIR must then identify the next most environmentally protective or beneficial alternative. Here, the EIS/EIR presents evidence that Alternative 3 and Alternative 4 each would lessen the environmental impacts of the proposed project. The EIS/EIR however then shirks its responsibility to identify the environmentally superior alternative by casting the benefits of Alternatives 3 and 4 as mere “trade-offs.” This gross mischaracterization misleads the public and agency decision-makers, as the only “trade-off” between the proposed alternative and Alternatives 3 or 4 would be more or less adverse environmental effect.

The EIS/EIR argument that its conclusion that no project impacts are significant and unavoidable misses the point. Just as an EIS/EIR may not simply omit any alternatives analysis when there is purported to be no significant and unavoidable impact, neither can the agencies decline to identify the environmentally superior alternative. In fact, the proposed project would cause numerous significant and adverse environmental effects, and the EIS/EIR relies on wholly deferred and inadequate mitigation measures to lessen those effects, even allowing some level of significant impacts to occur before kicking in. But mitigation measures alone are not the only way to lessen or avoid significant project effects: the alternatives analysis performs the same function, and should be considered irrespective of the mitigation measures proposed.

b. Feasible Alternatives to Lessen Project Impacts are Excluded.

In light of the oversubscribed water rights system of allocation in California, changing climate conditions, and severely imperiled ecological conditions throughout the Delta, the EIS/EIR

⁶⁵ Forty Most Asked Questions Concerning CEQ’s NEPA Regulations, 48 Fed. Reg. 18,026 (Mar.16, 1981) Questions 6a.

should consider additional project alternatives to lessen the strain on water resources. Alternatives not considered in the EIS/EIR that promote improved water usage and conservation include:

Fallowing in the area of demand. The EIS/EIR proposes fallowing in the area of origin to supply water for the transfers yet fails to present the obvious alternative that would fallow land south of the Delta that holds junior, not senior, water rights. This would qualify as an, “immediately implementable and flexible” alternative that is part of the Purpose and Need section (p.1-2). Whether or not this is a preference for the buyers, this is a pragmatic alternative that should be fully explored in a recirculated EIS/EIR.

Crop shifting in the area of demand. The EIS/EIR proposes crop shifting in the area of origin to supply water for the transfers yet fails to present the obvious alternative that would shift crops south of the Delta for land that holds junior, not senior, water rights. Hardening demand by planting perennial crops (or houses) must be viewed as a business decision with its inherent risks, not a reason to dewater already stressed hydrologic systems in the Sacramento Valley. This would qualify as an, “immediately implementable and flexible” alternative that is part of the Purpose and Need section (p.1-2). Whether or not this is a preference for the buyers, this is a pragmatic alternative that should be fully explored in a recirculated EIS/EIR.

Mandatory conservation in urban areas. In the third year of a drought, an example of urban areas failing to require serious conservation is EBMUD’s flyer from October’s bills that reflects the weak mandates from the SWRCB.

- Limit watering of outdoor landscapes to two times per week maximum and prevent excess runoff.
- Use only hoses with shutoff nozzles to wash vehicles.
- Use a broom or air blower, not water, to clean hard surfaces such as driveways and sidewalks, except as needed for health and safety purposes.
- Turn off any fountain or decorative water feature unless the water is recirculated.

While it is laudable that EBMUD customers have cut water use by 20 percent over the last decade,⁶⁶ before additional water is ever transferred from the Sacramento River watershed to urban areas, mandatory usage cuts must be enacted during statewide droughts. This would qualify as an, “immediately implementable and flexible” alternative that is part of the Purpose and Need section (p.1-2). This alternative should be fully vetted in a recirculated EIS/EIR.

Land retirement in the area of demand. Compounding the insanity of growing perennial crops in a desert is the resulting excess contamination of 1 million acres of irrigated land in the San Joaquin Valley and the Tulare Lake Basin that are tainted with salts and trace metals like selenium, boron, arsenic, and mercury. This water drains back—after leaching from these soils

⁶⁶ <https://www.ebmud.com/water-and-wastewater/latest-water-supply-update>

the salts and trace metals—into sloughs and wetlands and the San Joaquin River, carrying along these pollutants. Retirement of these lands from irrigation usage would stop wasteful use of precious fresh water resources and help stem further bioaccumulation of these toxins that have settled in the sediments of these water bodies. The Lead and Approving Agencies have known about this massive pollution of soil and water in the area of demand for over three decades.⁶⁷ Accelerating land retirement could diminish south of Delta exports and provide water for non-polluting buyers. Whether or not this is a preference for all of the buyers, this is a pragmatic alternative that should be fully explored in a recirculated EIS/EIR.

Adherence to California's water rights. As mentioned above, the claims to water in the Central Valley far exceed hydrologic reality by more than five times. Unless senior water rights holders wish to abandon or sell their rights, junior claimants must live within the hydrologic systems of their watersheds. This would qualify as an, “immediately implementable and flexible” alternative that is part of the Purpose and Need section (p.1-2). Whether or not this is a preference for the buyers, this is a pragmatic alternative that should be fully explored in a recirculated EIS/EIR.

IX. The EIS/EIR Fails to Disclose Irreversible and Irretrievable Commitment of Resources, and Significant and Unavoidable Impacts.

Under NEPA, impacts should be addressed in proportion to their significance (40 C.F.R. § 1502.2(b)), and all irreversible or irretrievable commitment of resources must be identified (40 C.F.R. § 1502.16). And CEQA requires disclosure of any significant impact that will not be avoided by required mitigation measures or alternatives. CEQA Guidelines § 15093. Here, the EIS/EIR does neither, relegating significant impacts to groundwater depletion, land subsidence, and hardened demand for California’s already-oversubscribed water resources, to future study pursuant to inadequately described mitigation measures, if discussed at all.

a. Groundwater Depletion.

As discussed, above, the EIS/EIR groundwater supply mitigation measures rely heavily on monitoring and analysis proposed to occur *after* groundwater substitution pumping has begun, perhaps for a month or more. Only after groundwater interference, injury, overdraft, or other harms (none of which are assigned a definition or significance threshold) occur, would the EIS/EIR require sellers to propose mitigation measures, which are as of yet undefined. As a result, significant and irretrievable impacts to groundwater are fully permitted by the proposed project.

b. Subsidence.

Here, again, the EIS/EIR suffers the same flaw of only catching and proposing to mitigate

⁶⁷ <http://www.usbr.gov/mp/cvpia/3408h/>

subsidence after it occurs. But damages caused by subsidence can be severe, permanent, and complicated. The EIS/EIR does not purport to avoid these impacts, nor possibly mitigate them to less than significant levels. Instead, the EIS/EIR provides for “Reimbursement for modifications to infrastructure that may be affected by non-reversible subsidence.” This unequivocally provides for significant and irreversible impacts to occur.

c. Transfer Water Dependency.

The EIS/EIR fails to account for long-term impacts of supporting agriculture and urban demands and growth with transfer water. Agriculture hardens demand by expansion and crop type and urban users harden demand by expansion. Both sectors may fail to pursue aggressive conservation and grapple with long-term hydrologic constraints with the delivery of more northern California river water that has been made available by groundwater mining and following. Since California has high variability in precipitation year-to-year (<http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST>) (Exhibit Y), and how will purchased water be used and conserved? Should agricultural water users be able to buy Project water, how will DWR and the Bureau assure that transferred water for irrigation is used efficiently? Could purchased water be used for any kind of crop or landscaping, rather than clearly domestic purposes or strictly for drought-tolerant landscaping?

Without a hierarchy of priority uses among agricultural or urban users for purchasing CVP and non-CVP water, the EIS/EIR fails to ensure that California water resources will not go to waste, and will not be used to harden unsustainable demands.

X. The EIS/EIR Fails to Adequately Evaluate Growth-Inducing Impacts.

The EIS/EIR gives short shrift to the growth inducing impact analyses required under both CEQA and NEPA by absolutely failing to realize or by obfuscating the obvious: these types of Long-Term Water Transfers inherently lead to economic and population growth. Not only are the amount of water sales and types of water sales unknown to the Lead Agencies and the public, but once water is sold and transferred to the buyer agency, there are no use limitations or priority-criteria imposed on the buyer. Whether agricultural support or municipal supply, hydraulic fracturing, industrial use, or onward transfer, the potential growth inducing impacts, both economically and physically are limitless. And once agencies and communities are hooked on buying water to sustain economic conditions or to support development and population growth, while drought conditions continue or are exacerbated, unwinding the clock may prove impossible.

Growth inducing impacts are addressed in Section 15126.2(d) of the CEQA Guidelines, and the Council on Environmental Quality NEPA Sections 1502.16(b) and 1508.8(b). CEQA Section 15126.2(b) requires an analysis of a project’s influence on economic or population growth, or increased housing construction and the future developments’ associated environmental impacts. The CEQA Guidelines define growth inducing impacts as “...the ways in which the

proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment.” Under NEPA, indirect effects as declared in Section 1508.8(b) include reasonably foreseeable growth inducing effects from changes caused by a project.

A project may have characteristics that encourage and facilitate other activities that could significantly affect the environment, either individually or cumulatively. CEQA Guidelines section 15126.2(d) admonishes the planner not to assume that growth in any area is necessarily beneficial, detrimental, or of little significance to the environment. Included here are projects that would remove physical obstacles to growth, such as provision of new water supply achieved through Long Term Water Transfers. Removal of a barrier such as water shortages may lead to the cultivation of crops with higher-level water dependency and higher profit margins at market, or may supplement perceived and actual advantages of living in population-dense locales, leading to increased population growth.

The EIS/EIR states that direct growth-inducing impacts are typically associated with the construction of new infrastructure while projects promoting growth, like increased water supply in dry years, could have indirect growth inducing effects. Claiming that growth inducing impacts would only be considered significant if the ability to provide needed public services is hindered, or the potential for growth adversely affects the environment, the EIS/EIR then incorrectly concludes that the proposed water transfer from willing sellers to buyers, to meet existing demands, would not directly or indirectly affect growth beyond what is already planned. But the EIS/EIR does not describe “what is already planned,” nor how binding such plans would be.

Similar to the drought period in the late 1980’s and early 1990’s, urban agencies demand was approximately 40 percent of the transfer market. During that drought period, dry-year purchases were short term deals, intended to offset lower deliveries. However, this time around most of the transfer water is available to support longer-term growth, not solely to make up for shortfalls during droughts. Under current law, urban water agencies must establish long-term water supply to support new development, and long term transfers can provide this necessary evidence.⁶⁸

Adding to these concerns is the increase in fracking interests throughout the state, requiring large-scale water demand to extract oil and gas, run by companies with the financial ability to influence water rights through payment. While one county directly south of the boundary involving this proposed transfer agreement recently banned fracking, other counties in

⁶⁸ California Senate Bills 221 and 610, entered into law, 2001: requires agencies with over 5000 service connections and those with under 5000 service connections to demonstrate at least 20 years of available water supply respectively, for projects in excess of 500 residential units, or equivalent in combined residential and other demand (large service agencies), or for projects demanding least 10 percent growth in local water needs (small service agencies).

California are either involved in the practice of fracking, have yet to ban the practice, or have no interest in a fracking ban. Notably, the Monterey Shale Formation that stretches south through central California is in the buyer-area of the water districts served by this potential Long-Term Water Transfer Agreement. Without use limitations upon water transfers proposed within this agreement, water transferred under this plan may well be used for fracking

The EIS/EIR inappropriately fails to evaluate or disclose these reasonably foreseeable growth-inducing impacts.

XI. Conclusion

Taken together, the Bureau, SLDMWA, and DWR treat these serious issues carelessly in the EIS/EIR, the *Draft Technical Information for Water Transfers in 2013*, and in DWR's specious avoidance of CEQA review. In so doing, the Lead and Approving Agencies deprive decision makers and the public of their ability to evaluate the potential environmental effects of this Project and violate the full-disclosure purposes and methods of both the National Environmental Policy Act and the California Environmental Quality Act. For each of the foregoing reasons, we urge that the environmental review document for this project be substantially revised and recirculated for public and agency review and comment before any subject project is permitted to proceed.

Sincerely,



Barbara Vlamis, Executive Director
AquAlliance



Bill Jennings, Executive Director
California Sportfishing Protection Association



April 2, 2014

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Subject: Comments on the Draft Environmental Assessment/Initial Study 2014 San Luis & Delta Mendota Water Authority Water Transfers

Dear Mr. Hubbard and Ms. Mizuno:

AquAlliance submits the following comments and questions for the Bureau of Reclamation (“Bureau”) and the San Luis Delta Mendota Water Authority’s (“SLDMWA”) (“Agencies”) *Draft Environmental Assessment* (“EA”) and *Initial Study* (“IS”) (“EA/IS”), for the *2014 San Luis & Delta Mendota Water Authority Water Transfers* program (“Project”). We include by reference the comments and documents submitted by AquAlliance’s Executive Director for the *2009 Drought Water Bank* (“DWB”), the *2010-2011 Water Transfer Program*, and the *2013 Water Transfer Program* with other items in Appendix A that disclose the environmental impacts associated with these types of serial “temporary” transfers.

I. Lead Agency

SLDMWA is not the proper Lead Agency for the Project. California Environmental Quality Act (“CEQA”) Guidelines section 15367 and Section 15051 require that the California Department of Water Resources, as the operator of the California Aqueduct and who has responsibility to protect the public health and safety and the financial security of bondholders with respect to the aqueduct, is the more appropriate lead agency. In *PCL v DWR*, the court found that DWR’s attempt to delegate lead agency authority impermissibly insulated the department from “public awareness and possible reaction to the individual members’ environmental and economic values.”¹ DWR clearly has approval authority for parts of the Project and is guiding the transfer process as noted on page 3-41: “Potential sellers will be required to submit well data for Reclamation and, where appropriate, DWR review, as part of the transfer approval process. Required information is detailed in the *DRAFT Technical Information for Preparing Water Transfer Proposals* (Reclamation and DWR 2013) and Addendum (Reclamation and DWR 2014) for groundwater substitution transfers.”

¹ *Planning and Conservation League et al. v Department of Water Resources* (2000) 83 Cal.App.4th 892, 907, citing *Kleist v. City of Glendale* (1976) 56 Cal. App. 3d 770, 779.

Additionally, the EA/IS p 1-2 says: "Other transfers not involving the SLDMWA and its Participating Members could occur during the same time period. The Tehama-Colusa Canal Authority (TCCA) is releasing a separate EA/IS to analyze transfers from a very similar list of sellers to the TCCA Member Units. These two documents reflect different potential buyers for the same water sources; that is, the sellers have only the amounts of water listed in Section 2 available for transfer, but the water could be purchased by SLDMWA or TCCA members." This is another reason that DWR should be the lead agency: environmental review of transfers should be unified and comprehensive, and cumulative across both geography and over time.

II. Document Presentation

Document Identification

A foundational requirement under the National Environmental Policy Act ("NEPA") and CEQA is disclosure. This begins with the proper identification of the document that is circulated for public review. The title page of the environmental review document provided for the proposed Project states that it is a *Draft Environmental Assessment/Initial Study 2014 San Luis & Delta Mendota Water Authority Water Transfers*. The headers on alternate pages throughout the document and the appendices identify the document with: *2014 San Luis & Delta-Mendota Water Authority Water Transfers Draft Environmental Assessment/Initial Study*. From these titles, the Bureau appears not to be a party to the document.

The Notice of Intent that was mailed to AquAlliance, but was not available on the Bureau's web site (http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=16681), asserts that SLDMWA plans to adopt a Mitigated Negative Declaration and refers the reader to the Bureau's web site provided above for the EA/IS. In addition, the CEQA cover sheets that were initially attached to the EA/IS when it was first released on the Bureau's web site, but are now absent from the site, also asserted the intent to adopt a Mitigated Declaration. Included in the CEQA cover sheets are two pages signed by Frances Mizuno on March 11, 2014 entitled *MITIGATED NEGATIVE DECLARATION FOR 2014 SAN LUIS & DELTA-MENDOTA WATER AUTHORITY WATER TRANSFERS* that refers the reader to the Bureau's web site for the EA/IS, but, as stated above, these four cover pages are no longer available on the Bureau's web site (http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=16681). Lastly, to add to the confusion, there is no mention of a Mitigated Negative Declaration anywhere in the EA/IS.

As discussed above, there is an absence of clarity regarding 1) the intent to adopt a Mitigated Declaration under CEQA and 2) the ownership of the NEPA/CEQA document. On March 14, 2014, the day after the formal release of the EA/IS on the Bureau's web site, the cover pages that informed the reader that SLDMWA intended to adopt a Mitigated Negative Declaration vanished. What has been available for public review since that date is confusing and deficient. It must also be emphasized that the NEPA/CEQA document is only available at the Bureau's web site. Next, regarding the lead agencies for the NEPA/CEQA document, we acknowledge that page 1-1 reveals the lead agency roles of the Bureau and SLDMWA, but we find that the lack of clear, dual ownership in the document's title and page headers confusing and deficient for the public.

Document Navigation

The Index fails to provide details for Chapter 3 with the CEQA check list headings and pages making the document less than user-friendly.

III. Purpose and Need

The Bureau's *Reclamation's NEPA Handbook* (2012) states, "The need for an accurate (and adequate) purpose and need statement early in the NEPA process cannot be overstated. This statement gives direction to the entire process and ensures alternatives are designed to address project goals." (p.11-1) While "need" is disclosed in section 1.2 (p. 1-3), there is no coherent discussion of that "need" that would establish how SLDMWA members find themselves in the current situation. Merely stating that, "As a result of the significantly reduced allocation, the SLDMWA is in need of water for irrigation, primarily of permanent crops to prevent the long term impacts of allowing these crops to die," lacks context, specificity, and rigor. First, the hydrologic conditions described on page 1-3 apply to the entire state, including the region where buyers are sought, not just the areas served by SLDMWA as presented here. Second, SLDMWA has chronic water shortages due to its contractors' junior position in water rights, risks taken by growers to plant permanent crops, and serious long-term overdraft in its service area. Where is this divulged? Third, SLDMWA or its member agencies have sought to buy and actually procured water in many past water years to make up for poor planning and risky business decisions. which violates CEQA's prohibition against segmenting a project to evade proper environmental review?²

In reference to the Bureau, the EA/IS states, "Reclamation's need is to approve the transfer of Base Supply or Project Water that may require the use of CVP facilities, consistent with state and federal law, the Sacramento River Settlement Contract, and the Interim Guidelines for Implementation of the Water Transfer Provisions of the Central Valley Project Improvement Act (Title XXXIV of Public Law 102-575). This "need" statement, highlights the conflicts in the Bureau's mission, deficiencies in planning for 2014, and the inadequacy of the EA/IS that should provide, among other things, the following background.

- During Bureau meetings held in 2013³, the Bureau and DWR knew full well that 2013 was a dry year and that reservoir levels at the dams were exceedingly low⁴. Despite that awareness, the same federal and state agencies continued to export almost 2,400,000 AF of water to South State interests between June and December 2013. (*Id at p. 8*)
- In 2011 the Bureau gave away approximately 450,000 AF of additional storage water and DWR exported more than 826,000 AF of water above what it disclosed it could in 2013.⁵
- After taking the above actions, the Bureau (p. 1-3) and DWR are diminishing water allocations to senior water rights holders in and north of the Delta and yet asking some of the same water districts to actually sell water.

² Laurel Heights Improvement Association v. Regents of the University of California, 1988, 47 Cal.3d 376

³ http://www.usbr.gov/mp/Waters_Supply_Meetings/About.html

⁴ Bureau WY 2013 Handout (4)

⁵ <http://calsport.org/news/wp-content/uploads/St-Bd-Drought-Wkshp.pdf>

The Proposed Action Alternative is poorly specified and needs additional clarity before decision makers and the public can understand the human and environmental consequences of the *2014 Water Transfers*. The EA describes the Proposed Action Alternative as one reflecting the Bureau's intention to approve transfers of Central Valley Project water from willing sellers who contract with the Bureau ordinarily to use surface water on their croplands. Up to 195,126 AF of CVP water are offered from these sellers, according to Table 2-1. (EA/IS p. 2-3). In contrast to the EA/FONSI for the 2009 Drought Water Bank (p. 3-88), the Project EA/IS contains no "priority criteria" to determine water deliveries and simply acknowledges that CVP river water will be transferred to San Luis & Delta Mendota Water Authority contractors. The EA/IS fails to indicate how much water has been requested by the buyers of CVP or non-CVP water, which is also in contrast to the 2009 DWB EA/FONSI and DWR's addendum for the 2009 DWB. Potential buyers of non-CVP water are also not disclosed. These significant omissions eliminate the public's ability to consider, assess, and comment on possible impacts in the receiving areas. This denial of information further obfuscates the need for the Project.

The Bureau and SLDMWA's draft environmental review of the Project does not comply with the requirements of NEPA⁶ or CEQA⁷ for the reasons described below.

IV. An EIS/EIR is Required

The Bureau must prepare an environmental impact statement ("EIS") and DWR, as the proper lead agency (not SLDMWA), must prepare an environmental impact report ("EIR") on this proposal. The current project is similar to the 2009 Drought Water Bank project that allowed up to 600,000 acre-feet (AF) of surface water transfers, up to 340,000 AF of groundwater substitution, and significant crop idling. At that time, DWR staff conceded that the 2009 Drought Water Bank project would have significant environmental impacts. The 2009 Drought Water Bank (2009 DWB) was a water transfer program very similar to the current proposal. Litigation of the 2009 DWB disclosed internal DWR emails showing DWR staff's view that the 2009 DWB would have significant impacts on the environment.⁸ (See Supplemental Administrative Record ("Suppl. AR") 2007 [email from Curt Spencer stating: "Without an air override, we face a limited water supply, See Suppl. AR 2020, 203.]⁹ DWR staff were also concerned the proposed addendum would not meet CEQA's requirements because the mitigation measures for impacts on the giant garter snake were based on an expired 2003 biological opinion. (See Suppl. AR 2010, 2014, 2022, 2044, and 2056.) Other concerns included the adequacy of the mitigation measures to protect the giant garter snake given the lack of up to date scientific information on the species (see Suppl. AR 2026, 2028, and 2034). Indeed, even after invoking the emergency exemption, DWR continued to express concerns regarding the project's potentially significant environmental impacts and whether these impacts would be mitigated. (See Suppl. AR 2064, 2066, and 2070 [emails discussing concern re air impacts]; Suppl. AR 2054 [email planning

⁶ 42 U.S.C. §4321 *et seq*

⁷ Public Resources Code §21000 *et seq*

⁸ DWR E-mail Regarding 2009 Drought Water Bank.

⁹ Pages of the Suppl AR are attached hereto as Exhibit ____.

“CEQA analysis [that] will focus on the emissions impacts associated with the increased use of diesel [ground water] pumps.”.)

The proposed Project also mirrors the *2010-2011 Water Transfer Program* that sought approval for 200,000 AF of CVP related water and assumed NEPA coverage for additional non-CVP transfer water up to 195,910 AF and the *2013 Water Transfer Program* that sought approval for 37,505 AF of CVP water made available by groundwater substitution and NEPA coverage for an additional 92,806 AF of North State water from groundwater substitution and 65,000 AF from reservoir storage.

NEPA requires federal agencies to prepare a detailed EIS on all “major Federal actions significantly affecting the quality of the human environment”¹⁰ and CEQA has similar requirements and criteria. NEPA regulations promulgated by the Council on Environmental Quality identify factors that the Bureau must consider in assessing whether a project may have significant environmental effects, including:

- (1) “The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.” 40 C.F.R. §1508.27(b)(5).
- (2) “The degree to which the effects on the quality of the human environment are likely to be highly controversial.” *Id.* §1508.27(b)(4).
- (3) “Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate on a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.” *Id.* §1508.27(b)(7).
- (4) “The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.” *Id.* §1508.27(b)(6).
- (5) “The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.” *Id.* §1508.27(b)(9).

Here, the Bureau and the state agency have failed to take a hard look at the environmental impacts of the Project. As elucidated below, there are substantial questions about whether the Project’s proposed water transfers will have significant effects on the region’s environment, biology, and hydrology. There are also substantial questions about whether the Project will have significant adverse environmental impacts when considered in conjunction with the other related water projects underway, planned, and proposed in the region. The Bureau and the state agency simply cannot, consistent with NEPA, allow these foreseeable environmental impacts to escape full analysis in an EIS of the proposed Project. AquAlliance’s comments below will further highlight the EA/IS deficiencies in disclosure, analysis, and justification for its conclusions.

¹⁰ 42 U.S.C. §4332(2)(C).

The EA/IS Violates NEPA and CEQA Rules Against Segmenting Environmental Review of Projects

It is noteworthy that the Bureau and the state agency assert that the Project is not part of a “Program” as it has for past water transfers (p. 1-2) and that a draft Findings of No Significant Impact (“FONSI”) has not been provided with the release of the EA/IS as is the Bureau’s custom.

The Bureau and DWR have known for over a decade that programmatic environmental review was and is necessary for water transfers from the Sacramento Valley. The following examples highlight the Bureau and DWR’s deficiencies in complying with NEPA and CEQA.

- The Sacramento Valley Water Management Agreement was signed in 2002, and the need for a programmatic EIS/EIR was clear at that time it was initiated but never completed.¹¹
- In 2000, the Governor’s Advisory Drought Planning Panel report, *Critical Water Shortage Contingency Plan* promised a program EIR on a drought-response water transfer program, but was never undertaken.
- Twice in recent history, the state readily acknowledged that CEQA review for a major drought water banking program was appropriate.
- Last, but not least, is the attempt by the Bureau and SLDMWA to analyze the 10-Year Plan, which also has failed to materialize since the scoping period in January 2011.

The Bureau’s most recent transfer approvals include:

- In 2009, the Bureau approved a 1 year water transfer program under which a number of transfers were made. Regarding NEPA, the Bureau issued a FONSI based on an EA.
- In 2010, the Bureau approved a 2 year water transfer program (for 2010 and 2011). No actual transfers were made under this approval. Regarding NEPA, the Bureau again issued a FONSI based on an EA.
- In 2013, the Bureau approved a 1 year water transfer program, again issuing a FONSI based on an EA. The EA incorporates by reference the environmental analysis in the 2010-2011 EA.

These Water Transfer approvals are “programmatic” in the sense that they cover a large geographic area, and applicants for specific water transfers must still obtain additional approvals (from the Bureau and from the SWRCB) before executing any specific water transfer. The additional approvals include:

¹¹ The Bureau and DWR actually began a joint Programmatic EIS/EIR to facilitate water transfers from the Sacramento Valley and the interconnected actions that are integrally related to the transfers, but never completed it. The Bureau has impermissibly broken out this current segment of the overall Program for piecemeal review in the present draft EA. See 68 Federal Register 46218 (Aug 5, 2003) (promising a Programmatic EIS on these related activities, “includ[ing] groundwater substitution in lieu of surface water supplies, conjunctive use of groundwater and surface water, refurbish existing groundwater extraction wells, install groundwater monitoring stations, install new groundwater extraction wells...” *Id.* At 46219. See also http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=788 (current Bureau website on “Short-term Sacramento Valley Water Management Program EIS/EIR”).

- A specific authorization from the Bureau, based on an application defined by a document entitled: “Draft Technical Information for Water Transfers in 2013.”
- A specific approval from the State Water Board of a petition for change in place or purpose of use under Water Code § 1725 et seq).

In sum, the Bureau and the state have approved water transfer programs (either 1-year or 2-year programs) in 5 out of the last 6 years. Therefore, it is clear that the need for such programs in the future (to the extent a need exists at all), is virtually certain. Therefore, to avoid violating the rules under both NEPA and CEQA against segmenting environmental review of projects, the Bureau and state are required to include future water transfers in the current environmental analysis, either as (1) part of the project description, as reasonably foreseeable future activities associated with the project, and/or as part of the assessment of cumulative impacts. The EA/IS fails to do so,

V. Chapter 2, Alternatives

The most fundamental deficiency of the EA/IS is the lack of alternatives considered, which, once again, continues the Bureau’s failure to comply with NEPA and DWR’s failure to comply with CEQA. NEPA’s implementing regulations call analysis of alternatives “the heart of the environmental impact statement,” 40 C.F.R. §1502.14, and they require an analysis of alternatives within an EA. *Id.* §1408.9. The statute itself specifically requires federal agencies to: study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning available uses of resources.

42 U.S.C. §4332(2)(E). CEQA has parallel requirements for alternatives to be analyzed in an EIR. Here, because the Bureau’s EA considers only the proposed Project and a “No Action” alternative, the EA violates NEPA.

The case law makes clear that an adequate analysis of alternatives is an essential element of an EA, and is designed to allow the decision-maker and the public to compare the environmental consequences of the proposed action with the environmental effects of other options for accomplishing the agency’s purpose. The Ninth Circuit has explained that “[i]nformed and meaningful consideration of alternatives ... is ... an integral part of the statutory scheme.”¹² An EA must consider a reasonable range of alternatives, and courts have not hesitated to overturn EAs that omit consideration of a reasonable and feasible alternative.¹³

Here, there are only two alternatives presented: the No Action and the Proposed Action. The lack of *any* alternative action proposal is unreasonable and is by itself a violation of NEPA’s requirement to consider a reasonable range of alternatives. 42 U.S.C. § 4332(2)(E).

¹² *Bob Marshall Alliance v. Hodel*, 852 F.2d 1223, 1228 (9th Cir. 1988) (holding that EA was flawed where it failed adequately to consider alternatives).

¹³ See *People ex rel. Van de Kamp v. Marsh*, 687 F.Supp. 495, 499 (N.D. Cal. 1988); *Sierra Club v. Watkins*, 808 F.Supp. 852, 870-75 (D.D.C. 1991).

2.2 Proposed Action/Proposed Project

Pages 2-3 to 2-6 present the sellers and the amounts of water that may be transferred under two different scenarios: Current Hydrologic Conditions and Improved Conditions. Table 2-1, *The Maximum Potential Transfer by Seller (Acre Feet)* indicates that the total under current hydrologic conditions may be 91,313 and under improved conditions may be 195,126. This is straight forward. However, when attempting to determine how much water may come from fallowing or groundwater substitution during two different time periods, April-June and July-September, the reader is left to guess.

The numbers in the "totals" row of Table 2-2 presumably should add up to 91,313. Instead, they add up to 110, 789. The numbers in the "totals" row of Table 2-3 presumably should add up to 195,126. Instead, they add up to 249,997. Both Tables 2-2 and 2-3 have a footnote stating: "These totals cannot be added together. Agencies could make water available through groundwater substitution, cropland idling, or a combination of the two; however, they will not make the full quantity available through both methods. Table 2-1 reflects the total upper limit for each agency."

This "explanation" is no explanation at all. As a result, the reader cannot know how much water is expected to be generated by groundwater substitution versus crop idling. This amount of uncertainty regarding potential sources of the water and the nature of the Project is confusing and impairs the public's ability to assess its environmental impacts.

The following paragraph is found on page 2-9:

An objective in planning a groundwater substitution transfer is to ensure that groundwater levels recover to their seasonal high levels under average hydrologic conditions. Because groundwater levels generally recover at the expense of stream flow, the wells used in a groundwater substitution transfer should be sited and pumped in such a manner that the stream flow losses resulting from pumping are primarily during the wet season, when losses to stream flow minimally affect other legal users of water. For the purposes of this EA/IS, the stream flow losses are assumed to be 12 percent of the amount pumped for transfer. The quantity of water available for transfer would be reduced by these estimated stream flow losses.

The EA's use of "average hydrologic conditions" as the baseline for assessing degree of impact and effectiveness of mitigation measures is unlawful for several reasons. "Average hydrologic conditions" is undefined. The EA asserts elsewhere that hydrologic conditions in 2014 are not "average." The assumption that "[s]tream flow losses are assumed to be 12 percent of the amount pumped for transfer" is unsupported for any location, including the locations where groundwater substitution transfers will occur. The suggestion that "the wells used in a groundwater substitution transfer should be sited and pumped in such a manner that the stream flow losses resulting from pumping are primarily during the wet season" is not embodied in any enforceable condition or mitigation measure. Since there is no guarantee this suggestion will be honored, it does not support a FONSI for impacts related to stream flow losses. Also, the EA/IS considers

the effects of stream flow losses on other water users, and fails to assess the effect of stream flow losses (either below or above the 12% threshold) on other environmental values and resources, such as:

Page 2-11, bullet one states that, “Historical amounts of idled land vary year-to-year by close to 20 percent, which indicates that the local economy has adjusted to similar amounts of crop idling.” What data support this assertion? Where is it presented in the EA/IS? If it is presented in the EA/IS, why is not cited with the above quotation? If GCID planned to idle about 15 percent of the district’s rice land with a 75 percent CVP allocation, it is fair to conclude that it would more than double with what is currently proposed at a 40 percent allocation. (EA/IS p. 4-5). The impacts from increased fallowing due to decreased CVP allocations, let alone in combination with the proposed transfers, are not presented here.

As the Agencies well know, the overall economy and the environment are supposed to be protected from unreasonable effects according to California Water Code Section 1810 and the CVPIA. Page 2-11, bullet two states that, “Cropland idling has not generally resulted in economic impacts outside of the historical variations.” What data support this assertion? How is “generally” defined in this context? What data are used to evaluate economic impacts from fallowing if there are unusual conditions? Where are these issues presented in the EA/IS? If they are presented in the EA/IS, why are they not cited with the above quotation? If the Agencies have data that support the quoted assertion, although it is not cited or presented in the EA/IS for public review, aren’t the current, unusually dry conditions (presented in Section 1.2, *Need for Proposal and Project Objectives*) combined with unprecedented cuts to CVP water deliveries a time when unusually significant impacts might occur? Over a decade ago David Gallo assessed the impacts on local economies from fallowing and concluded that the costs ranged from \$157 - \$170 per acre foot of water sold.¹⁴ This is what should have been analyzed and evaluated in the EA/IS, or better yet, in what the Agencies know is necessary: an EIS/EIR (EA/IS p.1-4).

In Chapter 2, Alternatives, page 2-11, bullet three states that, “Water Code Section 1745.05(b) requires a public hearing under some circumstances in which the amount of water from land idling exceeds 20 percent of the water that would have been applied or stored by the water supplier absent the water transfer in any given hydrologic year. Third parties would be able to attend the hearing and could argue to limit the transfer based on its economic effects.” With water deliveries potentially cut to 50 percent for senior SWP contractors and 40% for senior CVP contractors, what is the potential to exceed the 20 percent figure, particularly when cropland idling transfers are added to the cumulative impacts? Is a public hearing scheduled? How will potentially affected and interested parties receive notice of a hearing? It is noticeable that the EA/IS bullet language fails to disclose where a public hearing might be held and before what governmental body.

¹⁴ Gallo, David. Estimating Third Party Impacts From Water Transfers Through Riceland Fallowing: A Suggested Approach.

Section 2.3, *Recent Environmental Documents*, proudly touts the production of the *2010/2011 Water Transfer Program* Environmental Assessment. Although discussion of the document's failings are not disclosed here, AquAlliance presented many of them in our comments on the EA/FONSI and filed litigation to challenge it. During the litigation the Bureau decided to initiate the 10-Year Water Transfer Program (600,000 AF per year) with scoping meetings for an EIS/EIR in concert with SLDMWA. Despite the acknowledgment that an EIS/EIR is necessary for the repetitious water transfers, the release of the EIS/EIR has been delayed year-after-year while the Bureau continues to pursue one-year, so-called "temporary" transfers.

Mitigation and Monitoring

Where are the data that are referenced on page 2-12? "As part of the monitoring plans required by the EA/IS, the transferring parties have collected monitoring data starting pre-transfer. To date (through January 2014), the available monitoring data indicates that the groundwater aquifer is recovering to pre-transfer levels, as described in the EA. Final monitoring reports that describe the monitoring data will be available in May 2014." If the public doesn't have access to the "pre-transfer" data and the Agencies will not have final reports until May 2014, how can the public adequately comment and how can the Agencies reach a conclusion? This gaping hole in the assessment of the impacts from the 2013 water transfers indicates at a minimum that the 2014 Project EA/IS was circulated prematurely.

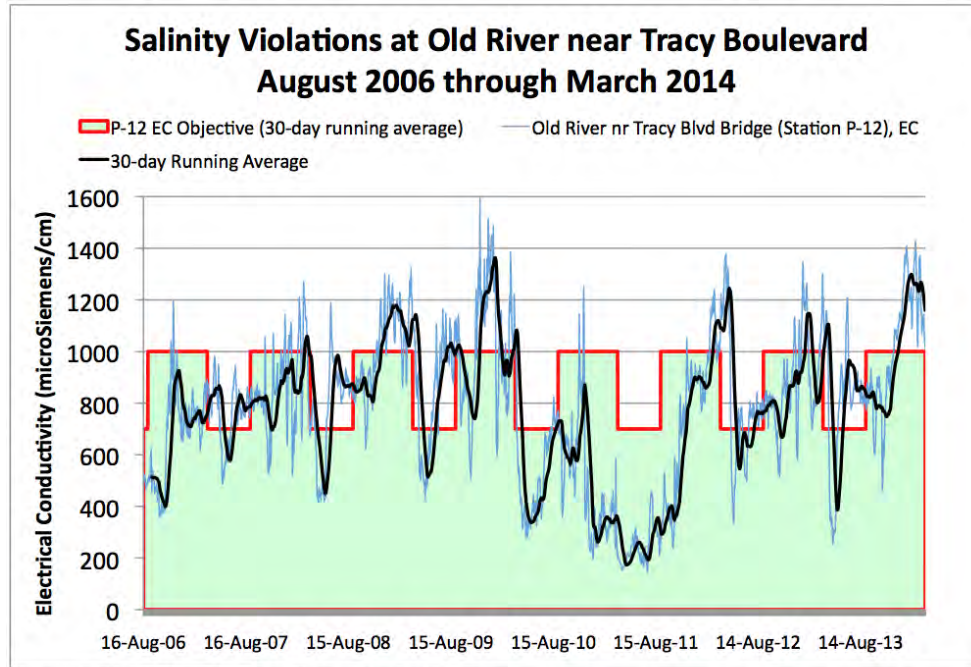
In light of the EA/IS's deficit in presenting groundwater conditions in the Sacramento Valley after the 2013 groundwater substitution transfers or historic trends, we attach the most current DWR maps that illustrate the serious condition of the groundwater basins in the Sacramento Valley. These DWR maps¹⁵ present a very different picture than what is supplied in Appendix F's attempt at modeling. There is a clear and significant downward trend in regional groundwater levels.

- Northern Sacramento Valley Change In Groundwater Elevation Map Change in Deep Fall 2012 to Fall 2013, Shallow Aquifer Zone
- Northern Sacramento Valley Change In Groundwater Elevation Map Change in Deep Fall 2012 to Fall 2013, Intermediate Aquifer Zone
- Northern Sacramento Valley Change In Groundwater Elevation Map Change in Deep Fall 2012 to Fall 2013, Deep Aquifer Zone
- Northern Sacramento Valley Change In Groundwater Elevation Map Change in Deep Fall 2004 to Fall 2013, Shallow Aquifer Zone
- Northern Sacramento Valley Change In Groundwater Elevation Map Change in Deep Fall 2004 to Fall 2013, Intermediate Aquifer Zone
- Northern Sacramento Valley Change In Groundwater Elevation Map Change in Deep Fall 2004 to Fall 2013, Deep Aquifer Zone

¹⁵http://www.water.ca.gov/groundwater/data_and_monitoring/northern_region/GroundwaterLevel/gw_level_monitoring.cfm#Level%20Monitoring%20Reports%20and%20Maps

Environmental Commitments

Page 2-12 (also p. A-1) attempts to assure the public that, “Carriage water will be used to maintain water quality standards in the Delta.” With that promise in mind, the Bureau and DWR have a record of violating these standards.¹⁶



Source: California Data Exchange Center, Station OLD.

On what basis should decision-makers or the public rely on the promises made by the Bureau and DWR, let alone the buyer, SLDMWA, which facilitates some of the most destructive practices in California: growing permanent crops in a desert, creating massive amounts of polluted water and soil,¹⁷ and crying foul when the spigot is dry?

Page 2-12 continues with assurances that, “Well reviews and monitoring and mitigation plans will be implemented to minimize potential effects of groundwater substitution on nearby surface and groundwater water resources. Well reviews, monitoring and mitigation plans will be coordinated and implemented in conjunction with local ordinances, basin management objectives, and all other applicable regulations.” The Agencies are asking the public to trust that this will happen and that the mitigation and monitoring plans will be adequate. The public has no mechanism to verify how well this has or hasn’t been handled in the past and isn’t presented with an opportunity for this year. Mitigation and Monitoring Plans must be available concurrently

¹⁶ Strohane chart and table 2014, Salinity Violations at Old River Near Tracy Blvd. August 2006-August 2013.

¹⁷ According to the December 2000 United States Geological Survey Open File Report 00-416, even if irrigation of drainage problem areas were halted today, it would take 63 to 300 years to drain contaminated water from the Western San Joaquin Valley’s aquifer underlying contaminated soils in WWD. The USGS report reiterates the findings in the Rainbow Report [USGS, Gilliom et.al. 1989] that the drainage problem area in 1990 was 450,000 acres. If irrigation continues without a resolution, the problem area will be 950,000 acres in 2040.

with NEPA and CEQA documents, so the public, knowledgeable about the areas where transfer sales are proposed, may evaluate and provide comments on their efficacy. This has been a repeated failure by the Bureau and DWR.

Geology and Soils (2.5.4)

Page 2-17 states, “There are some earthquake faults in the region but earthquakes are generally associated with coastal California, west of the Central Valley.” This casual statement fails to disclose significant history and information that is easily available.¹⁸ The major faults in the region should, at minimum, be disclosed.

VI. Chapter 3 - Environmental Impacts

Biological Resources (IV)

- a) Check list item “a” fails to include the National Marine Fisheries Service (“NMFS”) as a jurisdictional agency over species that may be affected by the Project (p.3-11) although they are referenced in the discussion on pages 3-12 to 3-13. This lack of clarity and consistency contributes to difficulty reviewing the EA/IS.
- b) On page 3-13, the EA/IS continues its discussion to support the finding of *Less Than Significant Impact* for, “[a]ny species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service,” with NMFS excluded as noted above (p.3-11). The EA/IS concludes that, “The incremental effects of transfers on special status fish species in the Delta from water transfers would be less than significant.” What data and analysis support this conclusion and where is the material found? Analysis conducted by Thomas Cannon contradicts the *Less Than Significant Impact* finding with disturbing results from the summer of 2013.¹⁹ His research reveals that summer water transfers are devastating, especially in dry years when the low salinity zone is in the western Delta and smelt are stuck within the Delta and threatened by warm water, which has been made available for transfer by either fallowing or groundwater substitution, and predators,
- c) The Bureau and DWR, not SLDMWA, should prepare an EIR because the Project will likely have significant environmental effects on the Giant Garter Snake (*Thamnophis gigas*) (“GGs”), a listed threatened species under the federal Endangered Species Act and California Endangered Species Act. 40 C.F.R. §1508.27(b)(9).

¹⁸ “Detailed analyses of this seismicity and focal mechanisms indicate that active geologic structures include blind thrust and reverse faults and associated folds (e.g., Dunnigan Hills) within the CRSB boundary zone on the western margin of the Sacramento Valley, the Willows and Corning faults in the valley interior, and reactivated portions of the Foothill fault system. Other possibly seismogenic faults include the Chico monocline fault in the Sierran foothills and the Paskenta, Elder Creek and Cold Fork faults on the northwestern margin of the Sacramento Valley.” http://archives.datapages.com/data/pacific/data/088/088001/5_ps0880005.htm

¹⁹ *Summer 2013: The demise of Delta smelt under D-1641 Delta Water Quality Standards*

The draft EA/IS fails to comprehensively describe or analyze the species, its baseline condition (that should at a minimum start with the CalFed ROD's approval in 2000), movements, habitat requirements, critical habitat, or recovery plan. Is the GGS part of any draft of final HCPs or NCCPs? The Agencies' *Environmental Commitments* are described on pages 2-12 to 2-14 (repeated verbatim in Appendix A) and seem to be the extent of what the Agencies' deem to be their responsibilities under NEPA and CEQA.

We would like to remind the Agencies that flooded rice fields and irrigation canals in the Sacramento Valley can be used by the giant garter snake for foraging, cover and dispersal purposes. The snake gives birth from July to September, months that the Project would be implemented. The Agencies must explain to decision-makers and the public just how the multiple strains of past and Project fallowing and groundwater substitution transfers, cuts in CVP and SWP deliveries, and recently past and existing dry conditions in the area of origin could significantly increase the potential impact to GGS habitat and the species itself. GGS depend on more than only rice fields in the Sacramento Valley.²⁰ "The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of: (1) adequate water during the snake's active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat..." (Id at p. 3) What analysis has occurred that removes GGS from consideration for potential significant impacts? How will the Project affect streams, wetlands, and emergent, herbaceous wetland vegetation? How will it be monitored? Crafting an *Environmental Commitment* to provide Reclamation with "[a]ccess to the land to verify how the water transfer is being made available and to verify that the actions to protect the GGS are being implemented," doesn't pass the blush test (2-13). As AquAlliance has stated repeatedly in previous water transfer comments, an *independent*, third-party monitor, with no financial ties to the Agencies, DWR, or any buyers and sellers is the only acceptable and credible monitor. See AquAlliance comments for the *2010/2011 Water Transfer Program* and the Bureau's *2013 Water Transfer Program*.

Hydrology and Water Quality (IX)

The draft EA does not provide sufficient evidence to support its conclusion that the Project will not have significant hydrological impacts.

- a) The EA/IS lacks detailed information, such as the most basic conditions in the local and regional environment in the area of origin, which has also experienced multi-year dry conditions and significantly lower precipitation. This essential background description is found neither in the *Background* section of Chapter 1 or in this section of Chapter 3, *Hydrology and Water Quality*. Without disclosing current site specific, local, and

²⁰ **Programmatic Consultation with the U.S. Army Corps of Engineers**

404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo Counties, California

regional conditions, it is impossible to evaluate the potential environmental impacts that should be made available to decision-makers and the public before the Bureau reaches a conclusion. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

- b) Item “a” considers if the Project will “Violate any water quality standards or waste discharge requirements?” and concludes that there will be a *Less than Significant Impact*.
- Proposed Action. 1) The EA/IS fails to disclose historic and ongoing degradation of water quality that has been caused by the CVP in the Delta and the SLDMWA import area.²¹²² ²³2) It also fails to consider that groundwater extractions may mobilize PCE, TCE, and nitrate plumes under the City of Chico²⁴ (p.4) or in other Sacramento Valley communities and the potential risks to human health and the environment. The EA/IS fails to even *disclose* the existence of all the hazardous waste plumes in the area of origin where groundwater substitution may occur. These are just more examples of the issues that should be considered and evaluated in an EIS/EIR.
- c) Item “b” discussed on pages 3-27 - 3-42 is considered a *Less than Significant Impact*. There are significant faults with the finding and the material that supports it in the EA/IS.
- No Action Alternative. Why do Figures 3-1, 3-2, and all the hydrographs in Appendix F end at 2002? Extending the timeline and using actual well monitoring data, not simply modeling, would provide valuable information for the Agencies, decision-makers, and the public. Figures 3-1, and 3-2 provide “[b]aseline modeling trends,” but present only a picture of possible groundwater responses when there is genuine historical and current data²⁵ that are ignored. The exercise in modeling actually obfuscates the demonstrable responses that have occurred during all measure of hydrologic conditions.
 - No Action Alternative. “In the Sacramento Valley, reductions in supply have historically resulted in increased groundwater pumping and decreased groundwater levels; however, the water levels have rebounded quickly after the dry period.” This conclusory statement fails to provide the decision-makers and the public with important factual data. For example, a summary of conditions in the Durham area of Butte County find that while water levels may recover after dry periods with intense use, wells aren’t returning to previous levels, but moving

²¹ SWRCB D-1641, “The source of much of the saline discharge to the San Joaquin River is from lands on the west side of the San Joaquin Valley which are irrigated with water provided from the Delta by the CVP, primarily through the Delta-Mendota Canal and the San Luis Unit.” “The USBR, through its activities associated with the in the San Joaquin River Basin, is responsible for significant deterioration of water quality in the Southern Delta.”

²² Drainage Problem area in 1990 was 450,000 acres. If no resolution, problem area will be 950,000 acres in 2040 (Rainbow Report)

²³ If no more irrigation of the western San Joaquin Valley were to occur and the San Luis Drain were completed, it would still take 63-300 years to drain the accumulated Se from the aquifer at a rate of 43,500 lbs./year. (USGS Open File Report 00-416)

²⁴ 2005. California GAMA Program: Groundwater Ambient Monitoring and Assessment Results for the Sacramento Valley and Volcanic Provinces of Northern California

²⁵ <http://www.water.ca.gov/waterdatalibrary/>

steadily in a downward trajectory.²⁶ Additionally, even the Yuba River area, often touted by state and federal agencies as a successful conjunctive use program, takes 3-4 years to recover from groundwater substitution in the south sub-basin²⁷ although the Yuba County Water Agency analysis fails to determine how much river water is sacrificed to achieve the multi-year recharge rate. (pp. 21, 22). More examples of what the EA/IS fails to provide are found in the most current DWR maps listed above in our comments regarding Chapter 2 that demonstrate the serious condition of the groundwater basins in the Sacramento Valley.

- No Action Alternative “Figures 3-1 and 3-2 show baseline groundwater trends (in addition to modeling results for the Proposed Action) at the groundwater table and in the deep aquifer, respectively, in the Sacramento Valley near Sycamore Mutual Water Company.” There is a noticeable absence of information north of Chico on either side of the Sacramento River (recall that Figures 3-3 and 3-4 stop before the northern Butte County line); south and east of Chico east of the Sacramento River in general; and west of Interstate 5. There may not be planned groundwater substitution transfers in some of this area, but that is no reason not to provide tangible data for this part of the common Tuscan groundwater basin. For examples of existing conditions see Table 1 below that is based on data provided by DWR. In addition, grave concern was expressed in the minutes of a December 2013 Glenn County Water Advisory Committee: “The report emphasized that despite the small upward trend in water levels observed on an annual basis in some areas, there is a general decline observable in the long term data across the majority of the region, particularly in the Northwestern portion of Glenn County.”

Table 1. Example of wells of concern in Butte and Tehama counties

3 yrs data multi completion. ~1mile west of Butte Creek Country Club, declining trend http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=24664 http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=24665 http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=24440
3 yrs data multi, ~6miles SW of Chico, declining trend http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=48992 http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=48990 http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=48991
4yr data multi, ~6miles WSW of chico, declining http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=38214 http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=24975 http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=24974

²⁶ Buck, Christina 2014. *Groundwater Conditions in Butte County*.

²⁷ 2012. *The Yuba Accord, GW Substitutions and the Yuba Basin*. Presentation to the Accord Technical Committee.

11 yrs, irrigation, ~8miles NW of Chico, declining trend

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=25770

12 yrs, cana-pine creek, -10'

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=25770

>40 yr data Near 99 and ~6miles E of Corning, dipping below 60' shallow aquifer (valley oak depth)

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=19988

Near Deer Creek ~10miles NE of Corning, 14 years, declining trend, monitoring well multi

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=19993

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=34741

Multi comp monitoring well, ~10miles NE Corning, 14 years, declining below valley oak roots, near deer creek

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=19047

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=19046

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=19045

Multi comp monitoring, 13 yrs, ~8miles SE of Durham, Declining toward valley oak limits if trend continues

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=35608

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=17160

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=17161

~2.5 miles NW of Thermal to Forebay, 14 yrs, 10-20' decline

http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/brr_hydro.cfm?CFGRIDKEY=16799

- No Action Alternative. “Appendix F, Groundwater Modeling Results, contains hydrographs at additional locations throughout the valley.” As noted above, presenting only modeling when historic records exist, conceals factual material and presents a false picture. The Agencies must produce the data from decades of well monitoring to provide a genuine look at the groundwater basins, both the Sacramento *and* Redding, More discussion was presented above.
- No Action Alternative. “The groundwater basin is likely to experience groundwater level declines similar to those that occurred during historic droughts (such as 1976- 1977 and 1987-1992), caused by increased pumping to address reduced surface water supplies. In the San Joaquin Valley, reductions in supply would also lead to increased groundwater pumping, but the groundwater historically has not recovered during subsequent dry years.” (p. 3-27). The EA/IS fails to provide any scientific research and analysis that leads to its conclusory

assertion that conditions in the Sacramento Valley groundwater basins will perform as they did during droughts between 38 and 22 years ago. As in much of California, the population has increased in the Sacramento Valley and the amount of irrigated agricultural has as well, placing greater demands on the groundwater basins. As noted above, the San Joaquin Valley groundwater basins are a casualty of very flawed state and federal policy combined with exuberance to place profit over human health, safety, and the environment.

- Proposed Action. The environmental checklist for Hydrology impacts, at section IX.b, finds that the Project impact to “Substantially deplete groundwater supplies ... such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level” is ‘less-than-significant.’
- This conclusion is, however, the result of failing to proceed in the manner required by law: (1) in assessing the significance of this impact, (2) in developing specific mitigation measures to reduce this impact; (3) in assessing the effectiveness of such mitigation measures; and (4) in adopting such mitigation measures. This conclusion is also unsupported by substantial evidence in the record. In addition, there is substantial evidence that this impact is significant. Therefore, CEQA requires preparation and certification of an EIR and NEPA requires preparation and certification of an EIS before Project approval.
- **The EA/IS fails to discharge the lead agencies' duty to find out and disclose all that they reasonably can. (14 CCR § 14144.)**

With respect to Sacramento Valley groundwater, the EA/IS states: “In the Sacramento Valley, reductions in supply have historically resulted in increased groundwater pumping and decreased groundwater levels; however, the water levels have rebounded quickly after the dry period.” (Page 3-27.) The EA/IS makes this assertion based on modeling results, while ignoring contrary empirical information. For example, a summary of conditions in the Durham area of Butte County find that while water levels may recover after dry periods with intense use, wells aren’t returning to previous levels, but moving steadily in a downward trajectory.²⁸ Significantly more material is found in our comments on the *2013 Water Transfer Program*.

In another example, even the Yuba River area, often touted by state and federal agencies as a successful conjunctive use program, takes 3-4 years to recover from groundwater substitution in the south sub-basin.²⁹ The Yuba River analysis, however, fails to determine how much river water is sacrificed to achieve the groundwater recharge rate mentioned (pp. 21, 22). It is highly likely that the Yuba River becomes a losing stream due to excess use of the groundwater. More examples of what the EA/IS fails to provide are found in the most current DWR

²⁸ Buck, Christina 2014. *Groundwater Conditions in Butte County*.

²⁹ 2012. *The Yuba Accord, GW Substitutions and the Yuba Basin*. Presentation to the Accord Technical Committee.

maps listed above in our comments regarding Chapter 2 that demonstrate the serious condition of the groundwater basins in the Sacramento Valley.

- In short, the EA/ IS fails to disclose all that it reasonably can. "If the local agency has failed to study an area of possible environmental impact, a fair argument may be based on the limited facts in the record. Deficiencies in the record may actually enlarge the scope of fair argument by lending a logical plausibility to a wider range of inferences." *Sundstrom v. County of Mendocino* (1988) 202 Cal.App.3d 296, 311.
- **There is substantial evidence that this impact is significant.**

The EA/IS concedes the Project may cause impacts to the groundwater basin from groundwater substitution transfers, including (1) increased groundwater pumping costs due to increased pumping depth; (2) decreased yield from groundwater wells due to reduction in the saturated thickness of the aquifer; (3) decrease of the groundwater table to a level below the vegetative root zone, which could result in environmental effects; and 4) third-party impacts to neighboring wells. (P. 3-29.) But the EA/ IS deems these impacts less-than-significant. In a confusing twist, however, the EA/ IS concedes there are uncertainties surrounding how this Project will affect specific locations, stating: "uncertainty of how groundwater levels could change, especially during a very dry year," in the Redding basin (p. 3-30) and "[t]he model results may not reflect all specific local conditions throughout the Sacramento Valley" (p. 3-37); and that, as a result, mitigation measures will be employed, stating: "Therefore, minimization measures described below would include development of monitoring and mitigation plans to monitor and address potential groundwater level changes that could affect third parties or biological resources." (P. 3-37.)
- This is confusing because the agencies cannot require mitigation measures unless impacts are deemed significant. (See e.g., 14 CCR § 15041(a).) This gives rise to an inference that the Project may cause these impacts to be significant, thus requiring an EIS/EIR.
- Further, the EA/IS unlawfully defers the development of specific mitigation measures until after project approval because there is no basis for assuming they will be effective, there are no objective criteria to judge whether they are successful in avoiding significant impacts, and nothing about them is definitive enough to be enforceable. In short, there is no reason to assume the "minimization measures" and the mitigation and monitoring plans that the EA/IS references will reduce these impacts to "less-than-significant"
- Proposed Action. The Redding Groundwater Basin discussed on pages 3-29 to 3-30 is not included in Figures 3-3 and 3-4. SacFEM modeling may not have been done for the Redding Groundwater Basin, but it would have been beneficial for readers to have the entire area of origin depicted in the only maps provided for the Project.

- Proposed Action. In addition, the Anderson Cottonwood Irrigation District (“ACID”) that is located in the Redding Groundwater Basin is going at the groundwater substitution transfers somewhat blind. It has not benefited from any modeling, but has instead, “[t]ested operation of these wells in the past at similar production rates and has observed no substantial impacts on groundwater levels or groundwater supplies (Anderson-Cottonwood ID 2013).” In attempting to review the reference from p. 5-1 for the: *Initial Study and Proposed Negative Declaration for Anderson-Cottonwood Irrigation District’s 2013 Water Transfer Program*. Available at: <http://www.andersoncottonwoodirrigationdistrict.org/library.html> or at: http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=13310, we found that the only environmental documents at the ACID web site relate to a 2011 Bureau EA/FONSI for the *Anderson-Cottonwood Irrigation District Integrated Regional Water Management Program – Groundwater Production Element Project* and the Bureau’s web site is for the EA/FONSI for the 2013 Water Transfer Program. The public has been obstructed from reviewing the referenced material to evaluate the efficacy of the findings in the Bureau/SLDMWA EA/IS that, “[g]roundwater substitution transfers are unlikely to have significant effects on groundwater levels.” (p. 3-30).
- Proposed Action. Table 3-8 fails to include ACID and Tule Basin Farms in the table. The last three listed *Potential Sellers* are not listed in alphabetical order with the other possible sellers.
- Proposed Action. Groundwater/Surface Water Interaction. The EA/IS acknowledges the potential for impacts and assumes a “[1]2 percent depletion factor to prevent any adverse impacts associated with surface water-groundwater interaction...” (p.3-39) This number is not supported with any documentation or analysis and runs counter to modeling done by CH2M HILL in a memo to DWR in 2010. “The effect of groundwater substitution transfer pumping on stream flow, when considered as a percent of the groundwater pumped for the program, is significant. The impacts were shown to vary as the hydrology of the periods following the transfer program varied. The three scenarios presented here estimated effects of transfer pumping on stream flow when dry, normal, and wet conditions followed transfer pumping. Estimated stream flow losses in the five-year period following each scenario were 44, 39, and 19 percent of the amount of groundwater pumped during the four month transfer period.”³⁰ Even with this modeling information in hand since 2010, the Agencies and DWR continue to use a 12 percent deduction for stream flow. The results of the model run are the best predictions available to date and suggests caution above all else, even though they are preliminary and the model subject to modification.³¹ By adhering to a 12 percent loss for stream flow, it is clear that the Bureau, SLDMWA, and DWR are

³⁰ Lawson 2010. *Groundwater Substitution Transfer Impact Analysis, Sacramento Valley*.

³¹ WRIME 2011. *Peer review of Sacramento valley Finite Element Groundwater Model (SacFEM)*

not erring on the side of caution and may be causing considerable legal injury to other users and the environment.

- The base map for Figures 3-3 and 3-4 lacks clarity. It is difficult to discern the approximate locations of wells # 1 through 6, 9, 15, 16, 19, 20, 21, 22, 28, and 30.
- This Project is part of serial, so-called “temporary” water transfers³² and is also part of a much larger Program that was introduced by the Agencies on page 1-4, *Long Term Water Transfers*. As noted above, the Project and the *Long Term Water Transfers* reach back much further and are components of the following programs, plans, and studies:
 - i. CalFed Bay-Delta Program, Record of Decision (August 2000)
 - ii. Sacramento Valley Water Management Agreement (Phase 8), (October 2001)
 - iii. Sacramento Valley Integrated Regional Water Management Plan (2006)
 - iv. Sacramento Valley Regional Water Management Plan (January 2006)
 - v. Stony Creek Fan Conjunctive Water Management Program
 - vi. Draft Initial Study for 2008-2009 Glenn-Colusa Irrigation District Landowner Groundwater Well Program
 - vii. Regional Integration of the Lower Tuscan Groundwater Formation into the Sacramento Valley Surface Water System Through Conjunctive Water Management (June 2005) (funded by the Bureau)
 - viii. Stony Creek Fan Aquifer Performance Testing Plan for 2008-09
 - ix. Annual forbearance agreements (2008 had an estimated 160,000 acre feet proposed).
 - x. The Delta Stewardship Council’s Plan and EIR approved in 2013.
 - xi. The Bay Delta Conservation Plan and EIS/EIR currently out for public review and comment.
- **Proposed Action. Land Subsidence.** The first paragraph on subsidence on page 3-39 is actually a useful summary of the hazards presented by the Project. The subsequent material also highlights the potential significant, adverse impacts, such as:
 - i. “Land subsidence has not been monitored in the Redding Groundwater Basin. However, there would be potential for subsidence in some areas of the basin if groundwater levels were substantially lowered. The groundwater basin west of the Sacramento River is composed of the Tehama Formation; this formation has exhibited subsidence in Yolo County and the similar hydrogeologic characteristics in the Redding Groundwater Basin could allow subsidence.”

³² AquAlliance 2014. *Past Water Transfers from the Sacramento Valley Through the Delta*.

- ii. Most areas of the Sacramento Valley Groundwater Basin have not experienced land subsidence that has caused impacts to the overlying land. However, portions of Colusa and Yolo counties have experienced subsidence; historically land subsidence occurred in the eastern portion of Yolo County and the southern portion of Colusa County, owing to groundwater extraction and geology. As much as four feet of land subsidence due to groundwater withdrawal has occurred east of Zamora over the last several decades.

The EA/IS then concludes that there will be a *Less Than Significant Impact* by using the “guidance” set forth in the *DRAFT Technical Information for Preparing Water Transfer Proposals* (Bureau and DWR 2013) and Addendum (Bureau and DWR 2014) to, “[m]inimize potential effects to other legal users of water; to provide a process for review and response to reported third party effects; and to assure that a local mitigation strategy is in place prior to the groundwater transfer.” In addition, “Reclamation’s transfer approval process and groundwater minimization measures set forth a framework that is designed to avoid and minimize adverse groundwater effects. Reclamation will verify that sellers adopt these minimization measures to minimize the potential for adverse effects related to groundwater extraction.”

Even if minimizing subsidence is possible in the Sacramento Valley where groundwater substitution is planned, which we will argue it is not (see below), minimizing an impact is not *avoiding* an impact. The mere acknowledgment that minimizing will be necessary to avoid potentially adverse impacts, points once again to the need for an EIS/EIR. The EA/IS, the *Draft Technical Information for Water Transfers* in 2013, and the 2014 Addendum don’t appear to weigh the significance of avoidance of impacts, pre-Project mitigation, during-Project mitigation, or post-Project mitigation. This fails to create objective standards and merely defers responsibility to the “willing sellers,” a broadly unsuspecting public, and a voiceless environment.

There is substantial evidence that this impact is significant.

As noted above, the EA/IS concedes the Project may cause land subsidence impacts in both the Redding Groundwater Basin, where it says previous subsidence has not been a problem (p. 3-39), and the Sacramento Groundwater Basin (p. 3-40), where it says previous subsidence from groundwater pumping has been a problem.

Regardless of these different histories, both are purportedly required to develop so-called mitigation and monitoring plans to deal with the assessment of whether pumping will cause significant subsidence and to develop mitigation measures to reduce this impact.

Again, because agencies cannot require mitigation measures unless impacts are deemed significant, this requirement indicates the Project may cause significant subsidence impacts, thereby requiring an EIS/EIR.

Further, the EA/IS unlawfully defers the assessment of whether pumping will cause significant subsidence. The EA/IS unlawfully defers the development of mitigation measures to reduce this impact until after project approval, but there is no basis for assuming they will be effective, there are no objective criteria to judge whether they are successful in avoiding significant impacts, and nothing about them is definitive enough to be enforceable. In short, there is no reason to assume the “minimization measures” and the mitigation and monitoring plans that the EA/IS references will reduce this impact to "less-than-significant"

The following evidence, however, demonstrates that the Project's subsidence impacts may be significant. AquAlliance has provided expert opinion on the issue of subsidence monitoring repeatedly during past water transfer environmental review. Despite its credibility, the findings of Dr. Kyran Mish, Presidential Professor, School of Civil Engineering and Environmental Science at the University of Oklahoma, have been ignored. Dr. Mish relates: “It is important to understand that *all* pumping operations have the potential to produce such settlement, and when it occurs with a settlement magnitude sufficient enough for us to notice at the surface, we call it *subsidence*, and we recognize that it is a serious problem (since such settlements can wreak havoc on roads, rivers, canals, pipelines, and other critical infrastructure).”³³ Dr. Mish further explains that “[b]ecause the clay soils that tend to contribute the most to ground settlement are highly impermeable, their subsidence behavior can continue well into the future, as the rate at which they settle is governed by their low permeability.” *Id.* “Thus simple real-time monitoring of ground settlement can be viewed as an *unconservative* measure of the potential for subsidence, as it will generally tend to underestimate the long-term settlement of the ground surface.” *Id.* (emphasis added).

- Proposed Action. The environmental checklist for Hydrology impacts, at section IX.d, finds "No Impact" with respect to, “Substantially alter the existing drainage pattern of the site or area” is "Not Significant." But the text of the EA/IS contradicts this check box, and finds that Project could have land subsidence impacts that could "alter drainage patterns" (pp. 3-39-3-40.). By sowing confusion rather than clarity, the EA/IS fails to inform.

This conclusion is, however, the result of failing to proceed in the manner required by law: (1) in assessing the significance of this impact, (2) in developing specific mitigation measures to reduce this impact; (3) in assessing the effectiveness of such mitigation measures; and (4) in adopting such mitigation measures. This conclusion is also unsupported by substantial evidence in the record. In addition, there is substantial evidence that this impact is significant.

³³ Mish, Kyran 2008. *Commentary on Ken Loy GCID Memorandum*. White Paper. University of Oklahoma.

Therefore, CEQA requires preparation and certification of an EIR and NEPA requires preparation and certification of an EIS before Project approval.

Minimization Measures (pp. 3-40, 3-41)

The *Draft Technical Information for Water Transfers* in 2013 and the 2014 Addendum contain *minimal* objectives and requirements elements of the monitoring and mitigation component of the Project. “Water transfer proponents transferring water via groundwater substitution transfers must establish a monitoring program capable of identifying any adverse transfer related effects before they become significant.” However, the reader (and possibly the sellers) are left wondering what exactly is “a monitoring program capable of identifying any adverse transfer related effects before they become significant,” since there are no standards or particular guidance to manage and analyze the very complex hydrologic relationships internal to groundwater and the connection to surface waters.

Certainly the public has no idea or ability to comment, which fails the full-disclosure mandate in NEPA and CEQA. Page 38 of the *Draft Technical Information for Water Transfers* in 2013 briefly lists “Potentially significant impacts identified in a water transfer proposals [that] must be avoided or mitigated for a proposed water transfer to continue, including:

- Contribution to long-term conditions of overdraft;
- Dewatering or substantially reducing water levels in nonparticipating wells;
- Degradation of groundwater quality that substantially impairs beneficial uses or violates water quality standards; and
- Affecting the hydrologic regime of wetlands and/or streams to the extent that ecological integrity is impaired.

The *Draft Technical Information for Water Transfers* in 2013 continues with suggestions to curtail pumping from lower bowls and pay higher energy costs to ease the impacts to owners of third-party wells (p. 38-39). While this bone thrown at mitigation is appreciated, the glaring omissions are notable. The *Draft Technical Information for Water Transfers* in 2013 completely fails to mention, even at a very general level, how individual well owners who may be harmed by the Project, will determine and prove where the impacts to their wells are coming from and that water quality and health could become a significant impact for impacted wells, users, and streams. The onus for coping with and disclosing potential impacts is deflected onto the nonparticipating public, species, and environment. How does this meet the requirements of NEPA and CEQA? Since wetlands and streams would require human observation or adequate monitoring to report an impact, how will, “Affecting the hydrologic regime of wetlands or streams to the extent that ecological health is impaired,” be avoided or mitigated without standards and requirements from the Bureau and DWR? (*Draft Technical Information for Water Transfers* p. 38) There also appears to be no consideration for species monitoring, just “practices” or “conservation measures” to “minimize impacts to terrestrial wildlife and waterfowl,” (*Id* pp. 16, 20, 22-24).

Another example of the inadequacy of the proposed monitoring is that the draft EA/IS fails to include any coordinated, programmatic plan to monitor stream flow of creeks and rivers located in proximity to the “willing sellers” that will evacuate more groundwater than has been used

historically. The potential for immediate impacts would be very close to water sellers' wells, but the long term impacts could be more subtle and geographically diverse. What precautions has the Bureau and DWR made for the cumulative impacts that come not only from this one-year Project, but in combination with the water sales from the last dozen years and those that are planned by the Bureau into the future (see list in g, iv below)? Bureau and DWR water transfers are not just one- or two-year transfers, but many serial actions in multiple years by the agencies, sellers, and buyers without the benefit of comprehensive environmental analysis under NEPA and CEQA.

As discussed above, adequate monitoring is vital to limit the significant risks posed by the Project to the health of the region's groundwater, streams, and fisheries (more discussion below). Moreover, to the extent this Project is conceived as an ongoing hardship program that will provide knowledge for future groundwater extraction and fallowing, its failure to include adequate monitoring protocols is even more disturbing and creates the risk of significant long-term, perhaps irreversible impacts from the Project.

One glaring omission in the EA/IS is the failure to disclose that the Project, when implemented under the State Water Resources Control Board's ("SWRCB") Temporary Urgency Change Petition Order(s), will exacerbate impacts in the area of origin, which is already suffering from dry conditions. Mismanaging storage in Shasta and Oroville dams, either intentionally or incompetently in the past three years (see above), created a scenario where the federal and state agencies plead hardship to some of the most senior water rights holders in California. Potentially cutting senior SWP contractors to 50 percent and senior CVP contractors to 40 percent allocations (EA/IS p. 2-2), portends dire consequences for local and regional groundwater that would not have been necessary without failures by the federal agency circulating this EA/IS and the 'hidden' state agency that should be the lead agency for the Project: DWR.³⁴

Mandatory Findings of Significance (XVIII)

The EA/IS fails to disclose that the Project is likely to have a cumulatively significant impact on the environment (p. 3-53). In assessing the significance of a project's impact, the Bureau must consider "[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." 40 C.F.R. §1508.25(a)(2). A "cumulative impact" includes "the impact on the environment which results from the incremental impact of the action when added to *other past, present and reasonably foreseeable future actions* regardless of what agency (Federal or non-Federal) or person undertakes such other actions." *Id.* §1508.7. The regulations warn that "[s]ignificance cannot be avoided by terming an action temporary or by breaking it down into small component parts." *Id.* §1508.27(b)(7).

An environmental impact statement should also consider "[c]onnected actions." *Id.* §1508.25(a)(1). Actions are connected where they "[a]re interdependent parts of a larger action and depend on the larger action for their justification." *Id.* §1508.25(a)(1)(iii). Further, an

³⁴ <http://calsport.org/news/wp-content/uploads/St-Bd-Drought-Wkshp.pdf>

environmental impact statement should consider “[s]imilar actions, which when viewed together with other *reasonably foreseeable or proposed agency actions*, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography.” *Id.* §1508.25(a)(3).

Here, as detailed below, instead of assessing the cumulative impacts of the proposed action as part of the larger program that even the Bureau has at least twice recognized should be subject to a programmatic EIS (but for which no programmatic EIS has been completed), the Bureau again attempts to break this program into component parts and approve it through an inadequate EA and has joined with the improper CEQA lead agency to play lip service to CEQA. Further, the Bureau has failed to take into account the cumulative effects of other groundwater and surface water projects in the region, the development of “conjunctive” water systems, and the planned integration of Sacramento Valley groundwater into the state water system.³⁵

The draft EA/IS briefly mentions that the Project is part of the *Long-Term Water Transfers* (p. 1-4). However, it fails to adequately describe that Program and how the Project relates to the Program, and further fails to describe the numerous other programs of which this Project is a small component part (see list of programs, plans, and studies above in section VI). It is clear that this Project is an “interdependent part of a larger action,” and that it “depend[s] on the larger action for [its] justification.” 40 C.F.R. §1508.25(a)(1)(iii). This is exactly the sort of segmentation that NEPA prohibits. Instead, NEPA requires that “[p]roposals or parts of proposals which are related to each other closely enough to be, in effect, a single course of action shall be evaluated in a single impact statement.” 40 C.F.R. §1502.4.

- Item “a” asserts that the proposed Project would have a *Less Than Significant* impact to all species within the region and local areas of water transfer is without any apparent scientific basis. (EA/IS p. 3-54). This conclusory assertion certainly does not constitute sufficient analysis of the potential impact of the Project on endangered, threatened, or special status species as described above. At a minimum, such conclusions rely on an improperly segmented and overly narrow view of the proposed action, which does not consider the larger project (p. 1-4) as described above or the cumulative impacts as also described above.

³⁵ *U.S. Bureau of Reclamation September 2006. Grant Assistance Agreement with Glenn Colusa Irrigation District.* "GCID shall define three hypothetical water delivery systems from the State Water Project (Oroville), the Central Valley Project (Shasta) and the Orland Project reservoirs sufficient to provide full and reliable surface water delivery to parties now pumping from the Lower Tuscan Formation. The purpose of this activity is to describe and compare the performance of three alternative ways of furnishing a substitute surface water supply to the current Lower Tuscan Formation groundwater users to eliminate the risks to them of more aggressive pumping from the Formation and to optimize conjunctive management of the Sacramento Valley water resources."

VII Conclusion

The 2014 water transfer Project clearly has the potential to affect the human and natural environments, both within the Sacramento Valley as well as in the areas of conveyance and delivery. It is entirely likely that injuries to other legal users of water will occur, including those entirely dependent on groundwater in the Sacramento Valley, if this project is approved. Groundwater, groundwater basins, and aquatic and terrestrial habitat that are essential for fishery and wildlife resources are also likely to suffer great harm. And the economic effects of the proposed Project are at best poorly disclosed and will reverberate through the communities in the Sacramento Valley.

Taken together, the Bureau, SLDMWA, and DWR treat these serious issues carelessly in the EA/IS, the *Draft Technical Information for Water Transfers in 2013*, the 2014 Addendum, and in DWR's specious avoidance of acting as the CEQA lead agency. In so doing, the Agencies and DWR deprive decision makers and the public of their ability to evaluate the potential environmental effects of this Project and violate the full-disclosure purposes and methods of both the National Environmental Policy Act and the California Environmental Quality Act.

Sincerely,



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Comments on:

LONG TERM TRANSFERS EIR/EIS REVIEW OF EFFECTS ON SPECIAL STATUS FISH

1. INTRODUCTION

Long term transfers represent Reclamation and San Luis Delta Mendota Water Authority's ability to move water from north of the Delta to south of the Delta using its Central Valley Project storage, conveyance, and export facilities, and associated authorities. The EIS/EIR describes the details and effects of Reclamation's actions to carry out such transfers. Water for transfers would come from stored and saved water north of the Delta that would be delivered in summer south of the Delta. The amount of water proposed for transfer by Reclamation could be up to 600,000 af (Federal Register and EIS/EIR at p. 1-5), but is likely to be over 200 thousand acre-ft. Reclamation's EIS/EIR covers myriad proposed transfers. Some additional proposed State transfers are addressed in the EIS/EIR cumulative impacts assessment.

CSPA has undertaken a review of transfers and the EIS/EIR effects analysis on special status fish species. The species addressed include Chinook salmon, Steelhead, Green and White sturgeon, and Longfin and Delta smelt. These fish all depend on Central Valley river and Delta flows and habitats for portions of their life cycles. A summary of this review is presented in this report.

2. SUMMARY OF CSPA COMMENTS ON SECTION 3.7

A. Effects of Transfers

1. Change in timing and amount of river flows

Table C2 shows that summer Delta inflows from the Sacramento River in dry and critical water years may increase by several thousand cfs to accommodate transfer Delta exports. With non-CVP transfers the total change is not inconsequential. With minimum river flows of 3000-5000 cfs, transfers can double river flow and Delta inflow in summer of drier years when reservoir levels are low and water deliveries are cut back. **Holding Delta outflow near minimum and nearly doubling inflow and exports warms the Delta, increases loss of Delta fishes to export pumps, and degrades freshwater and low salinity zone habitat. For more discussion of this effect see Attachments A and B.**

River flows in winter can be lower by 10-20% in dry years as previous year's transfer releases are made up by reservoir water retention. Rivers flows may be reduced by

over 1000 cfs although usually in higher precipitation months. **The refill of reservoirs the year after summer transfers reduces winter river flows and Delta inflow. The effect is greatest in drier years when river flows and reservoir releases are at a minimum. These indirect winter effects though not as dramatic as direct summer transfer effects have consequences to drier year winter river rearing and migration habitat of salmon and smelt.**

Overall effects from flow changes:

- **Significant negative effect on winter run salmon: (1) young rearing in lower Sacramento River in summer, (2) smolt migration in winter, (3) adult upstream migration in winter.**
- **Significant negative effect on delta smelt: (1) young rearing in the Delta in summer of drier years, (2) adults migrating upstream into Delta during winter.**

2. Changes in Delta Exports

Tables C8 and C9 show expected increases in drier year summer exports in the range of 20-60% from CVP transfers. With non-CVP transfer exports of similar magnitude, total drier year exports are near double or even more in critical years like 2014. **Higher exports increase entrainment and salvage losses of fish and degrade Delta rearing habitat (higher water temperatures, lower turbidity, and lower primary and secondary production).**

Overall effects from export increases in summer:

- **Significant negative effect on delta smelt: (1) from increased entrainment of young rearing in the Delta in summer of drier years, (2) from degradation of rearing habitat of young.**

3. Changes in water source

Water released from reservoirs for transfers in summer is not the same water exported from the Delta. Exports from the South Delta in summer of drier years typically take the cooler, slightly brackish, productive upper low salinity zone that has been in residence in the Delta for some time. The exported water includes nearly all the higher productivity water of the San Joaquin River that enters the Delta. Exported water is replaced by reservoir water including that released for transfers. The added reservoir water in higher Delta inflows degrades Delta habitat with fresher, warmer, clearer water.

Overall effects from changes:

- **Significant negative effect on delta smelt from degradation of rearing habitat of young in north, south, and west Delta, and eastern Suisun Bay.**

4. Changes in reservoir storage

As it may take several years or more to replace reservoir water released for transfers, reservoir storage is depleted by transfers in multiyear droughts. Reservoir depletion

over several years may reach 500,000 ac-ft or more total. Long term droughts already deplete reservoirs to the point of affecting cold water pools and winter-spring releases that benefit fish especially in droughts. Storage releases in the summer of 2014 were in fact higher than planned or believed needed to sustain transfers, other water demands, and outflow and water quality requirements. Thus the true effect of transfers on reservoir storage is unknown.

Reductions in cold water pools can lead to (1) adult salmon being susceptible to diseases from warm water, (2) delays in salmon spawning, (3) reduced survival of eggs and embryos, (4) lower young survival during rearing, and (5) and delays and lower survival of smolts during emigration.

Overall effects from reservoir storage reductions:

- **Significant negative effect on winter run salmon in multiyear droughts: (1) young rearing in lower Sacramento River in summer, (2) migrating smolts in winter, (3) eggs and embryos in summer, and (4) adults from lower winter attraction flows in multiyear droughts.**

B. Cumulative Effects

We believe the addition of water transfers places significant added burden on the special status fish species over that already imposed by climate change, drought, increasing water supply use, record-high Delta diversions, increasing demands on surface and groundwater, as well as increased demand forecasted under the BDCP. The EIS fails to address these factors, although it does mention the potential of added effects from other Central Valley transfers through the Delta (i.e., by State Water Project and non-project water) not covered by the EIS. The EIS acknowledges these effects, but simply states that the added and cumulative effects are insignificant without any analyses as to whether the severely depressed populations and habitats of special status species are potentially affected by the added stress. Based on our assessment of cumulative effects, significant added stresses would occur on the fish and their habitats:

1. Winter Run Salmon

The cumulative effects of the above stresses with addition of water transfers will put winter-run in continuing jeopardy and inhibit their recovery. Transfers reduce reservoir storage in multiyear droughts as transfer storage releases cannot be made up until wet years again occur. Low storage limits the amount of Shasta Reservoir cold water pool to sustain winter run through summer spawning, incubation, and rearing. Continuing low fall releases limits the extent of rearing habitat and early emigration cues. Higher August and September flows from reservoir transfer releases may improve early rearing habitat in the upper Sacramento River near Redding, but may also deplete the cold-water pool and send emigration cues that may push young into warmer portions of the lower Sacramento River. Low storage levels in multiyear droughts limit the available water for storage releases in winter to sustain young emigration and upstream adult migration through the Delta and Bay to and from the Pacific Ocean.

2. *Spring and Fall Run Salmon*

Lower river flows in winter and spring in drier years would effect downstream emigration success of fry to the Delta. Poor dry year Delta rearing habitat would be further degraded by lower Delta inflows. High late summer transfers would encourage early migrations and maturation of adult fall run only to subsequently be subjected to lower fall flows and higher water temperatures.

3. *Delta Smelt and Longfin Smelt*

Adult migration and spawning success would be negatively affected by lower Delta winter and spring inflows in multiyear droughts. Lower Delta inflow in late winter and springs of multiyear droughts will reduce survival of young smelt. Higher summer Delta inflows will reduce survival of rearing pre-adult smelt in the Delta from degradation of the low salinity zone and direct and indirect losses to higher Delta exports.

C. Are the Effects of Transfers Unreasonable?

Reclamation argues that the effects of transfers are not “unreasonable”. Their main argument is that the BOs state that planned summer transfers up to 600,000 ac-ft would not constitute jeopardy, and that NMFS and USFWS have “OK’d” individual transfers in summer 2014 and past years. The facts are that winter-run salmon and delta smelt populations have further declined significantly since the BOs were prepared. Based on the present situation after two recent periods of drought (6 of last 8 years being dry or critical) we believe the predicted added stress of the whole array of planned transfers is an unreasonable threat to listed salmon and smelt.

D. Reasonableness of Reclamation’s Assessment in EIS

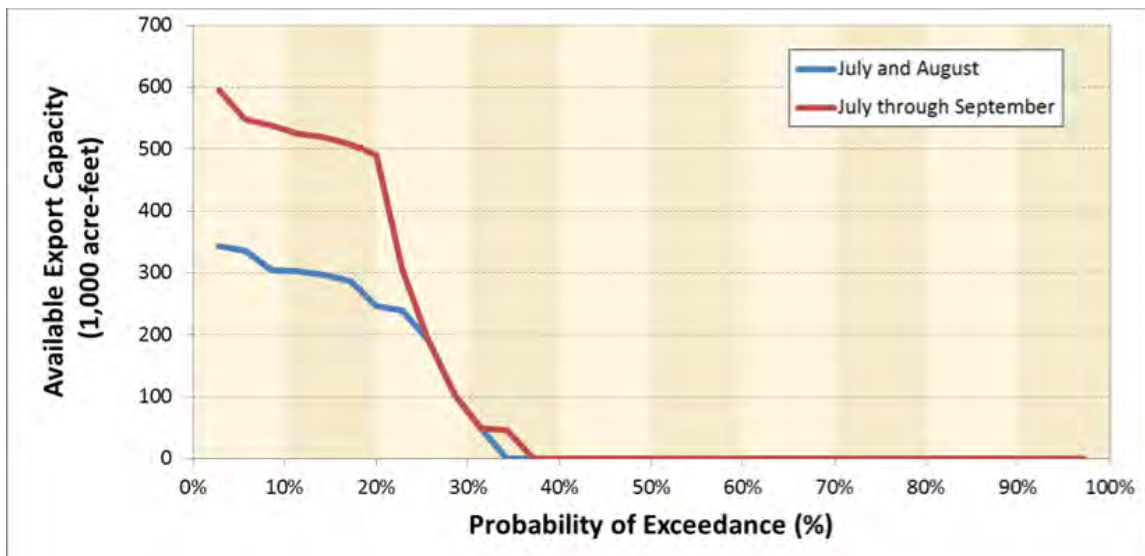
As shown in Tables 2-9 and 2-10, the Proposed Action in Reclamation’s opinion would not have any significant, unavoidable adverse impacts. From our review the proposed transfers have significant potential effects that are avoidable. Our review shows that potential effects are greatest in multiyear droughts when listed fish are already under maximum stress. Many of the most significant effects can be avoided by limiting transfers in the second or later years of drought. A more detailed review might yield specific criteria or rules that would allow some transfers to occur under certain circumstances. If transfers cannot be avoided, then other types of restrictions on water supply storage or deliveries could be considered to reduce effects of transfers and risks to the listed species.

E. Flaws in Reclamation’s Assessment

Major flaws in Reclamation’s assessment are as follows:

- 1) Reclamation assumes delta smelt are not found in the Delta in the summer transfer season, when in fact during dry and critical years when transfers would occur most if not all delta smelt are found in the Delta (see Attachments A and B).

- 2) Reclamation downplays the potential total amount of all transfers, when in fact the capacity exists for transfer amounts up to 600,000 ac-ft (see EIS/EIR CHART BELOW). *“The “up to” amount of transfer water that could be made available in any year is approximately 473,000 acre-feet. However, it is unlikely that this amount of water could be transferred in any year due to Delta regulatory and other constraints.”* (Source: http://www.usbr.gov/mp/PA/water/docs/2014_water_plan_v10.pdf)
- 3) Reclamation has not assessed the effect on Delta habitat in terms of water temperature, turbidity, and location of the Low Salinity Zone.
- 4) Reclamation has failed to address population level effects on listed fish.
- 5) Reclamation has failed to follow the State Board’s recommendation: *““The key is to follow the water, not the agreements. Focus on the source of the actual water moving to the transferee. This is the water being transferred and will guide the types of changes in water rights that may be needed.”* (p 10-3 of SWRCB Guide to Water Transfers.). Reclamation has failed to identify that the water they divert for transfer in the Delta is not the water released upstream for transfer.
- 6) Reclamation has failed to assess the cumulative effects on listed fish in multi-year droughts and the consequences of adding transfers on top of emergency drought actions designed to save storage by reducing water demands, exports, and relaxing water quality standards. Reclamation failed to mention its own requests to the State Board for Temporary Urgency Changes in 2013 and 2014 including provisions to exempt transfers from the TUCs that allowed lower Delta outflow and higher salinities in the Delta in summer 2014. Neither BO allowed for transfers under these conditions.



F. Reclamation has not followed its own rules

1. • *Transfer may not cause significant adverse effects on Reclamation's ability to deliver CVP water to its contractors.*

In 2014 Reclamation had to release more water than expected to meet export demands including transfers. The unplanned release of "extra" Shasta and Folsom storage water adversely affects Reclamation's ability to meet its contractual demands and permit requirements. For example, North-of-Delta contractors were initially threatened with a 40 percent allocation that was later changed to 75 percent delivery.

2. • *Transfer will be limited to water that would be consumptively used or irretrievably lost to beneficial use.*

Water diverted from the Delta is not water that would be consumptively used; it is water that would have eventually move to San Francisco Bay.

3. • *Transfer will not adversely affect water supplies for fish and wildlife purposes.* Transfers results in storage levels lower than predicted, which limit cold-water pools and the ability to maintain downstream "fish flows".

4. • *Transfers cannot exceed the average annual quantity of water under contract actually delivered.*

The amount of CVP storage necessary to meet transfer export demands may be double the contracted amount.

G. Comments on Impact Statements in the EIR/EIS

1. *"Water supplies on the rivers downstream of reservoirs could decrease following stored reservoir water transfers, but would be limited by the refill agreements".* The whole subject of "refill agreements" is not adequately covered by Reclamation. The fact that it may take several years or more to refill is a significant effect not addressed.
2. *"Water transfers could change reservoir storage in CVP and SWP reservoirs and could result in water quality impacts."* No information as to the specific effects on Shasta, Trinity, or Folsom reservoir storage or downstream tailwater flows was provided.
3. *"Water transfers could change reservoir storage non-Project reservoirs participating in reservoir release transfers, which could result in water quality impacts."* The effect on reservoir and tailwater water quality in non-refill years of multiyear droughts was not addressed.
4. *"Water transfers could change river flow rates in the Seller Service Area and could affect water quality."* Effects on specific rivers and reaches were not addressed.

5. *“Water transfers could change Delta outflows and could result in water quality impacts.” “Water transfers could change Delta salinity and could result in water quality impacts.”* Specific effects on Delta water temperature, salinity, and turbidity in drought years like 2014 were not addressed.
6. *“Transfer actions could alter hydrologic conditions in the Delta, altering associated habitat availability and suitability”* Specific effects of transfers on Delta hydrology in drought years like 2014 were not addressed.

H. Specific Comments on Cumulative Impact Assessments in the EIR/EIS

“The cumulative analysis evaluates potential SWP transfers, but they are not part of the action alternatives for this EIS/EIR.” Given the difficulty of separating these actions and their effects, and that other environmental assessments and biological opinions address joint actions, we see no reason to not address the joint action of transfers through the Delta in this EIR/EIS, especially given the following EIR/EIS statement: *“Most of the pumping capacity available would be at the Banks Pumping Plant except for very dry years. Banks is an SWP facility, so SWP-related transfers would have priority. Agreements with DWR would be required for any transfers using SWP facilities.”*

Note: In 2013, DWR facilitated about 265 thousand acre-feet of water transfers through State Water Project facilities, nearly double the amount anticipated for CVP transfers.

http://www.water.ca.gov/watertransfers/docs/2014/Transfer_Activities_v11.pdf

I. Specific Comments on Section 3.7 Fisheries

1. *“Water transfers, which would occur from July through September, would coincide with the spawning period of winter-run Chinook salmon. However, spawning occurs upstream of the areas potentially affected by the transfers. Due in part to elevated water temperatures in these downstream areas during this period, emigration would be complete before water transfers commence in July.”* P3.7-12

Water transfers also come from Shasta storage releases. Downstream emigration of fry from spawning reaches near Redding commences in July and continues through September.

2. *“Summer rearing of CV steelhead would overlap with water transfers occurring in the Selder Service Area (July-September), both in the Sacramento and San Joaquin River and their tributaries (see specific tributaries listed above). Thus water*

transfers have the potential to affect steelhead. The majority of rearing, however, would occur in the cooler sections of rivers and creeks above the influence for the water transfers.” P3.7-14. The “majority” of rearing occurs in tailwaters, which would be affected by transfers (e.g., the lower American River tailwater below Folsom Reservoir).

3. *“ (Delta smelt) Larvae and juveniles are generally present in the Delta from March through June. Delta smelt have typically moved downstream towards Suisun Bay by July because elevated water temperatures and low turbidity conditions in the Delta are less suitable than those downstream (Nobriga et al. 2008). Some delta smelt reside year-round in and around Cache Slough (Sommer et al. 2011). Delta smelt in Suisun Bay and Cache Slough would be outside of the influence of the export facilities.” P3-7-16. In dry and critical years, delta smelt reside primarily in the Delta in summer in the direct path of water moving across the Delta to South Delta export pumps (see Attachments A and B for details).*
4. Consistency of Section 3.7 with the provisions of the California Environmental Quality Act (CEQA) and the CEQA Guidelines. Section 3.7 concludes that all effects are less than significant (e.g., p37-37). Using CEQA criteria - *An alternative would have a significant impact on fisheries resources if it would:*
 - a. *Cause a substantial reduction in the amount or quality of habitat for target species. YES*
 - b. *Have a substantial adverse effect, such as a reduction in area or geographic range, on any riverine, riparian, or wetland habitats, or other sensitive aquatic natural community, or significant natural areas identified in local or regional plans, policies, regulations, or by CDFW, NOAA Fisheries, or USFWS that may affect fisheries resources. YES*
 - c. *Conflict with the provisions of an adopted HCP, NCCP, or other approved local, regional, or state habitat conservation plan. YES (Delta Water Quality Control Plan)*
 - d. *Cause a substantial adverse effect to any special-status species, – Have a substantial adverse effect, either directly or through habitat modifications, on any endangered, rare, or threatened species, as listed in Title 14 of the California Code of Regulations (sections 670.2 or 670.5) or in Title 50, Code of Federal Regulations. A significant impact is one that affects the population of a species as a whole, not individual members. YES (WINTER RUN, DELTA SMELT)*
 - e. *Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW, NOAA Fisheries, or USFWS, including substantially reducing the number or restricting the range of an*

endangered, rare, or threatened species. YES (WINTER RUN, DELTA SMELT)

- f. Cause a substantial reduction in the area or habitat value of critical habitat areas designated under the federal ESA or essential fish habitat as designated under the Magnusson Stevens Fisheries Act.* YES (WINTER, SPRING, FALL, LATE FALL RUN; STEELHEAD, GREEN AND WHITE STURGEON, DELTA AND LONGFIN SMELT)
- g. Conflict substantially with goals set forth in an approved recovery plan for a federally listed species, or with goals set forth in an approved State Recovery Strategy (Fish & Game Code Section 2112) for a state listed species.* YES, RECOVERY PLANS FOR CV SALMON, DELTA SMELT, AND LONGFIN SMELT.

3. ATTACHMENTS

A. Summer 2014 Water Transfers

Transfers were conducted in the summer of 2014 under a Finding of No Significant Impact NEPA document. Our review of the proposed 2014 transfers is presented in Attachment A.

B. Summer 2014

As background on the overall effect of summer transfers, we present an assessment of the overall effect on Delta Smelt in summer 2014 in Attachment B.

A Strategic Review of CALSIM II and its Use for Water Planning, Management, and Operations in Central California



**Submitted to the
California Bay Delta Authority Science Program
Association of Bay Governments
Oakland, California**

by

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December 4, 2003

Executive Summary

1. Summary

The central all-encompassing question put to the panel is whether the CALFED program has adopted an appropriate approach to modeling the CVP-SWP-Central Valley system. Is the general CALSIM modeling approach appropriate for predicting the performance of the general facilities and for use in allocation planning, assessing water supply reliabilities and for carrying out operational studies? We believe the use of an optimization engine for simulating the hydrology and for making allocation decisions is an appropriate approach and is in fact the approach many serious efforts of this kind are using. It is a substantial improvement of the previous modeling approaches and provides a basis for consensus among federal and state interests. The modeling approach addresses many of the complexities of the CVP-SWP system and its water management decisions.

There exists a common tension between those who wish for greater detail and those who want less detail from the model. This argues for a more comprehensive, modular and flexible approach than is now available. In this report we suggest some ways this might be accomplished in the future. We also propose some management procedures that could be considered to improve model and model application quality control and documentation. The openness and availability of the model is admirable and very important given the numerous stakeholders who have interests in the management and allocation of water in the state. To increase the public's confidence in the many components and features of CALSIM II, we suggest that these components of CALSIM be subjected to careful technical peer review by appropriate experts and stakeholders.

2. Background

The California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR) have developed a computer model called CALSIM II that simulates much of the water resources infrastructure in the Central Valley of California and the Delta region. This infrastructure is referred to as the CVP-SWP system. In particular CALSIM II provides quantitative hydrologic-based information to those responsible for planning, managing and operating the State Water Project (SWP) and the federal Central Valley Project (CVP). As the official model of those projects, CALSIM II is the default system model for any inter-regional or statewide analysis of water in the Central Valley of California.

CALSIM II has a central role in the analysis of many CVP-SWP and related issues, some of which require capabilities beyond those included in the model. California needs a large-scale relatively versatile inter-regional operations planning model and CALSIM II currently serves that purpose reasonably well. As the primary State and Federal-sponsored model available for water operations and planning, CALSIM II is critical to the study of many technical and policy issues related to water supply reliability, environmental management and performance, water demands, economics, hydrology and climate, and regulatory compliance.

CALSIM II is a particular application of the California Water Resources Simulation Model called CALSIM. It uses a mixed integer linear programming model solver to route water through a network over time. Currently it uses monthly time steps. Policies and priorities are implemented through the use of user-defined weights applied to the flows in the system (represented by arcs of the network). Simulation cycles at different temporal scales allow for successive implementation of constraints. The model can simulate the operation of relatively complex environmental water accounts and state and federal environmental regulations. In our judgment CALSIM II represents a very impressive modeling effort on the part of all those involved with its development and application.

The CALFED Science Program commissioned this external review panel (Appendix D) to 1) provide an independent analysis and evaluation of the strengths and weaknesses of CALSIM and CALSIM II, and 2) to offer suggestions on the appropriate uses of these modeling tools, on ways their use might complement or be complemented by other models, and on further development, quality assurance, and use in major water systems operations and planning in California.

The panel received background documents (Appendix B), including a survey by the University of California at Davis of stakeholder responses to questions about CALSIM II. We subsequently met for one and a half days in Sacramento for discussions and presentations (Appendix A) by CALFED, DWR and USBR staff. The discussions concluded with a summary presentation by the panel outlining our tentative conclusions.

The information we received and the shortness of our meetings with modeling staff precluded a thorough technical analysis of CALSIM II. We believe such a technical review should be carried out. Only then will users of CALSIM II have some assurance as to the appropriateness of its assumptions and to the quality (accuracy) of its results. By necessity our review is more strategic. It offers some suggestions for establishing a more complete technical peer review, for managing the CALSIM II applications and for ensuring greater quality control over the model and its input data, and for increasing the quality of the model, the precision of its results, and their documentation.

In this review we were asked to address the following questions:

1. Is CALSIM a reasonable modeling approach for current and proposed applications and problems?
2. Do other modeling approaches show similar or greater promise and flexibility for such problems? If so, how?
3. What are the major comparative strengths and weaknesses of the current CALSIM approach and alternative approaches?
4. What are major scientific, technical, and institutional limitations, uncertainties, and impediments for current and proposed applications of CALSIM?
5. What model, software, and data developments, special studies or tests would be beneficial to improve CALSIM for current and proposed uses?
6. How might CALSIM development and applications be managed and overseen to improve the quality assurance of model results for current and proposed applications?

7. What are your suggestions for long-term use, development, or replacement of the current suite of models and data available for the current and proposed uses of CALSIM?

The following sections of this summary present our responses to these questions. The main parts of this report and its appendices provide additional detail.

3. CALSIM Modeling Approach

CALSIM II is a simulation model developed as a joint venture between the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR) to (i) provide a significant modernization and upgrading of the DWRSIM and PROSIM models developed and used by these organizations, (ii) develop a comprehensive modeling system that simultaneously addresses the current and future needs of both the SWP and CVP systems; and (iii) develop a generalized modeling system that could be applied in any river basin system, in contrast with the previous models that were less generalized and more specifically designed for the existing SWP and CVP systems. In this respect, CALSIM II represents a state-of-the-art modeling system that is similar in general concept, while differing in specific details, to other data-driven river basin modeling systems such as ARSP, MODSIM, OASIS, REALM, RiverWare and WEAP.

CALSIM uses linear programming to solve sets of equations that simulate water movement through the CVP-SWP system in accordance with various objectives and constraints. This is a modeling approach which has been used successfully in California (Johnson et al., 1991). In a complex system such as that being modeled, it is essential to have some mathematical representation of system flows that reflects all of the interconnections and constraints. Use of an optimization algorithm allows good decisions to be identified from among all possible and feasible decisions. To the extent this simulates what actually occurs, it is a good modeling approach. To the extent it optimizes when in reality no such optimization is implemented, it has the potential to produce inaccurate and overly optimistic outputs.

Most successful applications of optimization that attempt to simulate the behavior of a system have calibrated their objective functions (i.e., set the weights that prioritize flows over time and space) so that the model results correspond to what actually happens or would happen under a particular hydrologic and demand scenario. In these cases the model's decisions correspond to those the operators would make, as often prescribed by rules that have been worked out in a legal/political process. It does not appear that such a calibration of the objective function weights in CALSIM has yet been completed.

4. Other Modeling Approaches

There are two aspects of modeling, the model structure and algorithms used, and the model software. The use of linear optimization algorithms to solve simultaneous equations for simulating hydrology is a common way of avoiding a typically long list of procedural rules for simulating regional water systems. Such sets of procedures can be difficult to generate for

complex systems, and very different and new rule sets may be needed if structural or significant policy changes are to be investigated. In addition the performance of the system when simulated will be less than that which can be achieved in practice if a good set of rules is not provided. Optimization models are generally easier to reformulate when system changes are to be investigated. However unless the optimization is calibrated in such a way as to actually resemble what takes place in practice it can produce an optimistic description of system performance. This is particularly true if the optimization model is allowed to have perfect foresight of future events that in practice would not be available to system operators.

Large simulation models using optimization and procedural rules both need to have internal checks to ensure to the extent possible that errors in mass balances, for example, do not occur due to errors made when the model is being defined or created. Such internal checking is not apparent to us in our admittedly brief review of CALSIM II. Nor were calibration procedures well defined.

One obvious limitation of using linear optimization procedures is its inability to model accurately and efficiently some of the non-linear hydrologic and decision processes that occur in systems as complex as the CVP-SWP. One approach to addressing this issue of model accuracy, and possibly for decreasing the computational time as well, is to link linear optimization models to non-linear simulation models in a way that permits the simulation to represent the hydrology in any spatial and temporal detail desired. The optimization is used to determine what the decisions should be at every site where a water allocation, reservoir release, or other management decisions must be made. The time steps for simulation could be daily, or weekly or longer, depending on the needs of the user, but would likely be of shorter durations than the optimization time steps. After a predetermined number of simulation time steps, the optimization model would be run. The initial state of the optimization should be set at the beginning of each optimization time step. The optimization component should include multiple future time periods, with imperfect hydrologic and demand forecasts, but once solved only the current period's solutions are implemented – i.e., these decision variable values are sent to the simulation component. The decisions indicated for future periods are ignored. When appropriate, the initial state of the multi-period optimization model is updated and the model is again solved. And so on. Such a modeling approach may prove to be both more realistic, more accurate, and require less time, once developed. We believe such an approach might be worth considering for future development.

CALSIM II currently consists of a combination of software modules developed in several languages, including FORTRAN, Java and C. Several of the modules require proprietary software packages in order to run CALSIM II (Lahey FORTRAN and XA Solver). DWR and USBR staff have said that these components are being replaced by public domain software that can be obtained free of charge. We agree with this decision. Very good public domain software packages of optimization, visualization, file management, and data base support are currently available, and new ones will continually be produced. Periodic updates should be anticipated as part of the business of maintaining the modeling system.

Significant thought should be given to the sustainability of the CALSIM II software. How will future programmers be able to maintain this software? How will future software developments

be incorporated into the system? Will the solver currently being developed by LBNL be adequate in terms of accuracy and computation speed? Will other solvers need to be tested? Can the system accommodate these future developments without major modifications? What reasonable modifications could be made now in anticipate of future developments?

5. Comparative Strengths and Weaknesses

Many of the stakeholder perceived strengths and weaknesses of CALSIM and CALSIM II are very well identified in the survey report from the University of California at Davis (Ferreira, et al. 2003). Our background materials and briefings covered various strengths and weaknesses, but without first hand experience, all we can do here is to summarize those that we have heard expressed by others.

Here we provide a brief summary list.

5.1 Some Prominent Strengths

The strengths of CALSIM II are many. Most are expressed in comparison to previous DWRSIM and PROSIM models DWR and USBR were using. Some of these strengths include:

- Consensus model. CALSIM II is the official joint modeling environment of the State DWR and USBR. This includes a common schematic, hydrologic representation of the system, common set of facility capacities, and common representation of system operating policies. This helps all parties improve representations, rather than compete over representations.
- Common effort. The joint development of CALSIM II by USBR and DWR has provided more focused and effective use of resources and expertise than previous development of agency-specific models. CALSIM II development has also involved other agencies and consulting expertise more than pervious models of this system.
- Data-driven model. CALSIM II is a rather data-driven simulation model with an optimization engine. This modeling approach provides:
 - a. greater flexibility than its predecessors and traditional water resources simulation approaches.
 - b. a promising framework for improving transparency, data, and model documentation, compared to other approaches.
- Public domain. The model and data are substantially in the public domain, facilitating transparency and adaptability for California's decentralized water system.
- Steady improvements. Data improvements have been steadily pursued following the adoption of CALSIM II, although deficiencies remain.

- Improved Delta water quality representation. Although problems appear to remain, the model developers have made substantial gains in representing Delta water quality operating criteria and performance.
- Better groundwater representation. Efforts to better include groundwater and non-CVP-SWP project operations merit continuation and expansion.
- Benchmark Studies. The development of documented benchmark studies have resulted in significant model improvements and aided in the development of comparative model applications. Such exercises should be continued and improved.
- Long-term vision. The vision of a more transparent and publicly available model that can be employed by those outside the major agencies is excellent. This is a major change in direction, and achieving this vision will require adjustments over time. Often, these adjustments will be externally driven. Externally-driven improvements are a price of success and evidence of success for an open, public, modeling policy.
- Important CALSIM II features:
 - a. CALSIM II is able to simulate the operation of the complete CVP-SWP system in all areas that contribute flow to the Delta in monthly time-steps.
 - b. CALSIM II is being applied to examine a diverse range of options including flood control, water conservation and supply, power generation, recreation, water transfers, groundwater banking, recycling, desalination, conjunctive use, the purchase of options and streamflow and water quality protection.
 - c. CALSIM II has successfully been applied by both DWR and USBR to examine both structural and non-structural changes to the CVP-SWP system as well as to ascertain the risks involved with different potential operating scenarios and to quantify the impacts of proposed actions.
 - d. CALSIM II can dynamically model operation of environmental water accounts.
 - e. Demands may vary according to various levels of development (e.g. 2001, 2020) and to hydrologic conditions.
 - f. The regulatory environment under which the projects must operate can be simulated.
 - g. CALSIM II can link to external modules as needed, e.g., to estimate the salinity at water quality stations within the Delta.

5.2 Some prominent weaknesses

As its strengths are many, so are its weaknesses. It seems worth saying, however, that no model can perfectly (meaning efficiently and effectively) serve all interests in a system as complex as the CVP-SWP. Tradeoffs need to be made. This can result in what some would call weaknesses. Such weaknesses are often accepted to gain strengths in another ways.

We heard that the CALSIM II model was too complex. We also heard that it did not handle particular components of the system with sufficient detail. And such is the dilemma of any

complex model, such as CALSIM II. The model is clearly too complex, and not complex enough. The root of this difficulty is that when such a model is constructed, it is not clear what level of detail is needed, so the model must be made sufficiently complex to ensure it is complex enough. And the complexity needed to address some issues will remain in the model when it is used to address other less complex issues, or the same issues at less complex locations. One approach to addressing this issue is to develop different linkable modules of CALSIM II having different complexities. In this way the level of detail can be varied to be consistent the application or study at hand, and level of sophistication and resources available to the user.

Other weaknesses model users would like addressed include:

- The model provides limited and inadequate coverage of non CVP or SWP water and of the California water system south of the Delta.
- The model assumes that facilities, land-use, water supply contracts and regulatory requirements are constant over this period, representing a fixed level of development rather than one that varies in response to hydrologic conditions or changes over time.
- Groundwater has only limited representation in CALSIM II.
- Groundwater resources are assumed infinite, i.e., there is no upper limit to groundwater pumping.
- The linear programming model considers only the current month, and hence CALSIM II operating rules are required to determine annual water allocations, to establish reservoir carryover storage targets, and to trigger transfers from north of Delta to south of Delta storage.
- Better quality control is needed both for the model and its current version and the input data. Procedures for model calibration and verification are also needed. Currently many users are not sure of the accuracy of the results. A sensitivity and uncertainty prediction capability and analysis is needed.
- Need improved ways of altering the model's geographic scope and resolution and its temporal resolution to better meet the needs of various analyses and studies.
- Need to improve the model's comparative as well as absolute (or predictive) capabilities.
- CALSIM II needs better capabilities for analyzing economic, water quality, and groundwater issues.
- Need improved documentation explaining how the model works, its assumptions, its limitations, and its applicability to various planning and management issues.
- DWR and USBR have not provided a centralized source of support for CALSIM II. More training for CALSIM II is needed. There is a need for more people who can run CALSIM II. There is a need for a well-publicized user group. A more extensive users' guide is needed.
- Improved capabilities are needed for real-time operations especially during droughts, gaming involving stakeholders during a simulation run, handling of evapotranspiration and agriculture demand changes over time, water transfers, Delta storage, carryover contract rights, refuge water demands and more up to date representation of Feather River, Stanislaus River, Upper American River, San Joaquin River and Yuba River operations.

- Need an improved graphical user interface to facilitate input of model data, setting of model constraints and weights, operating the model, and displaying and post analysis of model results.
- Need to be able to change the model time period durations for improved accuracy of model results.

6. Limitations, Uncertainties, and Impediments

6.1 Absolute Values or Comparative Results

Modelers sometimes make a distinction between the use of a model for *absolute* versus *comparative* analyses. In an absolute analysis one runs the model once to predict an outcome. In a comparative analysis, one runs the model twice, once as a baseline and the other with some specific change, in order to assess change in outcome due to the given change in model input configuration. The suggestion is that, while the model might not generate a highly reliable absolute prediction because of errors in model specification and/or estimation, nevertheless it might produce a reasonably reliable estimate of the relative change in outcome. The panel is somewhat skeptical of this notion because it relies on the assumption that the model errors which render an absolute forecast unreliable are sufficiently independent of, or orthogonal to, the change being modeled that they do not similarly affect the forecast of change in outcome; they mostly cancel out. This feature of the model is something that would need to be documented rather than merely assumed.

In our opinion CALSIM II has not yet been calibrated or validated for making absolute predictions values. Yet it is apparent that there has been a distinct need by model users for absolute predictions. In the absence of alternatives, users are adopting CALSIM II results as the best absolute prediction available and they are likely to continue to do so. We recommend that model developers recognize the requirement for CALSIM II to provide absolute predictions. To satisfy this new purpose, additional calibration of the model will be required to ensure that the output it produces is fit for this purpose. Regardless of how possible it is to match the model closely with observed behavior, statistics on the accuracy of the calibration run should be supplied to users to enable them to gauge the likely errors involved with using the model output.

6.2 Sensitivity and Uncertainty Analyses

Sensitivity analyses would be useful to identify which parameters and input data have major impacts on decisions and system performance criteria of concern. Uncertainty analyses would help users of the model understand better the risks of various decisions and the confidence they can have in various predictions.

6.3 Graphical User Interface

Having a graphical user interface would substantially aid those who use the model in managing both input and output data, and in controlling or managing model operations. This model will not likely become as available to and as well understood by the public, to the extent desired by the model developers, until an effective menu-driven GUI has been created that can help create and draw from a database of system parameters and characteristics, and simulation results.

6.4 Documentation and Training

When if ever is adequate documentation and training available? Rarely, but we believe there is a serious need to improve the documentation as well as the training available for all those interested in using CALSIM II.

7. Options for Improving CALSIM

7.1 CALSIM Model Software

We encourage the developers of CALSIM to convert their present software to that which is publicly available and to develop a useful graphic based user interface that can facilitate the input, editing, and display of all the data that are input to and output from CALSIM II. There are many options, some of which we have discussed with the model developers.

The CALSIM package should be made more modular and capable of linking to other more complex models of components of the CVP-SWP system. If the changes in code and modeling approach result in a quicker running model, it might be possible to link, when desired, modules that facilitate position analyses and other types of uncertainty analyses. A modular system would allow alternative representations of different components of the system. Thus different levels of spatial detail, or representations of the fundamental processes, would be allowed within the overall system representation and record of California hydrology. This will allow the use of more general and streamlined models for use of preliminary investigation and general planning, as well as a more detailed representation of the system for final analyses and more detailed studies. This would be very useful.

7.2 Sensitivity and uncertainty analyses

Both sensitivity analyses need to be performed, and procedures need to be developed to enable the estimation of measures of uncertainty associated with model output. Perhaps workshops focused on just these needs should be scheduled to better determine how best to meet these needs. There are numerous procedures available that could be applied. Appendix H contains some approaches for performing sensitivity and uncertainty analyses.

7.3 Model calibration

There is a need to develop the model so that it is able to provide absolute estimates of key model outputs rather than limiting the use of the model to comparative studies. One way to do this is to subject the model to a comprehensive calibration process where it is fine-tuned until it is able to reproduce the historical behavior of the system with sufficient accuracy to provide absolute results. The calibration of the model should aim to test all the key outputs of model including water quality in the San Joaquin River and in the Delta. It is necessary to test the monthly values of outputs for those outputs for which the monthly pattern is important.

7.4 Other extensions and improvements

- The opportunity of improving the collection of data on the use of water (preferably broken down by irrigation district and water source) should be investigated. The use of groundwater should be included in this investigation.
- It would be useful to expand the geographic extent of the model so that it includes all the components of the linked water supply system, including both the San Joaquin and Tulare Lake Basins of the Central Valley. The model should also account in some manner for imported supplies of water to users in southern California from the Colorado River.
- The linkage between surface water and groundwater would appear to be of critical importance and output that would enable the impact of surface water use on groundwater extractions would appear to be useful.
- Examination of the report '*CALSIM II Simulation of Historical SWP/CVP Operations*', DWR (2003) indicates that the current formulation of CALSIM II:
 - Overestimates water deliveries to SWP and CVP contractors,
 - Determines carryover storage target values that differ from those the operators have determined in the past, and
 - Operates the San Luis Reservoir at lower levels and fills it later in the season than operators have in the past.

8. Managing CALSIM Development and Applications

The predicted impacts and other information derived from CALSIM II applied to the CVP and SWP can influence major investment decisions. It is thus self evident that those who use the model results need to have some confidence as to their precision. Is the science behind the information derived from CALSIM II been reviewed and judged correct? Is the model software free from errors? Are the assumptions made when performing the modeling the correct ones? Are the model results accurately and fully reported? In other words, just how much credence should decision makers place in the model output? Users of the model results should be assured that they are credible and unbiased. One way to help ensure this is to have the models, their associated software, and their applications under the control of some interagency organization that can oversee and provide quality control over model development, application and documentation. They can also plan and implement needed peer reviews.

One possible means of facilitating the peer review processes and for maintaining control on the particular versions of CALSIM II and accompanying models used for CVP-SWP planning and management decisions is to create an interagency modeling consortium (IMC) consisting of DWR, USBR, and other stakeholder organization (including university) personnel if they are interested and want to participate. This center would be responsible for maintaining a toolbox of ‘acceptable’ models for use by the agencies and contractors. The models placed in the toolbox should be peer reviewed with respect to their applicability and suitability for use in particular applications. Those that are not peer reviewed should be considered for peer review. New models proposed for use in California should be peer reviewed with respect to their suitability, and for their strengths and limitations, before being placed in the toolbox. The review should be of the theory underlying the model, the model’s software, the documentation of the model as well as of its software, the model’s functions and capabilities including those pertaining to model data input and output, the input data themselves, model calibration and verification, capabilities for sensitivity and uncertainty analyses, user control of all model operations including pre and post analyses (GUIs), spatial and temporal resolutions, and its limiting assumptions.

9. Future Use, Development, or Replacement of CALSIM

9.1 A coupled optimization simulation approach

Given a system as complex as the SWP/CVP system, it seems to us it might make sense to consider the development of a more detailed simulation ‘engine’ and couple it to an optimization or management ‘engine’. The simulation component can more accurately model hydrologic processes. For example it can include the deterministic non-linear routing of flows and their quality constituents through the system on a smaller time step (e.g., daily) and hence much more realistically or accurately, than can linear optimization using longer time steps, even with all the known tricks for linearizing separable (single variable) non-linear functions and ‘if-then-else’ statements. The simulation engine itself may require a simultaneous equation solver, especially for the Delta. But the simulation engine needs to know what to do, i.e., what decisions to make. Periodic use of the optimization, say once a week or even less frequently if conditions are relatively constant, for determining the decisions to be simulated, e.g., the water allocation and reservoir release decisions, eliminates much of the maze of rules that otherwise would be required and which developers of CALSIM II are avoiding through the use of optimization. Each time the optimization or management ‘engine’ is run it is first updated with the current state of the system as determined from the more precise simulation ‘engine’. The optimization component would include multiple time periods only to the extent that the current period’s solution is not affected by the time horizon in the optimization. The other time period solutions are ignored. This coupled optimization-simulation approach has the potential to be both more accurate as well as quicker to execute. In our opinion it is worth considering for future development.

9.2 Models as hypotheses

CALSIM II is really about the future, not the past. Benchmarking studies can help establish the credibility of the model and provide estimates of its accuracy by comparing its performance to actual historical operations. A concern is how well the model reproduces historical operations, not whether it is valid or invalid on some absolute scale of perfection. But the real issue is how well CALSIM can predict what might happen in the future with sets of hydrological and meteorological conditions that have not yet been experienced, and may be significantly different from the past if climate variability and climate change are considered. In these cases the ability of the model to forecast what will happen depends both upon its ability to describe what would happen should a particular system operating policy, priorities and water demands be adopted. In this sense CALSIM II modeling studies should be thought of as the exploration of a hypothesis that particular policies and priorities have been adopted. Our ability to predict the future has generally been poor, but it is the obligation of agencies such as DWR and USBR to attempt to ensure that should water demands, water supplies, and water policies evolve as one would expect, society is prepared for the consequences. And that would seem to be what CALSIM II is about.

9.3 Future Model Development and Use

From the list of perceived weaknesses above, there are clearly many opportunities for further refinement of CALSIM II. Rather than attempt to meet all needs using only one model, namely CALSIM II, it seems preferable to improve its adaptability to various levels of detail through its ability to link to other models when additional detail in a particular region or for a particular feature is desired. For example, the monthly time step used by CALSIM II is sufficient for many studies. Yet some seasonal (multi-month) decision making is needed in CALSIM II to reflect decisions made by the SWP and CVP as to what Table A and other allocations to honor in full. On the other hand, it is clear that many water quality and ecosystem management decisions would profit from more detailed weekly or daily time steps. However, such shorted time-step models will need the guidance of a longer time-step model. As discussed earlier, models with shorter time scales can require increased spatial resolution, both of which lead to increased model complexity and a strong argument for model modularity.

Additional potential applications of CALSIM II include operational planning using gaming, or the involvement of potential decision makers during the simulation runs via a well developed graphical user interface, and to improve the capability of modeling water quality, energy production, conjunctive groundwater and surface water interactions and use, to mention a few.

There will always be a need to perform alternative ‘what if’ policy analyses where a relatively fast model that also provides some capability for uncertainty analyses is required. Perhaps CALSIM II will never be able to serve this need, and if so another more simplified modeling approach could be developed to fill that need. This simpler screening tool would be calibrated to produce results comparable to those of CALSIM II or observed data. Is this possible? We can not be certain but feel the idea should be seriously considered.

Acknowledgments

We want to acknowledge and thank all those who were involved in preparing the materials we received, in presenting additional information to us, and in arranging our activities and taking care of us during our brief review visit. Our special thanks to Kim Taylor for leading this effort, and to all those who did their best to educate us on the finer points of CALSIM II. All those involved in the development and implementation of CALSIM II are to be congratulated for extending the state-of-the-art in water systems modeling and for making it a critical part of the planning, development and management of California's water resource infrastructure.

Caveat

Just as all models are approximations of reality, so may all advice be an approximation of what it should be. We hope what we have written in this report is correct and useful, but encourage CALSIM model managers and California's water community to take our assessments and suggestions for what they are, arrived at based on our own experiences and some limited exposure to those who know much more about CALSIM and CALSIM II than we do.

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1. CALSIM Compared to Other Modeling Approaches

Management of complex systems such as coordination of the California State Water Project (SWP) and the Federal Central Valley Project (CVP) requires effective decision support tools for simulating and analyzing system components in a fully integrated manner. The classic definition of a decision support system (DSS) provided by Sprague and Carlson (1982) is *"an interactive computer-based support system that helps decision makers utilize data and models to solve unstructured problems."*

A DSS integrates the following interactive subsystems: (i) dialog generation and management subsystem (DGMS) for managing the interface between the user and the system; (ii) data base management subsystem (DBMS); and (iii) model base management subsystem (MBMS).

CALSIM II is a DSS developed as a joint venture between the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Bureau) to (i) provide a significant modernization and upgrading of the previous models DWRSIM and PROSIM employed by these organizations, (ii) develop a comprehensive modeling system that simultaneously addresses the current and future needs of both the SWP and CVP; and (iii) develop a generalized modeling system that could be applied in any river basin system, in contrast with the previous models that were less generalized and more specifically designed for the SWP and CVP. In this respect, CALSIM II represents a state-of-the-art modeling system that is similar in general concept, while differing in specific details, to other river basin modeling systems such as AQUATOOL (Valencia Polytechnic University, Spain), ARSP (Acres Reservoir Simulation Program) (Boss International, 2003), IRAS (Interactive River-Aquifer Simulation) (Loucks, et al. 1996), MIKE BASIN (Danish Hydrologic Institute, 2002), MODSIM (Labadie and Larson, 2000), OASIS (Randall, et al., 1997), RAISON (Young, et al. 2000), ResSim (U.S. Army Corps of Engineers, Hydrologic Engineering Center), Ribasim (River BASin SIMulation Model) (Delft Hydraulics, Netherlands), REALM (REsource ALlocation Model) (James, 2003), RiverWare (Zagona, et al. 1998), WaterWare (Jamieson and Fedra, 1996), and WEAP (Water Evaluation and Planning System, 2003) (Hansen, 1994). All of these can be categorized as decision support systems since all three subsystems of a DSS are embodied within them.

A distinguishing feature of several of these modeling systems is the use of optimization on a period by period basis (not fully dynamic) to "simulate" the allocation of water under various prioritization schemes, such as water rights, without the presumption of perfect foreknowledge of future hydrology and other uncertain information. This is a valid approach since use of optimization overcomes the disadvantage of employing numerous, unwieldy prescriptive rules governing water allocation. Systems employing optimization in this manner include: ARSP, MODSIM, OASIS, REALM, RiverWare, and WEAP and are therefore more akin to CALSIM II. ARSP, MODSIM, REALM and Ribasim are further distinguished by use of specialized minimum cost network flow optimization algorithms, although of these only MODSIM includes iterative structures using an imbedded scripting language for including non-network "side constraints" in the optimization. The other modeling systems are essentially limited to a

pure network structure that does not allow inclusion of all the complex, non-network type constraints necessary to model the complex CVP-SWP system.

It may be useful to compare this use of optimization with some other uses that have appeared in the modeling literature. One use of optimization is purely for computational convenience; in this case optimization is employed as a numerical method for obtaining the solution of a series of simultaneous (often linear) equations. This approach, which was used in the first generation of computational economic models about forty years ago, exploited the fact that some existing computational algorithms for solving optimization problems were faster than those for solving large systems of simultaneous equations. A second use of optimization applies when the solution of the system of equations characterizing a water balance has multiple possible solutions; this is essentially the case described above, where optimization is being used primarily to identify a unique solution for a system of equations. Both of these uses of optimization are primarily descriptive rather than prescriptive (also referred to as positive vs. normative) in intent: the goal is to model how a system, characterized by a set of equations, operates. To the extent that the real-world managers of the system do optimize some objective function, the aim is to mimic their behavior by setting up and solving a similar optimization. But, the goal is to model what they actually do, not to advise them what they ought to do. The third use of optimization adopts an explicitly prescriptive goal and sets out to ascertain what managers ought to do if they wished to optimize some objective function (e.g. maximize economic efficiency). While this is certainly a legitimate analytical exercise, it should be kept conceptually distinct from the use of optimization in a purely descriptive context.

1.1 Advantages of Optimization-Driven Simulation

For large, complex, integrated systems, simulation models that optimize operation and allocation of water within each time-step by operational priorities have become the major simulation approach. Models of similar approach include ACRES (Acres Engineering), AQUATOOL (Spain), MODSIM (Colorado State U.), OASIS (Hydrologics, Inc.), WASP (Australia), and WEAP (Tellus Institute). Priority-based simulation models with optimization engines have become widespread in part because:

- The models are simpler to develop, comprehend, and modify.
- Their software is easier to upgrade, since the data set describing the system and its operating policies is substantially separate from the software code.
- Data are easier to update and modify, since changes require little or no software changes.
- Priority-based operations are a common basis for water rights and operating policies.
- Priority-based operations are relatively easy to explain.

The major exception to this technological trend in simulation modeling is to use more traditional procedural operating rules in simulation models with a graphical user interface for primarily flood control operations (HEC-RESSIM) or for exploratory study of large systems or detailed management of relatively small systems (Stella-type models).

Similar to several of these systems, CALSIM II allows specification of objectives and constraints in strategic planning and operations without the need for reprogramming of

complex models. The CALSIM II authors developed the English-like WRESL (Water Resources Engineering Simulation Language) as an intuitive means of defining the objective function and constraints for a mixed-integer linear programming model, similar to the OCL (Operational Control Language) used in OASIS and the Policy Editor employed in RiverWare. In MODSIM, the optimization model is formulated directly through the graphical user interface with no need for a modeling language, but with supplemental features of the optimization defined through the PERL scripting language. WRESL allows planners and operators to specify targets, objectives, guidelines, constraints, and their associated priorities, in ways familiar to them. WRESL provides simple text file output that is converted to FORTRAN 90 code by a parser-interpreter program, whereas PERL is fully embedded in the network optimization code. Both modeling systems are data centered, meaning that model operation is controlled solely by user specification of input data rather than hidden rules or hard-wired data structures.

CALSIM II, OASIS, RiverWare and MODSIM are similar in that all use a high level language with syntax and logical operators; are written to simple text files which are subsequently parsed and interpreted; use rule-based or IF-THEN-ELSE conditional structures; are designed to be easy for planners and operators to use without the need for reprogramming; allow adaptive and conditional rules which are dependent on current system state variable information; include constructs for assigning targets, guidelines and constraints, along with their associated priorities; and include a goal seeking capability. CALSIM employs a mixed integer linear programming solver for repeated period by period solution that is less efficient computationally than the network solver employed in MODSIM, ARSP, REALM and Ribasim.

Unfortunately, unlike these aforementioned modeling systems, CALSIM lacks a comprehensive graphical user interface for constructing and editing the river basin system topology. CALSIM II would be greatly enhanced if, similar to RiverWare, IRAS, and MODSIM, objects representing features of the basin such as reservoirs, canals, and river reaches, could be created on the palette of a graphical user interface by simply clicking and dragging various icons for the objects to the display. The objects are instances of various classes that share certain common characteristics, and each object contains its own physical process methods and associated data. We believe that complaints concerning the complexity of using CALSIM II would be greatly reduced with development of such an object-oriented graphical user interface.

2. Comparative Strengths and Weaknesses

2.1 Some Prominent Strengths

CALSIM II has important strengths as a general inter-regional operations planning model, particularly compared with available alternatives and its predecessors. The primary strengths include:

- Coordination of Federal and State Interests—A unique aspect of CALSIM II is the high degree of cooperation between Federal (i.e., U.S. Bureau of Reclamation) and State (i.e.,

California Department of Water Resources) interests in its development. This kind of cooperation is rare, and in fact this may be the only such example of such coordination for a system of this scale and complexity. Although it is clear that DWR staff have taken the greatest degree of responsibility in the planning, development, coding, testing and application of CALSIM II, it is also clear that USBR staff have also played an important role. CALSIM II can provide a showcase for other states as to what can be accomplished with Federal and State cooperation for river basin management.

- Consensus model. CALSIM II is the official joint modeling environment of the State and USBR. This includes a common schematic, hydrologic representation of the system, common set of facility capacities, and common representation of system operating policies. This saves a lot of unproductive bickering and helps all parties improve representations, rather than compete over representations.
- Common effort. The joint development of CALSIM II by USBR and DWR has provided more focused and effective use of resources and expertise than previous development of agency-specific models. CALSIM II development has also involved other agencies and consulting expertise more than previous models of this system.
- Data-driven model. CALSIM II is a rather data-driven simulation model with an optimization engine. This modeling approach provides:
 - a. much greater flexibility than its predecessors and traditional water resources simulation approaches.
 - b. a promising framework for improving transparency, data, and model documentation, compared to other approaches.
- Public domain. The model and data are substantially in the public domain, facilitating transparency and adaptability for California's decentralized water system. Ongoing software development efforts will improve CALSIM in this regard.
- Steady improvements. Data improvements have been steadily pursued following the adoption of CALSIM II, although deficiencies remain widespread.
- Improved Delta water quality representation. Although problems appear to remain, the model developers have made substantial gains in representing Delta water quality operating criteria and performance.
- Better groundwater representation. Efforts to better include groundwater and non-CVP-SWP project operations are good efforts in the right direction, and merit continuation and expansion.
- Benchmark Studies. The development of documented benchmark studies seems to have resulted in significant model improvements and aided in the development of comparative model applications. Such exercises should be continued and improved.

- Long-term vision. The vision of a more transparent and publicly available model that can be employed by those outside the major agencies is excellent. This is a major change in direction, and achieving this vision will require adjustments over time. Often, these adjustments will be externally driven. Externally-driven improvements are a price of success and evidence of success for modeling policy that is open and public.

Few, if any, modeling organizations in the country have consistently done as good a job on model development and application for such a large, complex, and controversial system as the modeling group which developed CALSIM II. They are to be commended for their work to take California water modeling beyond past “closed shop” practices in favor of the development and dissemination of modeling capabilities that are more relevant to California’s current water management problems. Most areas and suggestions for improvement noted below are meant to aid the model developers in moving further and faster in the direction they are already heading.

2.2 Some Prominent Weaknesses

The strengths and weaknesses of CALSIM II are not only technical (software, data, and methods), but also are institutional regarding how this model has been developed and employed. The administrative setting and objectives of model development and application are important, and difficult to manage. Alas, the management/policy problems of a system change frequently, while data and modeling capability change more slowly, and effective administrative structures change very slowly, if at all.

- Inadequate data development and management are principal shortcomings of CALSIM II. There has not been a sufficiently systematic, transparent, and accessible approach to the development and use of hydrologic, water demand, capacity, and operational data for CALSIM II. This problem extends beyond inadequate documentation and has led to controversy, confusion, and inefficiency in application of CALSIM II.
 - a. Inadequate data management steepens the unavoidably difficult learning curve inherent for a complex system. Data have mostly been considered a “back room” activity of a few experienced experts. Retirement, promotion, or departure of these experts has left many gaps in knowledge and created difficulties for re-developing data for newer policy and planning problems.
 - b. The administration of data development is fragmented, disintegrated, and lacks a coherent technical or administrative framework. Data required by CALSIM II are developed by several administrative units, without systematic technical vision or quality control for modeling purposes. Within DWR, different groups develop hydrologic and water demand data under different Deputy Directors, without effective coordination. This division must be overcome for a coherent data and analytical framework to be developed and implemented.
 - c. In many cases it appears that water use and other hydrologic data inputs to CALSIM II are based on data collection and analyses that took place during the 1960s when DWRSIM and PROSIM were being constructed. It is important to ensure that data used for CALSIM II are up-to-date and consistent with the best current information

- The expertise and insights of many in local agencies, system operators, and consulting firms have not been prominent in the development of CALSIM II. For such a system with many hundreds of local experts, this is somewhat unavoidable, especially early in model development. Periodic re-examinations of how each area in CALSIM II is represented, in consultation with local agency and consulting experts, might overcome these technical shortcomings, and create and maintain a broader technical, user, and credibility base for CALSIM II. Active involvement of local agencies in CALSIM II development and applications would be much easier with better data management, and would be rewarded with a broader base of CALSIM II expertise and enhanced model credibility.
- Compared to the current CALSIM II, any central operations planning model for California water management should be:
 - a. Expanded in geographic scope to include major non-CVP-SWP areas, especially the Tulare Basin, the Colorado River, and southern California. Operations and demands in these regions seem increasingly important for CVP and SWP operations, and are important for the integrated operations of California's major local and regional water management agencies.
 - b. Expanded in management scope to include local management options such as water conservation, reuse, water transfers, groundwater and conjunctive use management, etc. These additional water management options are important for local, regional, and statewide water policy, planning, and management efforts and can have significant effects on CVP and SWP water demands.
 - c. Made regionally modular, so smaller regional models can be run independently and tested locally, with boundary conditions consistent with the larger model.
 - d. Made modular in terms of hydrologic, water management, and water demand processes, allowing better development, comparison, and updating of hydrologic and water demand process models. Agricultural, urban, environmental, and other water demands should be represented more directly, and explicitly. Groundwater should be represented and operated more explicitly. Land use based local hydrology and water demand approaches might be implemented in such standardized modules.
 - e. Subject to a systematic model and data testing regime and continuous quality improvement program. As the problems of California water change, different and greater demands will be placed on analytical capability, requiring an essentially continuous testing, re-testing, and improvement of data and models. This might parallel a continuous review of local representations and data involving local agency and consulting experts.
 - f. Financed on a broader base, by more than the CVP and SWP projects. Increasing use of CALSIM II is being made by local, regional, State, and Federal agencies interested in developing bilateral or multi-lateral water transfers or projects, which incidentally involve the CVP and SWP. To develop inter-regional modeling capability needed to integrate these activities at local, regional, and inter-regional scales, more sustained funding and involvement from local and regional agencies is needed. In effect, local and regional agencies have been "free riders" on CALSIM

II's analytical capabilities, and it is not necessarily a good bargain for them. Everyone should benefit from broader technical and financial participation.

- g. Capable of analyzing a wide range of scenarios. More capability is needed to examine various long-term scenarios with respect to hydrologic, water demand, and operational uncertainties in the future. There also needs to be a better capacity to accommodate other approaches to representing hydrologic uncertainty and variability besides simply simulating 70-plus years of record.
- Input data and its development. Important aspects of CALSIM II rest upon the representations of other models of Delta hydrodynamics and water quality, water demands, and groundwater. The credibility of CALSIM II also rests on testing these models that send important data/representations to CALSIM II, and documenting them adequately. These models include:
 - a. CU Model and SIMETAW: The consumptive use model and the newer SIMETAW model, used to develop hydrologic inputs and estimate return flows, also require testing and more explicit documentation. The underlying data for these models also need more systematic, standardized, and transparent treatment.
 - b. DSM2: Representation of the Sacramento-San Joaquin Delta will always be important and prone to controversy, given the prominent importance of Delta flows and water quality for the operation and planning of California's water system. The difficulties of representing the Delta in operations and planning models are compounded by the tidal nature of the Delta, which usually implies a need for shorter time-steps. Representation of Delta water quality constraints currently falls heavily on an ANN method within CALSIM II. This ANN is calibrated (trained) based on a hydrodynamics model, DSM2. Thus, controversies regarding Delta representation in CALSIM II are likely to lead to questions of the adequacy of DSM2. The transparency and testing procedures valuable for establishing the credibility and limitations of a Central Valley operations model would also seem to apply to DSM2, or any other Delta hydrodynamics-water quality model. Tests of methods used to represent small-time step phenomena with larger time-steps (e.g., "partial month standards") should be tested in a forum that would give the approach credibility and where its limits could be developed, discussed, and documented.
 - c. CVPM/CALAG/LCPSIM/IWR-MAIN: Representations of water demands in CALSIM II rely heavily on other models, particularly CVPM and eventually CALAG for agricultural water demands and LCPSIM and eventually IWR-MAIN for urban water demands. Thus, these models also will attract attention, and will probably require the same types of testing, transparency, and documentation suggested for DSM2 and CALSIM II. Many water contractors of the CVP and SWP also have internal water sources (groundwater, water conservation, and water reuse) and side contracts with other agencies to supply water that can increase or decrease (at different times) their water demands from the CVP and SWP contracts and from the demands estimated from CALAG and IWR-MAIN types of models.
 - d. IGSM/CVGSM: Water users in California rely on groundwater as a water source and as the major source of over-year drought storage. Groundwater is also being increasingly used and looked-towards as a source of storage as part of conjunctive use schemes, and water transfer and market schemes. Thus, representation of

groundwater in the system is important, and probably should be expanded considerably. The representation of groundwater quantities, storage, and recharge and pumping capability will also attract attention from interested and critical parties. Thus, the IGSM/CVGSM modeling efforts of DWR and USBR should include the same types of transparency, documentation, and testing suggested for CALSIM II.

- e. Agricultural demands: Agricultural demands in the model are estimated by an external modeling system (CU model). Staff noted that the estimation methods being used include out of date information on agricultural cropping patterns and irrigation technology, both of which result in inaccurate estimates of agricultural water demands. This estimation process needs to be revised and updated to include current information on an ongoing basis. The methodology needs to be improved to include economic factors in the estimation of cropping decisions and water demands. In many cases, the preferred spatial scale for the economic modeling of agricultural water demand is going to be the individual irrigation district rather than very broad areas containing multiple quite heterogeneous districts.
- CALSIM II is currently awkward to apply for broader State and CVP-SWP policy questions. Practically, the time needed to complete analyses is too long and CALSIM II does not explicitly represent many of the management options which policy makers are interested in investigating, evaluating, and orchestrating.
 - More CALSIM II modelers are needed. Many water managers and policy makers across California look to CALSIM II for many purposes, and there is near-universal consensus that the application of CALSIM II is currently limited by a dearth of knowledgeable modelers. Current training by DWR and USBR on CALSIM software is useful, but clearly insufficient. To be a functioning and credible CALSIM II modeler one must understand both CALSIM software and the operational complexities of the system (which probably no one can know in its entirety). Improved model and data documentation is also essential here.
 - Stakeholders and policy makers are poorly guided in how to interpret CALSIM II results. Not only must CALSIM II become more responsive to current planning and policy concerns and management options, but current policy makers must receive some education in the benefits and limits of such modeling for their purposes. This is a very difficult problem that will often involve the role assigned to modeling and model results within larger politically-driven policy making processes.
 - Non-interpretation of model results is not helpful. Several recent DWR reports based on CALSIM II results have been considerable improvements over past practices in terms of presenting model results, discussion of the model, and examination of model performance in a historical context. However, often the studies have not contained the kind of written discussion and interpretation of results that would demonstrate that the authors have thought about the results and drawn conclusions in a realistic and self-critical manner. This detracts from the perceived credibility of the work and makes the study less informative for readers (most of who surely do not have the modeling background of the authors).

- Some needs exist to improve CALSIM software. These are well-known to the model developers and include:
 - a. Elimination of the need for the FORTRAN compiler,
 - b. A public-domain mixed integer-linear programming (MIP) solver,
 - c. A graphical user interface, including ties to databases and GIS display if possible,
 - d. Post-processing tools for users to help new users and broader application and scrutiny of CALSIM II results,
 - d. Version control software and system (also a problem for model administration),
 - e. Better data and database management software and protocols (this has great data management and administration implications),
 - f. An ability to more systematically set objective function weights,
 - g. More automated input and output data checking is needed to improve productivity in model application and quality control of modeling output. This would also facilitate use of CALSIM II by a broader range of modelers,
 - h. Ability to access and employ sensitivity analysis information coming from the MIP solver to identify possible multiple optima and identify binding constraints and slacks,
 - i. A debug version of the code where water can be added or subtracted at any location and time (at a great penalty) to quickly identify locations and times of model infeasibilities. (Prof. J. Lund has had great success with this approach to correcting infeasibilities in the CALVIN model of California for a network flow algorithm.),
 - j. Time-step issues should be explored and evaluated comparatively. There are major drawbacks to shortening time-steps system-wide (run-time, data development, interpretability of results, etc.), but short time-step components within the model or other approaches might adequately represent short-period aspects of the system for many purposes.

There will be some who argue that CALSIM II is and should remain a model of only the CVP and SWP system. While this would be simpler administratively and financially, it seems technically and politically untenable. California's water system is being asked to operate in an increasingly integrated manner across local and regional scales, with multiple local water demands, supplies, and aquifers being coordinated with the operations of major aqueduct and storage infrastructure. Any model of the CVP and SWP systems must be responsive to this operational integration, either implicitly through better parameterization of local supplies and demands, or explicitly by widening the geographic and functional scope of the model.

3. Limitations, Uncertainties, and Impediments

3.1 Removal of Unnecessary Ties to DWRSIM and PROSIM

Much of the spatial detail employed in CALSIM II is a carryover from the previous DWRSIM model. This is particularly evident in the coarse delineation of watersheds and sub-areas, which may no longer be relevant for future applications of CALSIM II. It is recommended that all unnecessary ties to the previous DWRSIM and PROSIM models be removed in further development of CALSIM II.

3.2 Relative vs. Absolute Predictions

As noted in the Executive Summary, we are skeptical of the usefulness of the distinction between comparative and absolute predictions. To declare that CALSIM II is intended for comparative predictions and should not be used for absolute predictions is not a helpful or desirable strategy. Rather than embracing this limited view of what CALSIM II can be expected to accomplish, we recommend that model developers recognize the requirement for CALSIM II to provide absolute values. To satisfy this purpose, additional calibration of the model will be required to ensure that it provides a reasonably reliable depiction of how the California water system operates. In addition, data on model accuracy and the outcome of the calibration runs should be made available so that users can gauge the likely errors involved in using the model for their own particular purposes. Some methods for doing this and performing sensitivity and uncertainty analyses are contained in Appendix H.

Model users should realize that model calibration and validation exercises can illustrate only how well the model can reproduce historical decisions and system behavior. Our ability to predict future policy decisions and the emergency responses to water shortages is clearly limited, thus decreasing the absolute precision of any model's predicted values of various system performance measures. Thus it is useful to distinguish between the ability of the model to reproduce correctly the physical operations of the water systems in California (which should be good), its ability to reproduce and anticipate decisions by the agricultural sector that determine the quantities of water they consume, and its ability to mimic historical and current water operation decisions by the CVP, SWP and other water management agencies.

In general, it appears that the developers of CALSIM II do not have a clear idea of how to define the scope of CALSIM II use and many of the applications are evolving in a reactionary manner. Model developers should identify clearly the desired uses for CALSIM II and then determine acceptable approaches for satisfying those desires. Developers should seek to improve data accuracy and overcome unrealistic assumptions to improve confidence in model results.

3.3 Hydropower

CALSIM II is currently greatly lacking in hydropower computations, which is an important part of the federal CVP system. This should include risk-based power capacity evaluation, and possibly incorporate the ISM (indexed sequential hydrologic modeling) method that the Bureau has used for many years in hydropower capacity analysis. Also, hydropower should not simply be an after-the-fact calculation, but explicitly included in the system objectives.

3.4 Daily operations

A great challenge awaits the developers as they attempt to adapt CALSIM II to daily operations. These challenges are primarily related to the impacts of routing on distribution of flows and scheduling of reservoir releases. Under the current period-by-period optimization structure over daily time increments, without appropriate consideration of routing there is the

danger that the model will allow diversion of upstream flows to lower priority users, resulting in injury to higher priority downstream users in the following days where travel times exceed 1 day. The proper inclusion of routing in the daily operations requires some kind of look-ahead capability in CALSIM II, which is currently lacking. In addition, scheduling of reservoir releases on a daily basis creates difficult timing issues in order to minimize unnecessary downstream spills or shortages caused by routing and attenuation of upstream reservoir releases. Another complexity in moving into daily operations is that reservoir discharges now become head-dependent, whereas this can usually be ignored on a monthly time scale. This means that the maximum reservoir release in any day will be dependent on the head, and should be based on the average head over the day, which introduces the potential for time consuming iterative processes to deal with nonlinear relationships in discharge-head curves for any reservoir.

3.5 Groundwater model

Groundwater has only limited representation in CALSIM II. This resource is modeled as a series of inter-connected lumped-parameter basins. Groundwater pumping, recharge from irrigation, stream-aquifer interaction and inter-basin flow are calculated dynamically by the model.

The purpose of the multi-cell groundwater model is to better represent groundwater levels in the vicinity of the streams to better estimate stream gains and losses to aquifers.

In the Sacramento Valley floor, groundwater is explicitly modeled in CALSIM II using a multiple-cell approach based on DSA boundaries. For the Sacramento Valley, there are a total of 14 groundwater cells.

Currently no multi-cell model has been developed for the San Joaquin Valley. Instead stream-aquifer interaction is estimated from historical stream gage data. These flows are fixed and are not dynamically varied according to stream flows or groundwater elevation.

The approach to modeling groundwater in CALSIM II, a lumped-parameter tank model seems to be a reasonable approach. However, few details of this implementation were provided to the review panel, that it is not possible to assess its accuracy or reliability. Details of the calibration and verification activities performed to date should be carried out and reported for the groundwater tank model. The effect of using large size tanks should be assessed and the level of uncertainty in computed results reported. In addition, the effect of these uncertainties on CALSIM II calculations should also be assessed. The San Joaquin valley aquifers are not well represented in the tank model, but it is in the CVGSWM. The San Joaquin valley groundwater should also be modeled in CALSIM II.

Groundwater availability from aquifers is poorly represented in the model. This results from the fact that aquifers in the northern part of the state (Sacramento Valley) have not been investigated regarding storage and recharge characteristics. Thus, in the model, upper bounds on potential pumping from aquifers are undefined. This does not represent reality, since, if CALSIM II is used for statewide planning, it would allow pumping of vast quantities of water for export to southern parts of the state, something which agency staff claim is unrealistic.

Realistic upper bounds to pumping from any of the aquifers represented in the model need to be developed and implemented.

In addition, historical groundwater pumping is used to estimate local groundwater sources in the model. However, the information on the historical pumping is very limited, causing these pumping rates to be very uncertain. Better pumping information is needed and an analysis of the effect of this uncertainty on model results needs to be conducted.

In general, the level of representation of groundwater in CALSIM II is not reasonable from the point of view of the reviewers. This is due to several factors, perhaps the most important being the lack of information presented to the reviewers for their assessment. Another factor is the lack of data collected and analyzed by the State of California to properly account for groundwater resources in the Central Valley. These data are critical to an understanding of the availability of water in the state and the operation of the major water systems that supply water to agriculture and small municipalities in the Central Valley. Assumptions of unlimited groundwater resources in the Sacramento Valley are unfounded and unbelievable. Efforts should be taken to make reasonable estimates of these resources.

There are other approaches that provide reasonably accurate estimates of river-aquifer interactions and groundwater basin response, while not sacrificing computer time. The response function approach is a good example, whereby the CVGSM model is used to develop kernel functions describing this response. A similar approach is described in Fredericks, et al. (1998). These kernels may require readjustment as head conditions change in the basin, but they provide a more accurate prediction tool and are easily incorporated in the MIP model since they apply a linear superposition assumption and retain the linearity of the constraints in the model. A dynamically linked CALSIM-CVGSM configuration is not necessary for reasonably accurate solutions. If computer run time for CALSIM II is considered excessive now, it could only considerably worsen if this type of linkage is incorporated.

Soil moisture is not dealt with in a realistic manner and needs to be improved in applications where the model output might be sensitive to these assumptions.

3.6 Dynamic Variation of Priority Weights

A severe restriction in CALSIM II is the inability to dynamically vary the weights used to prioritize flow allocation in the system. It should not only be possible to dynamically vary these weights, but this variation should be conditional on the current system state, however that state (or states) is defined. In addition to dynamic variation of weights, more explanation is needed of the reservoir operating rules and how these rules are incorporated into CALSIM II. The description of operating rules used in the system is not very clear. For example, what kinds of hedging or shortage rules are used to mitigate the effects of drought?

3.7 Expanding Scope of CALSIM II

CALSIM II is a considerable advance on earlier models in that it fully incorporates both the State Water Project run by the Department of Water Resources and the Central Valley Project

operated by the Bureau of Reclamation. However to be able to examine the full range of Californian water issues, it would be desirable that all components of the linked system should be incorporated in the model including the Friant system, the larger Tulare Basin, and southern California and its links to the Colorado River. Also because of the very important linkage between surface water and groundwater use, improvements should be made in this area particularly with regard to how that linkage affects demand for surface water and how access to groundwater reduces the economic impact of surface water restrictions.

When expanding the geographical scope of the model to include non CVP-SWP areas, as well as Southern California, a hierarchical, decomposition approach would allow development of separate models for these areas that can then be linked together through iterative processes. Otherwise, the CALSIM II model can become extremely unwieldy. Again, integration can still be achieved through appropriate iterative interaction between the regional models. In the same vein, it is also unnecessary to explicitly integrate water quality and detailed water demand/consumptive use models into the model structure. Iterative schemes involving successive estimation of water quality and other parameters can produce comparable accuracy at reduced computer run times, while reducing the complexity of the model.

The replacement of DSM2 with a neural network is consistent with reinforcement or machine learning methods which are increasingly being used to replace complex, computationally time consuming models employed in decision support systems. The complex models are only used to provide the data sets used for training the neural network. Current research at Colorado State University and elsewhere is using neural networks for groundwater surface water interaction and return flow computation to replace computationally expensive groundwater models.

3.8 Key Model Outputs

In the past, the primary purpose behind the development of CALSIM II and its predecessors has been the examination of the reliability of water supplied to the State Water and the Central Valley Projects. However it is clear that there is now a demand for a model that will provide a wider range of outputs including:

- Water supply reliability for all water users
- Demand for water by existing users
- Outflows to Delta
- Use of groundwater and the rate of depletion of aquifers
- Water quality in the Delta and in the San Joaquin River
- Indicators of ecological health in particular with regard to key fish species
- The value of hydroelectric generation.

Although the modules in the CALSIM II package currently address many of these areas, the recognition that all these outputs are important may necessitate some further model development and a greater degree of testing and calibration of these parameters.

3.9 Modeling Allocation, Accounting and Operating Rules

CALSIM II uses a system of weights and constraints to define the water allocation process and the operating rules for storage reservoirs. Unfortunately these do not accurately reflect how operators of the state and federal water projects behave in managing their complex systems. Ideally, CALSIM should both reflect how the operators behave and be accepted by them as a useful tool when considering their management alternatives. The failure to achieve this limits the usefulness of CALSIM to investigate the specific operating or accounting rules that are of interest to those operators. For example, CALSIM II was not used to test changes to the accounting and allocation rules that have recently been proposed by the Department of Water Resources and the US Bureau of Reclamation because the rules that were changed do not exist in CALSIM II.

4. Options for Improving CALSIM

4.1 Optimization Model and Run Times

Many of the complaints regarding using of CALSIM II relate to long run times, which is not conducive to sensitivity or uncertainty analyses. Since CALSIM II employs a mixed integer linear programming (MIP) solver, the usual sensitivity information available in linear programming solvers, such as dual variables and right-hand-side ranging, are not available. The problem is that small changes in right-hand-side constants or objective coefficients (i.e., weights on water allocation priorities) can produce large abrupt changes in model solutions. In this case, dual variables do not provide useful information for MIP problems. Sensitivity analysis can only be conducted through trial and error processes involving incremental adjustment of important weights, coefficients, and uncertain data inputs with subsequent repetitive execution of the model. In light of this, it is crucial that the MIP solver employed in CALSIM II is upgraded. Significant advances have been made in MIP solvers, as described by Bixby, et al. (2000), which are not reflected in the current XA solver utilized in CALSIM II. There have been many recent improvements to the branch and bound method which should be incorporated, and the LP solver itself can be improved with better sparse matrix analysis. As planned by the CALSIM II developers, removal of the need for use of the FORTRAN 90 compiler will also improve run times when changes in optimization model structure are required.

4.2 Confidence in the model

The usefulness of a computer model in water resource management is only as good as the confidence that the stakeholders have in the accuracy and reliability of the model and the trust that they have in the modelers. There are several factors that affect that confidence and a number of ways that confidence can be improved.

- **Documentation**

Producing documentation of models requires considerable resources to do properly and ongoing resources to maintain especially when model development is continuing. Typically documentation of any water resource model is poorly done. However, where there are external model users, as is the case with CALSIM II, it is important. The survey conducted by Ferreira et al (2003) indicated that many users of the model thought that documentation of CALSIM II was poor.

- **Seminars**

In the Murray-Darling Basin, seminars with key users and interest groups in which the operation of the model is described and discussed have proved to be useful in increasing confidence in models. The practicality of this approach will depend on the number and location of the prospective participants and the resources available to support the process.

- **Data**

A model can only be as good as the data that is used to develop and calibrate it. The agreement over an acceptable set of hydrologic data that occurred during the development of CALSIM II is a considerable advance. However, there appears to be a need to improve the collection and use of data on water diversions and return flows. Because of the close links between the surface water use and groundwater use there also is a need to have better information on the use of groundwater.

The models used to calculate the Local Water Supplies in the Depletion Study Areas depend on estimates of surface water use, crop evapotranspiration rates and water use efficiencies developed using data from the 1970's. Confidence would be improved if more recent data were available to check these estimates.

- **Calibration**

A very good way to improve confidence in a model is to calibrate it against historical data to ensure that the model output is able to reproduce the observed data. Calibration is the process of using the model to reproduce the historical behavior of the system and then fine-tuning the model so that the match between modeled and observed values improves. The calibration of the model assists in detecting errors in the model and the input data. It also enables a comparison to be made between the way that the operators actually manage the system and the way that the model assumes that the system is managed.

A further consequence of the calibration process is that the statistics of the match between modeled and observed values can be used as a reasonable estimate of the absolute accuracy of the model output.

It is legitimate in a calibration/validation run to incorporate changes to infrastructure, institutional or operational rules as they occurred especially if these changes are specified as

input parameters to the model. This was done to a limited extent in the CALSIM II validation run with three regulatory periods modeled related to decisions made by the State Water Resources Control Board. It is also legitimate to incorporate growth in demand especially if that growth is described in a manner that is consistent with the way that demand is specified in the production run. Demand north of the Delta was specified in the validation run by inputting the historical crop areas.

A Calibration/Validation report should be very useful in demonstrating the accuracy of the model. However there are a number of elements in the CALSIM II validation run and the validation report which reduce that confidence including:

- State Water Project (SWP) demands south of the Delta were set at historical deliveries in years with no restriction and at the contractor's request level in restricted years. Neither of these pieces of information is available to a production run which calculates demand based on crop areas. Therefore the validation run does not provide reliable information on how well the model can represent these demands.
- The validation run omitted Article 21 deliveries. Although this omission will not affect the delivery of 'Table A' volumes south of the Delta, it will affect flow in the Delta and Delta water quality. Also, in the example model run presented in the paper by Draper A.J. et al (2003) which was supplied as part of the review, changes to Article 21 deliveries constituted the largest impact resulting from a change to the allowable pumping capacity at Banks between March and December. This suggests that the modeling of these demands is important.
- The DWR (2003) report produces estimates of SWP and Central Valley Project (CVP) deliveries south of the Delta but then adjusts them for changes in storage before presenting comparisons of those results with observed deliveries. This process merely checks that the model is preserving a water balance and does not present a legitimate validation of model deliveries.
- The report provides statistics on long term average deliveries and flows but no statistics on the fit for individual years. Additional analysis of the output would assist stakeholders to assess whether the estimate of water supply reliability and in particular the modeled volumes of water available in the most restricted years are accurate.
- In some instances, such as the examination of water quality in the Delta, the ability to accurately model monthly flows and deliveries will be important. The validation report contains no information that would enable the ability to model monthly flows to be assessed.
- A key model output is the water quality in the Delta. It would assist the validation of the model if a comparison of parameters such as the location of the X2 boundary was provided.

The users of CALSIM should recognize that models are a summary of what one believes to be true and important about a system. Validation is then an exercise to test how good that summary and understanding really is.

Appendix I contains brief descriptions of calibration modeling in the Murray-Darling Basin in Australia and in the State of Texas.

4.3 Assessment of the reliability of “delivered” water

An important recent application of CALSIM II which has drawn widespread attention is the “State Water Project Delivery Reliability Report. While this is an important step forward in the use of CALSIM for policy purposes, it highlights a number of issues, both conceptual and empirical, that need to be resolved in order to provide a more adequate assessment of the reliability of water supply in California.

First, it illustrates the need for sound calibration of CALSIM. The question being asked is not a comparative one – What are the consequences of changing some aspect of the system from X to Y? – but rather an absolute one – How does the system function at present? How often can users expect a shortage in deliveries of Z%?

Second, it highlights the fact any water system model such as CALSIM requires a blend of hydrology and behavioral analysis. To conduct a water balance, the model needs to know what deliveries are required by the customers of the given project, and what are the diversions by other user groups who extract water from the same surface or groundwater sources. These are fundamentally questions of economic and institutional behavior, not matters of hydrology. Therefore they cannot be dealt with by hydrologists alone. Like its predecessors, CALSIM tends to treat these as black boxes. The diversions by water users outside the CVP-SWP are taken as exogenously given, based on an assumed “level of development” and simplistic assumptions about the patterns of water use associated with that level of development. The deliveries required by the water users who are served by CVP-SWP are generally taken as given. For reasons explained below, both of these treatments are simplistic and unsatisfactory.

In CALSIM modeling exercises the level of development plays two different roles depending upon the context. In a simulation context, the level of development is used to represent hydrologic variability and uncertainty; in a calibration/validation context, it is used to reflect the actual historical demand for water withdrawals. These are very different purposes and it is important to keep them distinct. In most applications of CALSIM prior to the recent reliability study, the main focus was simulation and the representation of hydrologic variability. The chief purpose served by using 73 years of adjusted streamflow records was to represent the variability and uncertainty in the streamflow that one can expect to observe in any single year. Therefore, the calendar date of the record has no substantive significance, the (adjusted) streamflows for 1952 or 1982 are not being used to represent what happened historically in 1952 or 1982, but rather as an indication of the variation in streamflow that could be expected to occur next year, or any other year. In this context of simulating hydrologic variability, it makes good sense to apply the *same* level of development (i.e. the same pattern of water use) to every year in the sequence, rather than a series of different levels of development that vary with calendar time, because the streamflows represent alternative hydrologies that can occur in any given year.¹ The situation is different when one is conducting a calibration or validation

¹ This could be modified to allow for the fact that local weather conditions have a significant impact on irrigation (and urban) demands – e.g., farmers plant fewer acres of crops in a drought year. In that case, one could have different levels of water demand and extraction in different year *types*; but, these would all be keyed to the same overall level of economic development (e.g. the California economy in the 1990s). CALSIM II does not presently

exercise. In that case, one wants to represent the historical demands in 1952 or 1982 in order to compare what the model predicts with what actually happened. Therefore, in a calibration or validation exercise one wants the level of development to change each year in order to reflect the demand that occurred historically.

Both simulation and calibration/validation raise some other important technical issues. In the context of simulation, there are several different ways to generate a hydrologic sequence that is calibrated to a fixed level of development. One can use all 73 years for which data are available. One could use a subset of those years chosen either according to some deterministic rule or randomly. The subset could be oriented, for example, towards the extremes of the 73 sequence of annual records. However, the drawback of any approach based on sampling from the observed historical record is that it *understates* the full variability in streamflow that could be experienced in the future. The 73 years of record are drawings from a probability distribution the extremes of which extend beyond the minimum and maximum flows observed in the historical record. Relying on this record, therefore, understates the true minimum and maximum flows that might be encountered. In a reliability assessment exercise, one might want to take some steps to minimize the potential understatement of streamflow uncertainty. This could be accomplished by fitting a (parametric) probability model to the historical streamflow record and then sampling from the tails of the fitted distribution (Stedinger, 1981). The use of statistical models of streamflow variability could be considered in future applications of CALSIM to assess delivery reliability.

The assessment of delivery reliability requires that particular attention be given to the definition and measurement of the water users' demands. In this context, the user's demands play two roles: they affect the definition of "deliveries" and they influence the assessment of "reliability". With respect to deliveries, CALSIM II considers water to be delivered whenever it has the water irrespective of the ability of a contractor to use the water or to store it; The reality is that, if the contractor does not have a demand for the full quantity of water and is not able to store the excess, that amount will not be delivered. Therefore, the calculation of deliveries would be flawed. Furthermore, reliability cannot be assessed without reference to demand. Stating that a water supply system can deliver 100 acre feet in a wet year but only 70 acre feet in a dry year is useful only if one knows what the demands will be in wet and dry years. The implications are quite different if the user needs 105 acre feet per year than if he or she needs 65 acre feet per year. Thus, the users' demands should serve as the norm against which reliability is assessed. Instead, the recent reliability report uses the so-called 'Table A' water amounts as the norm for assessing deliveries to SWP contractors. This does not seem to be a satisfactory approach because there is no presumption that the Table A amounts, negotiated in 1960, measure the actual demands of SWP contractors in any particular year. The actual demands of the individual contractors will be influenced by how much storage they have, what access they have to other surface water or groundwater, and the demands of the farmers they serve to plant crops and apply water. Without accounting for these factors, it is difficult to generate a meaningful assessment of supply reliability.

consider the impact of annual weather conditions on demands. In order to model water demands accurately in a year, the climate conditions would be linked to the flow conditions to provide an input set for a particular year.

The assessment of reliability should ideally go beyond a comparison with quantities demanded to incorporate the notion of a loss function. If a user has a demand for 100 acre feet and can only receive 90 acre feet in one scenario and 80 acre feet in another, while the shortfall is twice as large in the second scenario the actual *consequences* of the shortfall to the user, in terms of lost profit or higher cost, might be more than twice as large. To assess the economic value of reliability, or the economic cost of a lack of reliability, one needs to be able translate shortages into monetary losses. To accomplish this, the warning time provided and the delivery shortfalls from CALSIM would need to be processed through an economic model of the value of water to different SWP contractors.

Because water users face difference demands and have access to different sources of supply, when assessing reliability it is unhelpful to aggregate all contractors and simply present the results in terms of total annual project deliveries, as was done in the report. Precisely because of the potential non-linearity of the loss function, a given aggregate shortfall can have different consequences when distributed differently among the individual contractors. A similar observation applies to the temporal distribution of delivery shortfalls across the year. It is unhelpful to aggregate supply system deliveries into an annual total, as done in the report. For a user to be able to obtain 100% of his or her demands in the period from March to May but only 60% in the next three-month period from June to August has different consequences than being able to obtain 80% in each of the six months. Furthermore, for both agricultural users and many urban users, major decisions affecting water use have to be made in the spring. They are based on the expectation around March about the amount of water that will subsequently be available for delivery during the summer months. What matters to these users when assessing supply reliability is the amount of water they can expect around March to be delivered over the summer, rather than the ultimate total delivery.

For both reliability assessment and also model calibration/validation, it is important to avoid excessive aggregation when describing shortfalls between demand and supply, or deviations between model predictions and actual outcomes. In regression analysis, it is the convention to measure the goodness of fit of a regression equation not by the average deviation but rather by the sum of the squared deviations. In ordinary least squares regression, by definition the average deviation is always zero (that is to say, the average of the predicted values of the dependent variable always equals the average of the actual values) regardless of how well or badly the regression equation fits the data. The average deviation thus provides *no* information regarding the goodness of fit; by contrast, the sum of squared deviations or the sum of the absolute values of the deviations are sensitive measures of goodness of fit. Although the calibration of CALSIM is not an exercise in least squares regression, the same general principle applies. To judge whether the model is doing a good job, the goodness of fit should be measured by reference to the disaggregate results and not simply by the overall average deviation.

Additional comments on the 2003 CALSIM II Validation Report are contained in Appendix F.

5. Managing CALSIM Development and Applications

The costs of not continuously and substantially improving our analytical capabilities are political (in terms of continued controversy and diminished agency credibility), economic (as inferior system performance for agricultural and urban water users), environmental (in terms of inferior environmental system performance), and financial (lawyers and policy consultants are more expensive than engineers and scientists).

CALSIM II is a substantial improvement over its predecessor models, DWRSIM and PROSIM, with a great deal more flexibility, transparency, and potential than these earlier models. The modeling team for CALSIM has identified an exciting and relevant vision of how modeling should be done for this complex and difficult system in the coming years. However, implementation of this vision in a coherent technical manner that leads to both technical and stakeholder credibility will be a difficult process, requiring financial and institutional support if this kind of capability is to be developed and sustained.

To accomplish these objectives CALSIM II developers need to be in an institutional position where they can see the model more as “outsiders” view it. This would allow them to be more responsive in supporting the credibility of their work and the relevancy of their tools and results to the broad range of current water management problems. As such CALSIM II should no longer be solely responsible to CVP-SWP managers, but should be responsible to a broader range of technical managers from additional interests, reflecting its current and prospective uses.

It would be imprudent to manage a state’s finances, a business, or a retirement plan without quantification – quantification in such matters is necessarily imperfect, but necessary nonetheless. While shortcomings have been identified in CALSIM II, it would be similarly irresponsible to manage California’s water budget without carefully-interpreted quantification. Progressive and continuous improvement in our quantitative understanding of California’s water system provides a common basis for improving its performance for all interests.

One possible means of maintaining control of the quality of particular versions of CALSIM II and accompanying models used for SWP-CVP planning and management decisions is to create an interagency modeling consortium (IMC) consisting of DWR, USBR, and persons from other stakeholder organizations if they are interested and want to participate. This consortium would be responsible for maintaining a toolbox of ‘acceptable’ models for ‘official’ use by the agencies and contractors.

IMC responsibilities and authority could include:

- Prioritize, coordinate, and provide consistency, technical guidance and oversight for all modeling applications,
- Approve model selection and insure that each requested application is carried out using the most appropriate model(s) and input data,
- Provide or otherwise insure documentation of the modeling process itself as well as the modeling results,

- Insure that the results are expressed and made available in a way such that others can understand and benefit from that modeling application, as applicable.
- Implement peer reviews of models and their applications as deemed appropriate.

To help meet their responsibilities the IMC will need to establish, publish and implement some procedures for insuring the quality of the entire model development and application process. They will need to identify among all the models that might be used, which are the most appropriate to address each of these separate groups of model applications. They must identify various models, i.e., establish a model toolbox, from which clients can choose the one that best meets their needs (or perhaps argue that another model should be added to the toolbox). The IMC will also need to maintain model documentation and provide for peer reviews of any model, its documentation, and/or its use in a project.

Further suggestions and discussion on the creation and operation of a possible IMC for model development and application, as well as for managing peer reviews of both the models and their applications, are contained in Appendix E.

6. Recommendations for Future Use, Development, and Application of CALSIM II

The most concise recommendation we might make would be to fix the shortcomings beginning with what are considered the most serious, and proceeding to those that are less serious, taking into account the time and other resources needed to address each weakness. However, we believe it is more useful to suggest ideas on how to systematically address both present shortcomings and those likely to emerge as stakeholders' quantitative understanding of California's water system and its problems continue to evolve.

6.1 Model development and support consortium

As discussed in the previous section and in Appendix E, it might be useful to explore creation of a broader interagency modeling consortium for developing operations planning models for California. The joint DWR-USBR development strategy used for CALSIM II has shown some notable successes, and should be expanded to include additional parties and sources of expertise. Such a consortium might include staffs from several agencies (DWR and USBR, as well as potential members from MWD, KCWA, CCWD, and other agencies), NGOs, some consultants, and universities. Such a model development forum would:

- a. Bring a wider range of expertise to bear on model development problems.
- b. Facilitate having more agencies involved in supporting model development with expertise and financial resources.
- c. Better enable model developers to see the model as "outsiders" see it.
- d. Potentially improve contracting for model development and testing.

- e. Take model development and testing outside of the explicit agency framework; a broader consortium should be more conducive to self-critical and transparent technical practices.
- f. Provide a common training ground for agency, NGO, and consulting staffs to become effective modelers, broadening the talent base for technical work in California.
- g. Reduce impediments to model development and testing arising from current State budgetary and personnel hiring problems.

Many of the questions, concerns, and problems mentioned in the user community interviews could be addressed well in such a distributed model development, testing, and support framework. It would still be necessary for each stakeholder group and agency to maintain its own modeling staff, but these would be partially shared in an interagency modeling consortium.

The governance and finance of such a consortium would be difficult and would probably require a steering committee or governing board, but any resulting model(s) would have broader credibility and a broader and deeper technical base.

In the immediate term, a users' group should be formed and the formal listing of model development activities should be posted on the web, including short descriptions of each development activity and contact information.

6.2 Quality Control Program

The DWR and USBR modeling team (or a broader model development consortium) need an explicit quality control program. Such a program should include a variety of activities:

- a. periodic external reviews on the broad modeling program
- b. specialized external reviews of model products and applications
- c. a standing (or sitting) external technical advisory body
- d. software engineering and maintenance
- e. a regime of model testing
- f. model and data documentation
- g. data development and management
- h. user group activities
- i. local agency and interest involvement
- j. model, data, and documentation accessibility (including web site use).
- k.

Such a quality control program would benefit from deep consultation with stakeholders and the broad community of water technical people, perhaps via the California Water and Environment Modeling Forum (www.cwemf.org).

6.3 A Training Program

DWR, USBR, and assorted agencies and consultants should establish a more formal common regimen to train new CALSIM II users in both CALSIM software and the complexities of actual system operation. All these groups currently rely on a relatively small pool of perhaps a

dozen knowledgeable CALSIM II users and all proclaim a need for many more capable users. A training regimen consisting of current CALSIM II training classes, supplemented by additional training in software application and system operation and apprenticeships or rotations through operations and model development shops would be useful to all concerned. The entire water community would benefit from having such expertise being widespread. Having widespread CALSIM II modeling expertise also makes explaining CALSIM II and its results easier. This might be an appropriate activity for a model development consortium.

6.4 Extend Improvements in Modeling Practice to Supporting Models

CALSIM II is at the center of a web of additional models used by DWR, USBR, and other agencies to prepare inputs for CALSIM II and post-process outputs from CALSIM II.

Delta controversies and difficulties of representation seem endemic to problems of modeling Central Valley operations. The technical basis for representations of Delta operations and water quality performance requires a similar level of transparency and testing to avoid this becoming a “weak link” in the Valley-wide operations planning model. Since so much is based on the DSM2 Delta model, documentation of fairly strenuous tests of the DSM2 model are highly desirable. This would provide a firm foundation for the use of ANN or other approaches for summarizing DSM2 behavior in an operations model. Similar documentation, testing, and development are desirable for the other models mentioned above which provide data for CALSIM II (CVGSM/IGSM, CVPM/CALAG, IWR-MAIN, LCPSIM, CU model, and SIMETAW).

6.5 Hydrologic Data and Data Development

An effort should be made to step back and perhaps re-define a more systematic and solid basis for developing hydrology for water management models of California’s inter-tied water system. Currently, several efforts exist to develop surface or groundwater hydrologies for parts of the Central Valley (sponsored by DWR-USBR, USACE-Sacramento District, USEPA, USGS, CALFED, local agencies, etc.). An effort should be made to broaden the range of hydrologic expertise involved in hydrology data development for management modeling of California’s inter-tied water system, and establish a consistent and high, but reasonable, standard of documentation and testing for developed data and any underlying hydrologic models. Establishing such a standard of documentation and testing would make existing hydrologic studies more accessible and useful for future studies and encourage the comparison and further development of existing representations of the system’s hydrology.

6.7 Performance-Based Optimization

Performance-based optimization should be added to CALSIM’s capabilities; it would not be difficult in terms of software or data, and would add much greater ability to explore and seek improvements in management within a complex system. The multi-period optimization approach being developed (CAM) is an operations-oriented first step in this direction, but could be expanded without great difficulty.

For large-scale water resource systems of great complexity and many options for system management, it is often difficult to find “optimal” operations with simulation modeling. There are simply many myriads of decision options and combinations of options, which theoretically each require a simulation model run – which would be prohibitive in terms of analysis cost and time. In such situations, performance-based optimization models, such as those seeking maximum economic performance, can offer useful insights as to where to look for improving system operations and management. Metropolitan Water District of Southern California (MWD) and San Diego County Water Authority (SDCWA) employ performance-based optimization modeling of parts of California’s water system to gain strategic insights for planning and management. An economic-engineering optimization model has been developed for California and, despite significant limitations, shows several insights for California (CALVIN), suitable for identifying promising operational and management strategies worthy of more detailed analysis (Jenkins et al. 2001; Draper et al. 2003; Jenkins et al. 2004). The CALSIM II modeling approach could easily be adapted to provide greater functionality to this type of performance optimization. Having performance-based optimization capability together with a compatible simulation model for more detailed analysis and trade-off evaluation could greatly improve the capability of California’s water community to explore and develop promising and creative options for improving operations, facilities, and overall system management.

6.8 Modular and Layered Versions of CALSIM II

Speedier versions of CALSIM II are needed for operations planning and integrated water planning studies. Such versions would be regional modules of CALSIM II (for regional studies) or explicitly aggregated system-wide models from the most detailed CALSIM II schematic for system-wide or statewide studies. Both approaches would simplify the model for particular purposes, yet be tied to a common detailed schematic and detailed hydrologic, operations, and water demand data sets.

Geographically modular or aggregated system-wide versions would allow additional local and regional water management options to be represented for particular operations and policy planning purposes and allow users to more quickly explore and develop operating policies. The final runs from such integrated or exploratory studies could then be evaluated using a more detailed and complete version of CALSIM II.

Modular regional models might represent regions with relatively few inter-ties, such as: Sacramento Valley, Delta and eastside streams, San Joaquin Valley, San Francisco Bay Area, Tulare Basin, and Southern California (DWR’s South Coast and Colorado River hydrologic regions). (We have had good success with the CALVIN model of California with 5 modular regional models, which combine to form a system-wide model. These geographic sub-models greatly improved quality control in model development, work flow and data checking, and identification of problems in the model.)

6.9 Model Calibration and Testing

Many approaches exist for model calibration and testing (Modeling Forum 2000). Calibrating a planning model oriented to operations in an uncertain and distant future is always challenging. For a model that serves many uses (including policy-urgent uses unforeseen by developers), use-specific testing will often be impossible within a responsive time frame and budget. Such unavoidable situations call for more thorough, general, and well-documented model calibration and testing than would otherwise be needed.

For the model to have technical credibility, stakeholder credibility, and to serve the kind of training and reference function needed for the water management community, a systematic and coherent means of setting parameter values in the model and documenting these values is needed. Similarly, a systematic self-critical means of testing is needed for a model to establish and retain credibility, and have defined limitations, for a range of applications.

A potentially excellent resource for model testing is comparisons of seasonal operations planning CALSIM II model runs with recent years' seasonal operations, as done by actual operators. Similarly, system operators could scrutinize historical simulations, such as those in the recent November report, for systematic differences from operating practice. Such comparison with operator policies and philosophy could also be performed with SWP or CVP delivery reliability estimates. Such comparative analyses would both help define the likely (and unavoidable) differences between actual and modeled operations and water deliveries and identify potential opportunities to narrow such differences.

Credibility arises, in part, from demonstration that problems and limitations are systematically identified and addressed or considered in model development and in making and interpreting model runs. This can be accomplished by use of documentation, metadata, written guidance, and protocols and logs for identifying model problems and recording model improvements.

Given present and anticipated uses of CALSIM II, the model should be calibrated, tested, and documented for "absolute" or non-comparative uses. This is what many applications require today and will be increasingly desired and required in the future. Maintaining the traditional "comparative-only" use of CALSIM II is undesirable if the model is to be useful for the CVP and SWP systems, the operations of water contractors, or for statewide planning purposes.

6.10 Documentation of Model Improvements

Along with better documentation of model versions, logs of data and model improvements and "bug fixes" should be maintained. Explicit protocols and records for identifying and correcting modeling errors and problems would enhance the credibility of the modeling effort with technical people and policy makers. Such protocols also provide an internal aid to staff and staff development in modeling. I understand that this kind of record-keeping is done, but the precise form of, nature, and extent of this record-keeping is unclear. It would be useful and reassuring to stakeholders and policy makers to know that this kind of record-keeping of the software and data was being done.

6.11 Better Model Integration in Decision-Processes and Stakeholder Education

Greater aid should be given to interested parties and decision-makers who must work with the unavoidable limitations of any model. If possible, a document should be prepared for stakeholders and interested parties outlining the model, summarizing the model's primary limitations, and providing guidelines for interpreting model results. Those developing policy-making forums and processes should thoughtfully incorporate computer models in these processes in ways that do not assume model omniscience, or otherwise place too great or exclusive a reliance on model results.

Models and model results will never be perfect. If models are to be important for planning and policy-making, they must be presented and used in ways that enlighten policy-makers more than they add confusion and controversy to already difficult situations, if possible.

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Appendix A: CALSIM II Science Review

Dates: Nov 13-14th
Location: Bay-Delta Room, CBDA Offices
650 Capitol Mall, 5th Floor
Sacramento, CA

Day 1: The Management Context, Model and Application Details

9:00 Welcome – Kim Taylor

- Overview of the CALFED Bay Delta Program -
- [Introduction of the Panel](#)

9:15 Water issues in California – [Francis Chung](#)

- General Hydrology
- SWP/CVP
- Operational challenges
- Sacramento-San Joaquin Delta – [Ron Ott](#) (5 min.)

9:35 Panel Q&A

9:45 Planning Models – [Andy Draper](#)

- CALSIM software
- CALSIM II application overview
- Interaction with other models

10:10 Panel Q&A

10:20 Break

10:30 Summary of CALSIM Applications

- DPLA/CalFed/US Bureau of Reclamation: Integrated Storage Investigations – [Steve Roberts](#)
- Bay Delta Office (DWR): SWP Delivery Reliability Report - [Kathy Kelly](#)
- USBR: Multi-layered modeling to simulate CVPIA (b)(2) water and Environmental Water Account Operations – [Nancy Parker](#)
- Operations Control Office (DWR): Oroville Relicensing, SWP Allocation decision procedure – [Curtis Creel](#)
- Department of Planning and Local Assistance (DWR): California Water Plan Update – [Kamyar Guivetchi/Ken Kirby](#)

12:15 Panel Q&A

12:30 Lunch

1:15 Summary of User and Stakeholder Interviews

1:15 Interview Summary and Findings – [UC Davis](#)

1:35 Panel Q&A

1:50 Public Comment

2:15 CalSim II Details

- Development philosophy – [Francis Chung](#)
- Operation priorities, constraints, common assumptions – [Erik Reyes](#)
- Hydrology development – [Andy Draper](#)
- Delta water quality constraints – [Ryan Wilbur](#)

3:15 CalSim Evaluation

- Historical Operations Study / Sensitivity Analysis – [Sushil Arora](#)

3:30 Panel Q&A

3:45 Break

4:00 Future Directions

- Data Structure / Version Control / Multi-Period Prescriptive Optimization – [Ryan Wilbur](#)
- Daily Time Step - [Dan Easton](#)
- CalSim II – CVGSM Integration – [Tariq Kadir](#)
- Water Quality / Upstream Models – [Nancy Parker](#)

5:00 Panel organizational meeting (additional information needs, questions of specific staff, discussion plan)

Day 2—Panel Deliberations and Preliminary Report

8:30 Panel Q&A with specific DWR and USBR staff on request

9:30 Panel *in camera* discussions

11:00 Panel presentation of draft main findings—[Pete Loucks](#)

12:00 Wrap up and next steps - [Kim Taylor](#)

Appendix B: Briefing Material for CALSIM II Peer Review

California Water

Averting a California Water Crisis (3 pages)

California Water Today, Bulletin 160-0, Chapter 2 (20 pages)

Water Supplies, California Water Plan Update, Bulletin 160-98, Chapter 3 (11 pages)

Urban, Agricultural and Environmental Water Use, California Water Plan Update, Bulletin 160-98, Chapter 4 (17 pages)

California's Major Water Projects (map) (1 page)

CVP and SWP

State Water Project Operations (6 pages)

Central Valley Project Operations (16 pages)

CalSim and CalSim II Overview

CalSim: A Generalized Model for Reservoir System Analysis (19 pages)

CalSim Software Details

CalSim water resources simulation model: Users guide (18 pages)

CalSim water resources simulation model: Wresl language reference (11 pages)

CalSim II Details

Network Representation (1 page)

Sacramento-San Joaquin Delta Operations (9 pages)

Coordinated Operating Agreement (3 pages)

Reservoir Rule Curves (2 pages)

CalSim ANN Implementation (8 pages)

CVPIA (b)(2) Management and Operations (6 pages).ii

EWA Management and Operations (8 pages)

Multi-Cell Groundwater Model (2 pages)

SWP and CVP Delivery Allocation Logic (3 pages)

Hydrology Development

Surface Water Hydrology Development for CalSim II (8 pages)

Supporting Computer Models

Model Interaction (1 page)

CALAG (2 pages)

CU Model (2 pages)

DSM2 (2 pages)

IGSM2 – CVGSM (4 pages)

LCPSIM (5 pages)

CalSim II Evaluation

Planned Sensitivity Analysis (7 pages)

CalSim II Simulation of Historical SWP-CVP Operations - Extracts (61 pages)

CalSim II Applications

CalSim II Project Applications Summary (not completed)
SWP Delivery Reliability Report – Extracts (25 pages)
North of Delta Offstream Storage Investigations (3 pages)
In-Delta Storage Investigations (3 pages)
California Water Plan Update 2003 (3 pages)
CalSim II and SWP Operations Control Office (1 page).iii

Future Model Development

(a) CalSim Software

CalSim Multi-period Prescriptive Optimization (not completed)
CalSim Daily Time Step Model (not completed)
CalSim Water Quality Module (not completed)
Data Structure / Version Control (not completed)
CalSim Graphical User Interface (not completed)

(b) CalSim II Applications

CalSim II – CVGSM Integration (not completed)
CalSim II Geographical Expansion (not completed)
Global Climate Change (not completed)
Refined Spatial Resolution (not completed)
Expansion of Land Use Based Demands (not completed)
CalSim II – CALVIN Integration (not completed)
Revision of Urban Water Demands (not completed)

(c) Supporting Models

Replacement of Consumptive Use Model (not completed)

Appendix C: CALSIM II Review Process and Timeline

Establishing the Peer Review Panel

Dr. Pete Loucks (Cornell University and South Florida Water Management District) has accepted the CALFED Science Program's invitation to chair the panel. Other members are being currently being contacted by the Science Program staff

Organization of Briefing Material

Science Program and key agency staff, in consultation with the review panel chair, are identifying and organizing briefing material for panel members. Target date for completion is Sept 1, 2003. (This was extended to December 8, 2003)

Public Meeting of Review Panel

Target: 2-day session in November, 2003 in Sacramento area

Review workshop structure will include:

- Presentation overviews of California hydrology, water management, current issues, and the development of CALSIM II
- Presentations on the range of different current and potential applications of CALSIM for planning, operations, and supply reliability projects
- A summary of an independent interview project by Dr. Jay Lund of users and stakeholders explaining the major questions people are trying to answer with CALSIM II and other models
- Public comment to the panel
- Detail discussion of the model, including assumptions used in different applications, verification studies, and sensitivity analyses
- Opportunity for panel members to ask follow up questions of CALSIM developers and users
- An in camera session for panelists to discuss and begin compiling review comments
- A public presentation of the panel's draft findings

Panel Chair Provides Final Report to CALFED Lead Scientist

The panelists will be asked to finalize their review comments within 3 weeks of the public meeting and to transmit those directly to the Lead Scientist. The Science Program will transmit the completed review to CBDA and the CALFED community.

Appendix D: Panelists CALSIM II Review, Nov. 13-14, 2003

Name	Affiliation	Position	Address/Phone/E-mail
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Pete Loucks	Cornell University	Professor	"Civil and Environmental Engineering, 311 Hollister Hall, Ithaca, NY 14853 " (607) 255-4896 DPL3@cornell.edu
Jay Lund	UC Davis	Professor	Civil and Environmental Engineering 3109 Engineering III, Davis, CA 95616" (530)752-5671 irlund@ucdavis.edu
Daene McKinney	University of Texas at Austin	Professor	Civil and Environmental Engineering Campus Mail Code: C1786, Austin, TX 78712 (512)471-8772 daene_mckinney@mail.utexas.edu
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Appendix E: Managing Model Development, Application, Documentation and Communication.

One possible means of maintaining control of the quality of particular versions of CALSIM II and accompanying models used for SWP-CVP planning and management decisions is to create an interagency modeling consortium (IMC) consisting of DWR, USBR, and persons from other stakeholder organizations, including NGOs and universities, if they are interested and want to participate. This consortium would be responsible for maintaining a toolbox of ‘acceptable’ models for ‘official’ use by the agencies and contractors.

IMC responsibilities and authority could include:

- Prioritize, coordinate, and provide consistency, technical guidance and oversight for all modeling applications,
- Approve model selection and insure that each requested application is carried out using the most appropriate model(s) and input data,
- Provide or otherwise insure documentation of the modeling process itself as well as the modeling results,
- Insure that the results are expressed and made available in a way such that others can understand and benefit from that modeling application, as applicable.
- Implement peer reviews of models and their applications as deemed appropriate.

To help meet their responsibilities the IMC will need to establish, publish and implement some procedures for insuring the quality of the entire model development and application process. They will need to identify among all the models that might be used, which are the most appropriate to address each of these separate groups of model applications. They must identify various models, i.e., establish a model toolbox, from which clients can choose the one that best meets their needs (or perhaps argue that another model should be added to the toolbox). The IMC will also need to maintain model documentation and provide for peer reviews of any model, its documentation, and/or its use in a project.

CMM Level 3 Performance Expectations

Firms that develop professional software are typically required to meet certain software standards. One such standard is defined in a book from Carnegie Mellon University. These so called Capability Maturity Model (CMM 1994) standards have various levels. For example, the South Florida Water Management District, that develops hydrologic models used as inputs to major investment decisions, strives to meet Level 3 standards. To meet such standards in software development and peer review, one needs to show that

- Modeling related problems are anticipated and prevented

- Model development and application groups work together as an integrated product team.
- Model use training is planned and provided as is needed.
- New modeling methodologies are identified and evaluated for possible implementation on a qualitative basis.
- Data are collected and used in all defined processes.
- Data are systematically shared across various projects.
- Both the models and their applications are evaluated and judged satisfactory by independent reviewers.

It seems to this panel that CALFED could without too much difficulty meet such standards if it chose to. Clearly planning for, conducting, and documenting these activities will require additional time and money. The expectation is that in the long run, such documentation and review will save time and money by redirecting misguided initiatives, identifying alternative approaches, or providing valuable technical support for a potentially controversial decision.

Model Toolbox

The IMC in collaboration with all agencies involved in water resources planning could be responsible for creating and maintaining a collection of models that agencies can use to meet their needs. As shown in Figure 1, this collection of models might be called the model toolbox. The criteria to be used as a basis for deciding whether a proposed model should or should not be included in the toolbox will depend in part on an assessment of the attributes of that model compared to alternative models and the suitability of the model to meet the needs of the project. Associated with the model toolbox is a library of completed model application documents and data bases for use by anyone who could benefit from them.

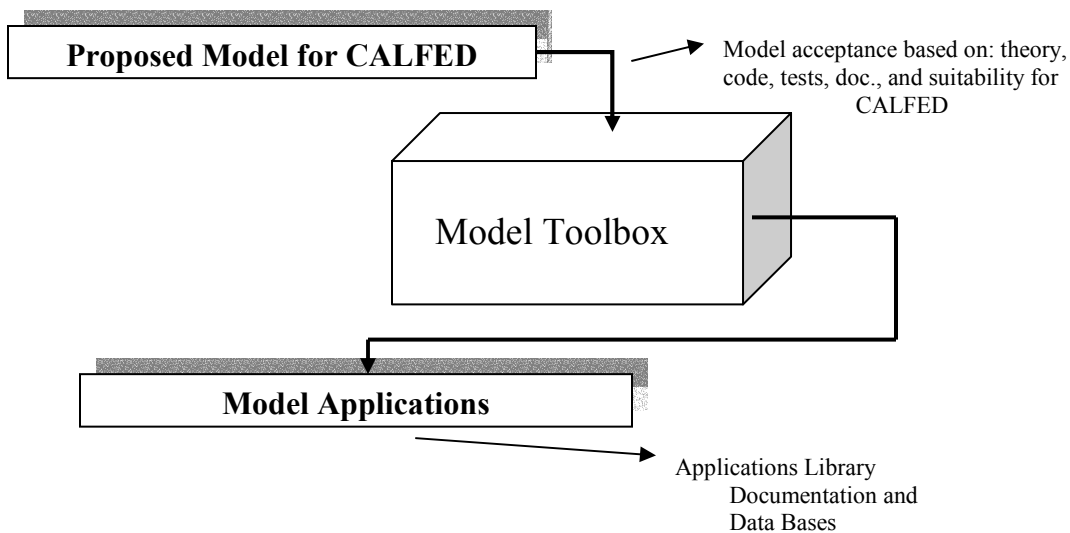


Figure 1. Model Toolbox consisting of approved models for use and Applications Library consisting of documentation and model data bases.

Everyone would agree that all modeling applications should be performed with the ‘best’ models available. But ‘best’ does not mean that all models used should be the most detailed, complex, realistic and thus usually the most expensive models available. The decision regarding the ‘best’ or most appropriate model should be based on the particular issues or questions being addressed, on the quantity and quality of the available input data, and on the time, personnel, and money available to perform the modeling application. The central question to be answered before initiating any modeling application is just what model output information (and precision) is needed to meet the needs of the decision making process. Expressed in other words, just how sensitive will the decision be to the type, amount and precision of the model output?

IMC in consultation with the other agencies could provide guidance on the adequacy of a particular version of CALSIM II or other associated model requested by each client with respect to the theory upon which it is based, its data requirements, its spatial and temporal resolutions, its documentation and status with respect to peer reviews, its capabilities, and its limitations. Similar considerations must be given to the proposed input data. To provide these services to each client requesting services from the IMC would require IMC to be staffed with personnel acquainted with the models in the toolbox, as well as be able to perform or review the simulations requested by various agencies.

There will likely be requests to use models not yet included in the model toolbox. IMC together with others from the DWR and/or USBR will need to judge the merits of such requests and if deemed beneficial, consider including such models in the toolbox. Undoubtedly the extent and quality of the documentation, testing, and peer review of various models in the toolbox will vary. However, a model’s inclusion in the toolbox should signify that the model has been judged to be the best available for meeting the goals for which it was designed and is applicable to conditions in California.

Information Flows and Documentation

The IMC will probably be devoting a substantial amount of time giving guidance to clients and, when applicable, to the public. They will need to be working with the clients who are requesting model applications, and in situations where they are not doing this work, they will need to be reviewing and approving the work of the agencies or contractors who are performing the modeling services. IMC would provide technical assistance as well as oversight and coordination among all CALSIM II modeling activities.

Requests for modeling are easy to make, and time and money are required to carry them out. Requests sent to this proposed IMC should reflect some thought by those requesting such model runs as to just why the model application is desired, and just how the results are to be used. We would propose that requests include such items as:

- Reason for modeling,

- Type of modeling (e.g., event based or continuous),
- Particular model preference if any, and why, and possible alternatives,
- Model output information (data) needed and why and when it is needed,
 - What questions are the model results going to answer?
 - What issues are being studied?
 - What decisions are to be made, or at least to be informed, based on these model results?
 - When are the model results needed?
 - What formats are desired for presenting the model results?
- Location or site being modeled and the spatial and temporal scales desired,
- Particular input data assumptions, boundary conditions and other regional assumptions required,
- Source of input data, and format required or desired for the output data,
- Model calibration and verification needs and preferred procedures if any,
- Money and time available for modeling,
- Extent (duration) of the simulations to be performed,
- Desired performance measures, other than variables being simulated, if any,
- Alternative scenarios to be modeled (i.e., number of simulation runs needed),
- Other analyses or model applications that may or will need the output from this model application,
- Sensitivity and uncertainty analyses needed, and for which decision variables and why,
- Client contact person,
- Requirements for intermediate reviews of results or needs for periodic review of modeling application process logs and documents, and
- Other particular requirements or needs.

The use of a model nearly always takes place within a broader context. The model itself can also be part of a larger whole, such as a network of models in which some are using the outputs of other models. These conditions may impose constraints on the simulation modeling project. All these considerations need to be specified in the modeling application request.

Along with the proposal, there should also be a simple order-of-magnitude estimate of the expected values of all relevant decision variables based on simple mass-balance analytical solution methods that can be used without requiring a computer. These estimated values should be used to validate (check the reasonableness of) selected portions of the model runs. If there are any serious discrepancies, it may signify a major problem in the model output.

Is all this paperwork useful? It is to the extent it leads to a more effective and efficient use of personnel, money and time. Preparing a formal modeling application request requires some serious thought as to just why this is necessary and just what information is needed to further the project or analysis. It involves defining the objectives that are to be accomplished. Writing this down in some detail helps reduce the differences in perception that can exist between those who need information and those who are going to provide that information (IMC or a contractor). The problem as stated is often not the problem as understood, by either

the client or the model user. In addition, problem perceptions and modeling objectives can change over the duration of a project. One should ask and answer the question of whether or not modeling in general is the right way to obtain the needed information. What are the alternatives to modeling?

The objective of any modeling project should be clearly understood with respect to the domain and the problem area, the reason for using a particular model, the questions to be answered by the model, the model assumptions and limitations, and the scenarios to be modeled. Throughout the project these objective components should be checked to see if any have changed and if they are being met.

If IMC is to serve as a central point to coordinate CALSIM II-related modeling activities, and to provide modeling services, it needs to have the authority to do so. This authority extends to giving advice on issues related to model and input data selection, and for reviewing, approving and prioritizing requests for services. Should contractors be involved in particular model applications, IMC must be authorized to specify the technical terms to be met and oversee the work done by the contractor. Finally IMC will need the financial and human resources needed to do this in a timely manner.

Modeling Application Documentation

One common problem of model studies once they are underway occurs when one wishes to go back over a series of simulation results to see what was changed or why a particular simulation was made or what was learned. It is also commonly difficult if not impossible for third parties to continue from the point at which any previous modeling project was terminated, especially if some time has passed. These problems are caused by a lack of information on how the study was carried out. What was the pattern of thought that took place? Which actions and activities were carried out? Who carried out what work and why? What choices were made? How reliable are the end results? These questions should be answerable if a model journal is kept. Just like computer programming documentation, modeling project documentation is often neglected under the pressure of time and perhaps because writing it is not as interesting as running the models themselves.

The paper trail of what has happened, what assumptions have been made, how calibration and verification were carried out, what results were obtained, why changes, if any, were made, what sensitivity analysis procedures were used and their results, and so on, could be contained in a modeling application documentation (MAD). Once the model application is completed, a copy of the MAD should be given to the requesting agency, as applicable and a copy should remain in IMC. These reports, or at least a summary of them, should be available for downloading from the web. Should further model applications be requested and approved, the requester as well as the IMC can refer to this previously prepared documentation to better understand what was done previously that pertains to the current request.

Model Calibration

Once a model is tested satisfactorily, it can be calibrated. Calibration of models such as CALSIM II are difficult because there are no historical observations of future scenarios to compare with model results. Historical runs, such as have been made, can provide some basis for calibration. In general the smaller the deviation between the calculated model results and the field observations, the better the model. This is true to a certain extent, as the deviations in a perfect model are only due to measurement errors. In practice, however, a good fit is by no means a guarantee of a good model.

The deviations between the model results and the field observations can be due to a number of factors. These factors include possible software errors, inappropriate modeling assumptions such as the (conscious) simplification of complex structures, neglecting certain processes, errors in the mathematical description or in the numerical method applied, inappropriate parameter values, errors in input data and boundary conditions, and measurement errors in the field observations.

To determine whether or not a calibrated model is a 'good' predictor, it should be validated or verified. Calibrated models should be able to reproduce field observations not used in calibration. Validation can be carried out for calibrated models if an independent data set has been kept aside for this purpose. If all available data are used in the calibration process in order to arrive at the best possible results, validation will not be possible. A decision to leave out validation may be a justifiable one especially when data are limited.

Philosophically it is impossible to know if a simulation model of a complex system is 'correct'. There is no way to prove it. Experimenting with a model, such as by carrying out multiple validation tests, can increase confidence in that model. After a sufficient number of successful tests, one might be willing to state that the model is 'good enough', based on the modeling project requirements. The model can then be regarded as having been validated, at least for the ranges of input data and field observations used in the validation.

If model predictions are to be made for situations or conditions for which the model has been validated, there may be some confidence in the reliability of those predictions. Yet one cannot be certain. Much less confidence can be placed on model predictions for conditions outside the range for which the model was validated.

While a model should not be used for extrapolations as commonly applied in predictions and in scenario analyses, this is often exactly the reason for the modeling project. What is likely to happen given events we have not yet experienced? A model's answer to this question should also include the uncertainties attached to these predictions. Depending on the type of model selected and used, one might end up predicting an incorrect future with great accuracy, or predicting the correct future with great uncertainty'. We don't yet know how to predict the correct future with great accuracy – so we do 'what ifs'. One can then argue about what scenarios – the ifs – are the most reasonable or probable, or about the impacts from improbable scenarios that you want to avoid should such scenarios occur.

Use the model

Once the model has been judged ‘good enough,’ the model may be used to obtain the information desired. Close communication between the client and the modeler during the modeling application process is essential to avoid any unnecessary misunderstandings about what information is wanted and the assumptions on which that information is to be based.

Before the end of this model-use step one should determine whether all the necessary simulations have been performed and whether they have been performed well. Questions to ask include

- did the model fulfill its purpose?
- are the results valid?
- are the quality requirements met?
- was the discretization of space and time chosen well?
- was the choice of the model restrictions correct?
- was the correct model and/or model program chosen?
- was the numerical approach appropriate?
- was the implementation performed correctly?
- what are the sensitive parameters (and other factors)?
- was an uncertainty analysis performed?

If any of the answers to these questions is no, then the situation should be corrected. If it cannot, the reason(s) for why it cannot be corrected should be documented in the model application document (MAD).

Interpret model results

Interpreting the information resulting from models is a crucial step in the modeling application process, especially in situations in which the client may only be interested in those results and not the way they were obtained. The model results can be compared to those of other similar studies. Are the results consistent? IMC must make that judgment. Any unanticipated results should be discussed and explained. The results should be judged with respect to the modeling project objectives.

The results of any modeling project typically include large files of time-series data. Only the most dedicated of clients will want to read those files. Thus these data must be presented in a more concise form. Statistical summaries should explicitly include any restrictions and uncertainties in the results. They should identify any gaps in the domain knowledge, thus generating new research questions or identifying the need for more field observations and measurements.

Report model results

Once the modeling application is completed, the organization doing the modeling will be responsible for preparing a report. The contents of this report should conform to the agreement

made between modeling organization and the client prior to the initiation of the modeling application (see above). Although the results of a model are very rarely used as the sole basis for policy decisions, those requesting model applications may have a responsibility to translate their model results into policy recommendations. Policymakers, managers, and indeed the participating stakeholders typically want simple and clear unambiguous answers to complex questions. Much of the scientifically justified discussion, say regarding the uncertainties associated with some of the data, included in the main body of a report are not included in the executive summary of that report. This executive summary is often the only part read by those responsible for making decisions. Therefore, the conclusions of the model study must not only be scientifically correct, but also concisely formulated, without jargon, and fully understandable by managers and policymakers. When preparing or reviewing contractor model results reports, the IMC should consider this need.

These model application and model results reports should include sufficient detail to allow others to reproduce the model study (including its results) and/or to proceed from the point where this study ended. The report therefore requires a clear indication of the validity, usability and any restrictions of the model results.

Data Management

CALSIM II and its associated or linked models will require data. They will also produce data. Many of these data will have spatial and temporal dimensions. This information must be documented (meta data), preserved, and made accessible to IMC customers, coordination agencies and others. IMC should participate in data management strategic development, storage, documentation and dissemination. It should work with data base managers of various agencies to help them satisfy the IMC's data management requirements.

The availability of quality assured data is a critical dependency that must be met to facilitate timely completion of model development, implementation and application. To mitigate the impact of the availability of data on the timeline for the major model completion deadlines, the following issues should be addressed. :

- Updating land use / land cover data at regular and timely intervals.
- Developing and maintaining a common modeling database. This data base should include infrastructure design and operating policy data as well as water quality, ecological, land use, economic and of course hydrological data. Many of these data sets will have spatial as well as temporal dimensions. Each data set should have an associated metadata file.
- Pre-processed and post-processed datasets from previous model runs should be archived along with its metadata file in a central location for ease of access and availability.
- Measures to insure the consistency and quality of the input data.
- Measures to insure adequate communication among model developers, users and stakeholders. This includes measures to assist in developing documentation appropriate for each type of stakeholder.

Support of IMC activities

Common failures of IMC type organizations are typically due to:

- Insufficient staff to enable cross-training. This may lead to the dependency on one person or a very small group of employees for each sub module or the overall effort.
- Inadequate funding to institute good project management discipline.
- Inadequate funding to contract for technical writers and software engineers.
- Inadequate funding to contract for peer reviews.

Risk assessments

A risk assessment of CALSIM II and its associated models and data should be completed. The timely availability of quality assured data for example, is a risk. Project risk management includes the processes concerned with identifying, analyzing, and responding to uncertainties. Risk management attempts to minimize the results of adverse events. As a guide, the template, such as shown at the end of this Appendix, may be used to facilitate the assessment of risks.

Problem Management

Given the high visibility and criticality of the CALSIM II modeling effort an issue or problem management process should be developed within IMC. Issue/problem management includes the process for identifying, communicating, and resolving issues and problems.

The purpose of this procedure is to ensure that:

- Issues are identified, reported, managed, and resolved in a timely and effective manner. Responsibility is assigned to an owner for reporting, managing and resolving each issue
- All affected stakeholders are aware of the status of the issues
- Escalation of unresolved issues take place according to a defined procedure

In order to ensure that project issues and problems are appropriately managed various issue/problem management steps should be identified and followed to track the actions taken to resolve the issue or problem throughout the life of a modeling project.

B. Managing Peer Reviews

One means of quality control involves peer reviews of the models, their associated software, and their applications. One possible means of facilitating the peer review processes and for maintaining control on the particular versions of CALSIM II and accompanying models used for SWP-CVP planning and management decisions is another reason to create an interagency modeling consortium (IMC) consisting of DWR, USBR, and other stakeholder organization personnel if they are interested and want to participate. As suggested above, this consortium could be responsible for maintaining a toolbox of 'acceptable' peer-reviewed models for use by the agencies and contractors. The peer reviews should be of the theory underlying each

model, the model's software, the documentation of that software, the model's functions and capabilities including those pertaining to model data input and output, model calibration and verification, sensitivity analyses, uncertainty analyses, user control (GUIs), spatial and temporal resolutions, limiting assumptions, and on the model (as opposed to code) documentation.

Just having evidence of published articles about a particular model in peer reviewed journals is not a substitute for a peer review of the model software and its applicability or suitability for certain types of analyses for SWP-CVP. Peer reviews of all models, their software, and their use should be accomplished by experts both within and outside of the originating agencies. 'Inside' agency (or internal) reviews may uncover some needed changes and identify other issues or problems that external reviewers could be asked to specifically examine and address. Internal reviews can make the external review process more effective, less costly and less time consuming.

Peer reviews are considered a key process area for Level 3 and higher of the Capability Maturity Model guidelines for improving the software process (Carnegie Mellon University, 1994). The purpose of peer review evaluations is to find defects in the model formulation and software and in its use, i.e., model application. Peer reviewers can also identify possible ways of correcting those defects, if any. If there are no defects, or after all known defects have been corrected, both the developers and users of any model and its software can have a stronger basis for believing that their product and its output are reliable.

Peer reviews serve the same function as accountants. Once a firm's financial records have been peer reviewed by accountants (assuming they are qualified, objective and honest) the board of directors as well as the stockholders will have more assurance of the liabilities and net worth of their firm, and just how well it is being managed. In this case it is the assurance of the quality of the models, their software, and on their use in project evaluations, that actual and potential users of the model results depend upon.

The types of problems and issues for which a model, its software, and its documentation are designed to address are called the model's 'application niche'. Peer review of model development should include the evaluation of the intended application niche along with consideration of other aspects of model performance. Users of any model should be aware of the types of analyses for which the model is best suited and those for which the model is not well suited. This, along with the results of a peer review of any model application, should help the potential model user, or the user of the model results, better understand the limitations of the scientific basis of the model and just how much confidence can be placed on the model output.

Peer review triggers

Clearly judgment will have to be exercised as to just when and in what detail a peer review needs to be implemented. However the triggers on when a decision about a peer review needs to be made can be defined.

As shown in Figure 2, decisions regarding peer review are needed when models are proposed for the tool box and when model applications are completed. Should IMC decide a peer review is warranted when either of those events takes place, they will have to decide on the type of review and its level of detail. They will also need to identify the individuals to be asked to carry out that peer review.

Peer reviews are going to take time and cost money. They will also require IMC time to prepare the documentation needed for the peer reviewers and to read and act on reports prepared by the peer reviewers. This will apply if the peer review is internal or external.

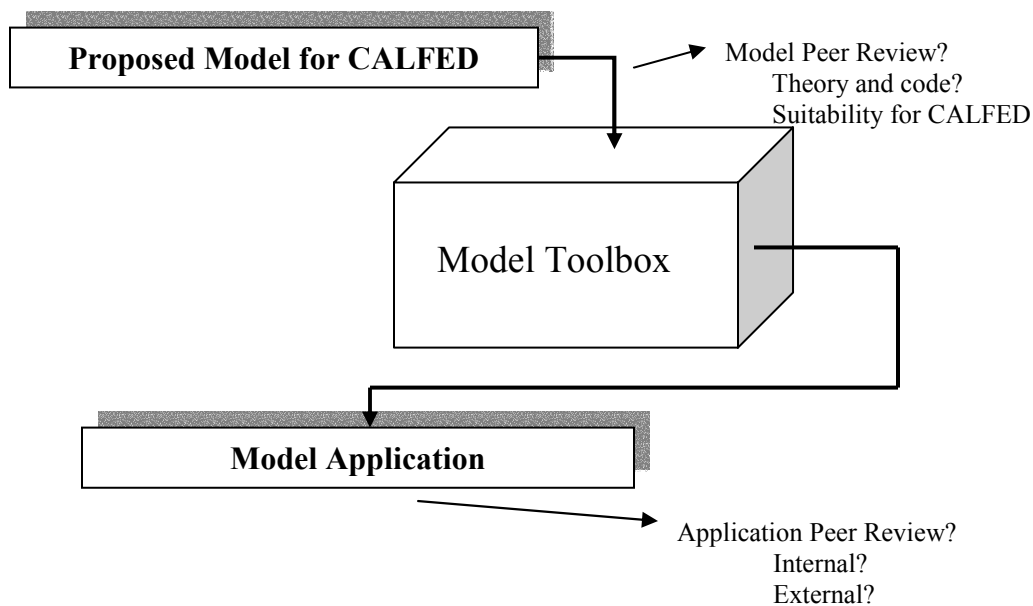


Figure 2. Schematic showing events where a peer review decision can be made.

The particular models and their associated software and documentation to be peer reviewed should be identified by the individuals or departments or agencies. This can include model process descriptions, software source code, documents, test results, and other supporting materials, as needed, for an adequate peer review of the entire model and its software. These products to be reviewed should be identified in writing and a written history of the review of different versions of each item should be maintained.

Events that take place in the progression of model development and use and subsequent modifications that warrant a peer review should be identified and specified in a written document. (This fits in to the model development and use documentation that should be maintained for Level 3 or higher CMM) When these events take place a peer review process should be considered, and if warranted, implemented. Depending on the event, the review can be solely internal, or it can involve an independent external review team as well.

Model application reviews should include an evaluation of the intended model application niche, and its applicability to current needs. Peer review may be appropriate for existing models when new information becomes available that could negate some or all of the conclusions of previous reviews or suggest a change in the currently specified application niche. Peer review of a model's applicability to a particular study should be planned well in advance of when model results are needed. The results of application reviews can influence the decisions made based on the model outputs. Once a peer review has been conducted for a particular model and its input data, peer reviews of subsequent applications of a model with similar inputs might be unnecessary. However, any time the model results may be controversial, or end up in litigation, another peer review may be justified.

Peer Review Process

The extent and process of performing and responding to peer reviews can vary in any organization. The ones discussed in this section attempt to follow the processes recommended by the Capability Maturity Model Level 3 guidelines.

Project peer review process should be specified in writing. A first step in this process should be to identify the particular modeling products and processes that will undergo peer review. This includes the models (i.e. the processes being modeled and the assumptions built into the models for describing these processes), their supporting software, the documentation of the model and its software, as well as all the written guidelines on how the models are to be used.

A second step is to perform an internal peer review prior to a model's use for project evaluation. It should be peer reviewed for accuracy, its suitability for use, and for identifying any possible errors in its logic, its coding, or in its documentation. Following an internal review, an external peer review can be performed.

Following the successful conclusion of internal and external peer reviews of a model and its documentation, the model can be applied to evaluate alternative projects. After the model has been applied to a particular project, the modeling process and its results should be peer reviewed to insure that the model has been applied properly, that the input data were appropriate, and that the conclusions drawn were valid.

Peer review teams should be selected, along with a peer review team leader. The particular personnel on the team will depend on the particular model and its software and documentation being reviewed. CALFED should have a list of qualified peer reviewers representing all applicable disciplines, both internal and external, that it can call upon to perform these reviews. The peer reviews are to be of the models and their use, not of the people who developed or used them. The reviews are to be used to evaluate the quality of modeling products and processes, not of the personnel involved.

Establishing and carrying out ongoing peer review processes costs money. Adequate funding must be made available to

1. identify and recruit a peer review team and team leader
2. prepare and distribute the peer review materials to the peer review team
3. support the time required for the team to review the materials prior to a team meeting
4. support the team meeting and to participate in it as appropriate (e.g., answering questions, conducting model experiments and sensitivity analyses, etc.)
5. reproduce and distribute the team report and to take actions as needed
6. monitor the modifications or changes being made to the model, its software, and its documentation, or redoing the model application, as needed.
7. prepare and distribute to model developers and potential users a report on the results of the peer review and the actions taken.

The particular peer review process may depend on just what is being peer reviewed and the resources and time available to perform the review. In general, however, the steps of a peer review could include the following:

1. DWR or CALFED should identify and establish a pool of possible reviewers representing various disciplines, with sufficient redundancy to allow for scheduling conflicts when ever some subset of those reviewers are needed. This includes both internal as well as external reviewers. What ever administrative work is need to establish this pool should be completed prior to when these reviewers will be needed.
2. At particular milestones in any new model development or in model application an internal peer review process could be initiated, to examine the modeling assumptions, the software that implements those assumptions in the case of model development or the data being used for model inputs in the case of model applications, and the documentation being prepared to describe the processes, to document the software code, and to document the tests that were run to test the code, or to document the results of the model application. If deemed appropriate, an external peer review could also be performed. If an external review is to take place, the particular reviewers need to be selected, notified, sent supporting documents, and be scheduled for one or more meetings, as needed. They should be issued contracts specifying the requirements (the checklist of items to be reviewed) and products expected.
3. Recommendations made by the peer review team need to be addressed and the actions taken along with the rationale for those actions should be documented.
4. The peer review team should review the actions taken and the results obtained from these actions. If not judged acceptable new recommendations should be made and submitted. A final report should be prepared by the peer review team when all recommendations have been successfully implemented or addressed, or if no further actions based on review team's recommendations will be taken by the model developers or users.

The time and effort required for various levels of review should also be assessed and provided to the review team so that they can carry out the level of review requested of them. Otherwise the reviews may be superficial and while appearing to be peer reviewed, a model and its

associated products may in fact be inadequately reviewed. Peer review teams have the responsibility to specify in writing the scope and limitations of their reviews.

As was the case for this peer review panel, the materials to be sent to the review team to allow them to prepare for their meeting should include the statement of review objectives and the level of detail desired, the applicable requirements and standards upon which to judge the adequacy of the products being reviewed, and of course the material that is to be reviewed. There should be a list of questions for the reviewers to address. Each review team member should be assigned and given responsibility for answering specific questions and for completing specific aspects of the overall review. All team members should be given specific review standards or requirements, including the expected completion dates. Checklists should be provided the review team that are applicable to the specific type of product being reviewed and the level of detail to be examined. These checklists will contain the criteria for judging the product, such as compliance with any standards and procedures, completeness, correctness, rules of construction, and maintainability.

Peer Review Issues and Questions

Each model development or application review will dictate its own special set of questions to be addressed. Some of these questions could relate to:

- Model Purpose and Objective
 - Use of model related to decisions being considered.
 - Model application niche, and why.
 - Model strengths and weaknesses –is it the best model?
- Model Processes and Limitations
 - Model processes, spatial and temporal scales, grid resolution.
 - Model variables and level of aggregation.
- Model Theoretical Basis
 - Model algorithms, numerical or analytical methods,
 - Model process formulation
 - Modeling approach in comparison with other models
 - Any shortcomings in relation to application niche
- Model Parameter Estimation
 - Methods used
 - Data available for parameter estimation
 - Parameter estimate reliabilities
 - Boundary conditions and appropriateness.
- Model Input Data Quantity/Quality
 - Data used in design of model
 - Data adequacy (quantity, quality, resolution) for model purpose and application
 - Data necessary for application of model
 - Key data gaps in model application
 - Additional data needs and why
- Model Key Assumptions
 - Basis for major assumptions

- Sensitivity of model outputs to key assumptions
- Sensitivity of potential decisions to key assumptions
- Ease in modifying key assumptions
- Model Performance Measures
 - Criteria for assessing model performance
 - Correspondence of model output with measured observed data
 - Any model bias throughout range of model predictions
 - Variability and uncertainty analyses and representations in model results
 - What determines model's variability and uncertainty.
 - Model performance relative to others in application niche
- Model Documentation and User's Guide
 - Clarity of documentation, comprehensiveness of user's guide
 - Model applicability and limitations
 - Input data requirements for calibration, verification, model runs
 - Post modeling analyses, display and interpretation of results
 - Model code documentation
 - Model application documentation examples for prospective users.
- Review Retrospective
 - How well model and its application meet objectives and needs of project
 - Possible changes in the model to improve model performance
 - Robustness of model solutions to small changes in uncertain parameters, etc.
 - Ease of including uncertainty analyses associated with uncertain input data.
 - Key research needs for model improvement.

Peer Review Completion Reports

Procedures need to be established to track and confirm actions based on suggested changes or modifications in the material being reviewed. Once these actions are taken and completed, and documented, the peer review process for that particular product is completed. Peer review completion reports should contain data on what was reviewed and the results of the review. These data should include a description of the products that were reviewed, the level of detail of the review, any review limitations or qualifications, the number and backgrounds of the reviewers, the time spent preparing for and during review team meetings, the defects found and recommendations made, and the actions taken to address these recommendations.

Overall Peer Review Evaluations

The IMC or initiating agency should document the planning for and scheduling of peer reviews. The products to be reviewed and the level of detail to be examined also need to be specified. The procedures to be followed for selecting peer review team members, and the team leader, should also be determined and documented. Procedures for training potential reviewers, if such training is needed, should be identified and implemented, as required.

Periodically the IMC or applicable agency should assess just how well the plan described in the preceding paragraph is being carried out, and just how beneficial these peer reviews are to the overall modeling effort. Measures should be identified and used to determine the status of the

peer review activities. These measures could include the number of completed peer reviews performed compared to the number expected to be performed, the overall effort expended on peer reviews compared to that expected, and the number and extent of peer review recommendations requiring actions.

At a minimum these periodic reviews should verify that

1. The planned peer reviews and/or audits are conducted.
2. The peer review leaders are adequately trained for their roles.
3. The reviewers are properly trained or experienced in their roles.
4. The processes for preparing for and conducting peer reviews, and for following up on reviewer's recommendations are adequate and are being followed.
5. The reporting of peer review results is complete, accurate, timely and is being made available to model users.

Risk Management Template

Risk Definition Name	Enter a short name that uniquely defines the risk
Risk #	Enter a unique number assigned to the risk. Range starts with 1 and continues.
Date Risk Identified	Enter the date the risk was identified
Risk Identification Source	Enter the source of the risk identification. In example, meeting name, group, or person.
Risk Owner	Enter the name of the person who will be responsible for ensuring the risk is approved, managed, periodically assessed, communicated, and tracked through closed or transfer.
Risk Detailed Description	Enter a detailed description of the risk so that a reader clearly understands the risk.
Probable Impact of Risk on Project (H, M, L)	<p>Enter the impact on the project.</p> <ul style="list-style-type: none"> o High = the risk will most likely occur and the impact could prevent the project from achieving its purpose. o Medium = there is a 50/50 change the risk would occur and the impact is serious but the project could still achieve its purpose if appropriately managed. o Low = there is a low probability that the risk would occur and minimal impact to the project's purpose.
Probable Impact of Risk on Project Costs	Enter the impact on the project in dollars. Determine what the potential cost to the project would be if the risk occurs.
Probable Impact of Risk on Project Schedule	Enter the schedule impact on the project. Determine how the schedule would be potentially impacted if the risk occurs.
Probable Impact of Risk on Project Results	Enter the impact on the project. Determine how the overall project purpose and results will be potentially impacted if the risk occurs.
Detailed Plan to Mitigate or Transfer Risk	Enter the detailed plan to mitigate the risk or a statement that the risk will be accepted. Mitigation could include ways to minimize, avoid, or transfer the risk to another party or group. Risk transfer would include evidence of agreement by the accepting party.
Detailed Project Action Items Required to Mitigate or Transfer Risk	Enter the detailed action items required to mitigate the risk. These items will be summarized and assigned within the project Action Log, along with an action item owner, and target completion date.
Detailed Project Plan Tasks Required to Mitigate Risk	Enter the detailed project plan task required to mitigate the risk. These items will be summarized and contained within the MS Project Schedule along with the effort, duration, schedule, and assigned resources.
Comments	Enter any permanent comments that cannot be included in the above items.
Referenced Documents	Enter any documents that a reader should consider in understanding, analyzing, mitigating, or accepting this risk.
Date Risk Closed	Enter the date this risk was closed. This would include when all action items or project tasks were completed, or the risk was transferred to another party or group.

Appendix F: Analysis of the November 2003 CALSIM II Validation Report

The following comments come from an analysis of the model results presented in the validation report ‘*CALSIM II Simulation of Historical SWP/CVP Operations*’, DWR (2003). The observations relate to the formulation of the model at November 2003. Changes might be made to that formulation which could resolve these issues.

Overestimation of Project Deliveries

The validation run suggests that the modeled demands included in CALSIM II overestimate the actual demands. CVP demands south of the Delta are assumed to be always equal to the contract entitlement whereas the observed deliveries in unrestricted years are consistently less than this amount. The modeled North of Delta deliveries are also consistently higher than observed. The modeled and observed CVP deliveries from the validation report are listed in Table 1.

Table 1. Comparison of modelled and observed CVP deliveries (1975-1998)

Project	Simulated Delivery (Taf/yr)	Historical Delivery (taf/yr)	Difference (taf/yr)	% Difference
CVP North of Delta	1960	1750	210	12
CVP South of Delta	2650	2490	160	6.4

Because the SWP south of delta demands were set to historical deliveries in many years, comparison with the historical deliveries in the validation report is of limited validity. However the fact that the historical SWP deliveries over the last ten years have averaged only 2385 taf/year while the modeled ‘year 2001 development’ SWP Delta deliveries reported in the 2002 State Water Project Delivery Reliability Report average 3090 taf/year, suggests that modeled SWP deliveries may also be too high.

Allocations to Project Contractors

Seasonal allocations to SWP and CVP contractors are made on the basis of water in storage, forecast inflows, projected carryover storage requirements and in-Basin and Delta regulatory requirements. The allocation processes used by the operators and those used by CALSIM II, are not identical. An examination of the way that CALSIM II has restricted project deliveries during the dry period of 1987-1992 (Figures 10, 16, 17 and 24 of the validation report) suggests that CALSIM II has allocated less water in the early years of the dry sequence than occurred in practice and consequently had more water available in 1991 and 1992 when the most severe restrictions were experienced. The carryover storage rules adopted can have a significant impact on the expected frequency and severity of water supply restrictions. The

model rules need to be examined to ensure that they accurately reflect the way the system will be managed in the future.

San Luis Reservoir Operation

The rules used by the system operators for transferring water from headwater storages to the San Luis Reservoir can have a significant impact on:

- the pattern of flow in the Delta,
- the operation of accounting rules between the SWP and the CVP and
- opportunities for SWP wheeling of CVP water and possibly the availability of Article 21 water to SWP contractors.

A comparison of the modeled and observed storage behavior of the SWP component of San Luis (Figure 15) reveals that the model consistently underestimates the volume in storage. A comparison of the CVP component of the storage (Figure 23) indicates that the actual storage is filled earlier in the season and that the actual storage is also slightly higher than the modeled.

Users of CALSIM II output need to be confident that the rules adopted by the model for determining these transfers reflect the way this component of the system will be operated in the future.

Appendix G: Some Principles for Strategic Water Analysis for the California Water Plan Bulletin 160-03 (from the stakeholder review Draft, Sept. 30, 2003)

Strategy:

- 1) A frequently amended strategic document will lay out DWR's strategic analysis framework and identify the technical objectives, roles, and responsibilities of major DWR data collection efforts and analytical tools and their interactions and their responsible managers.

Transparency:

- 2) All data and models should be in the public domain and available on the web.
- 3) All data and models should have significant documentation.
- 4) Known limitations should be documented.

Longer-term viability:

- 5) Modularity: Major analytical tools will be designed and implemented to fit modularly and explicitly within the larger strategic analysis framework.
- 6) Adaptive data management framework: Major data efforts will fall within a larger data management framework, including protocols for data documentation and updating, and documentation of limitations.
- 7) A frequently-updated document will outline short-term and long-term efforts, budgets, and responsibilities for continuous improvement of analytical tools and data, with policy for continued user, local agency, and stakeholder involvement.

Coverage:

- 8) Spatial coverage for the basic data and analytical framework will be statewide.
- 9) Local and regional water management and resources will be explicitly represented.

Accountability and Quality Control:

- 10) In developing analytical tools, systematic efforts should be made to involve local agencies and stakeholders.
- 11) Major analytical products will undergo external review by a) external unaffiliated experts and b) local agencies whose systems are included in the model. User groups will exist for all major analytical products.
- 12) DWR's strategic analysis framework will undergo periodic internal and external review.

Appendix H: Model Sensitivity and Uncertainty Analysis

(This is a draft of a book chapter by DPL/JRS that may be useful for CALSIM II developers)

- 1. Introduction**
- 2. Issues, concerns, and terminology**
- 3. Variability and uncertainty in model output**
 - 3.1 Natural variability**
 - 3.2 Knowledge uncertainty**
 - 3.3 Decision uncertainty**
- 4. Sensitivity and uncertainty analyses**
 - 4.1 Sensitivity Analyses**
 - 4.2 Uncertainty Analyses**
- 5. Performance indicator uncertainties**
 - 5.1 Performance measure target uncertainty**
 - 5.2 Distinguishing differences between performance indicator distributions**
- 6. Communicating model output uncertainty**
- 7. Conclusions**
- 8. References**

The usefulness of any model is in part dependent on the accuracy and reliability of its output data. Yet, because all models are imperfect abstractions of reality, and because precise input data are rarely if ever available, all output values are subject to imprecision. The input data and modeling uncertainties are not independent of each other. They can interact in various ways. The end result is imprecision and uncertainty associated with model output. This chapter focuses on ways of identifying, quantifying, and communicating the uncertainties in model outputs.

1. Introduction

Models are the primary way we have to estimate the multiple affects of alternative water resource system design and operating policies. Models predict the values of various system performance indicators. Model outputs are based on model structure, hydrologic and other time-series inputs and a host of parameters whose values describe the system being simulated. Even if these assumptions and input data reflect, or are at least representative of, conditions believed to be true, we know they will be wrong. Our models are always simplifications of the

real systems we are studying. Furthermore, we simply cannot forecast the future with precision. So we know the model outputs of future conditions are uncertain estimates, at best.

Some prediction uncertainties can be reduced by additional research and data collection and analysis. Before undertaking expensive studies to gather and analyze additional data it is reasonable to ask what improvement in estimates of system performance or what reduction in the uncertainty associated with those estimates would result if all data and model uncertainties could be reduced. Such information helps determine how much one would be willing to 'pay' to reduce prediction uncertainty. If prediction uncertainty on average is costing a lot, it may pay to invest in additional data collection, more studies, or in better models all aimed at reducing that prediction uncertainty. If that uncertainty has no, or only a very modest, impact on the likely decision that is to be made, one should find other issues to worry about.

If it appears that reducing prediction uncertainty is worthwhile, then one should consider how best to do it. If doing this involves obtaining additional information, then it is clear that the value of this additional information, however measured, should exceed the cost of obtaining it. The value of such information will be the increase in system performance, or the reduction in its variance, that one can expect from obtaining such information. If additional information is to be obtained, it should be that information which reduces the uncertainties considered important, not the unimportant ones.

This chapter reviews some methods for identifying and communicating model prediction uncertainty. The discussion begins with a review of the causes of risk and uncertainty in model output. It then examines ways of measuring or quantifying uncertainty and model output sensitivity to model input imprecision, concentrating on methods that seem most relevant or practical for large-scale regional simulation modeling. It builds on some of the statistical methods reviewed in Chapter III and the modeling of risk and uncertainty in Chapter VI.

2. Issues, concerns, and terminology

Outcomes or events that cannot be predicted with certainty are often called risky or uncertain. Some individuals draw a special and interesting distinction between risk and uncertainty. In particular, the term risk is often reserved to describe situations for which probabilities are available to describe the likelihood of various events or outcomes. If probabilities of various events or outcomes cannot be quantified, or if the events themselves are unpredictable, some would say the problem is then one of uncertainty, and not of risk. In this chapter what is not certain is considered uncertain, and uncertainty is often described by a probability distribution. When the ranges of possible events are known and their probabilities are measurable, risk is called objective risk. If the probabilities are based solely on human judgment, the risk is called subjective risk.

Such distinctions between objective and subjective risk, and between risk and uncertainty, rarely serve any useful purpose to those developing and using models. Likewise the distinctions are often unimportant to those who should be aware of the risks or uncertainties associated with system performance indicator values.

Uncertainty in information is inherent in future-oriented planning efforts. Uncertainty stems from inadequate information and incorrect assumptions, as well as from the variability of natural processes. Water managers often need to identify both the uncertainty as well as the sensitivity of, or changes in, system performance indicator values due to the any changes in possible input data and parameter values from what were predicted. They need to reduce this level of uncertainty to the extent practicable. Finally, they need to communicate the residual uncertainties clearly so that decisions can be made with this knowledge and understanding.

Sensitivity analysis can be distinguished from uncertainty analysis. Sensitivity analysis procedures explore and quantify the impact of possible errors in input data on predicted model outputs and system performance indices. Simple sensitivity analysis procedures can be used to illustrate either graphically or numerically the consequences of alternative assumptions about the future. Uncertainty analyses employing probabilistic descriptions of model inputs can be used to derive probability distributions of model outputs and system performance indices. Figure 1 illustrates the impact of both input data sensitivity and input data uncertainty on model output uncertainty.

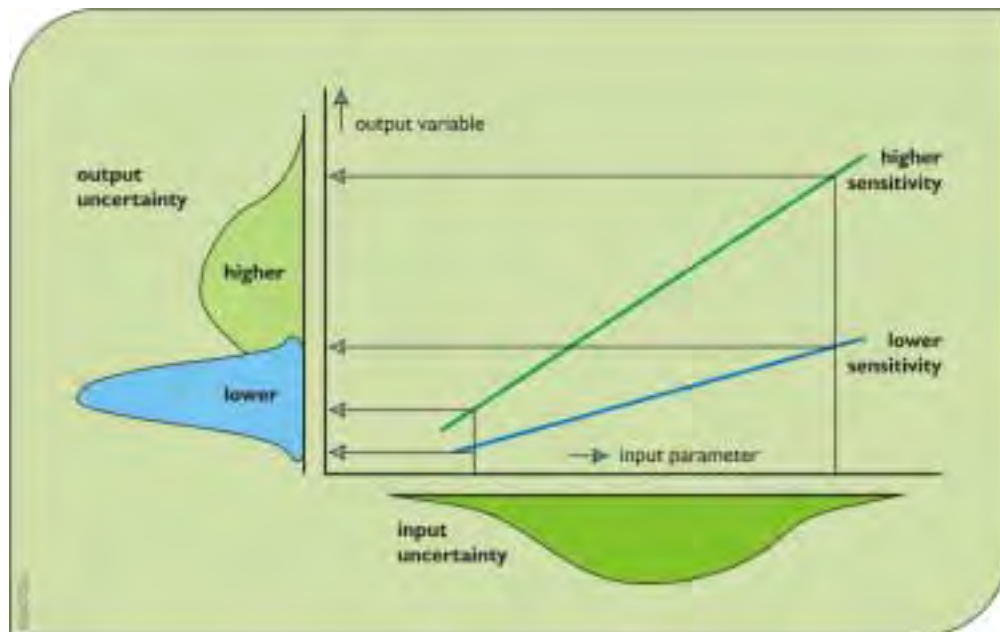


Figure 1. Schematic diagram showing relationship among model input parameter uncertainty and sensitivity to model output variable uncertainty (Lal, 1995).

It is worthwhile to explore the transformation of uncertainties in model inputs and parameters into uncertainty in model outputs when conditions differ from those reflected by the model inputs. Historical records of system characteristics are typically used as a basis for model inputs. Yet conditions in the future may change. There may be changes in the frequency and

amounts of precipitation, changes in land cover and topography, and changes in the design and operation of control structures, all resulting in changes of water stages and flows, and their qualities, and consequently changes in the impacted ecosystems.

If asked how the system would operate with inputs similar to those in the historical database, the model should be able to interpolate within the available knowledge base to provide a fairly precise estimate. Still that estimate will not be perfect. This is because our ability to reproduce current and recent operations is not perfect, though it should be fairly good. If asked to predict system performance for situations very different from those in the historical knowledge base, or when the historical data are not considered representative of what might happen in the future, say due to climate change, such predictions become much less precise. There are two reasons why. First, our description of the characteristics of those different situations or conditions may be imprecise. Second, our knowledge base may not be sufficient for calibrating model parameters in ways that would enable us to reliably predict how the system will operate under conditions unlike those that have been experienced historically. The more conditions of interest are unlike those in the historical knowledge base, the less confidence we have that the model is providing a reliable description of systems operation. Figure 2 illustrates this issue.

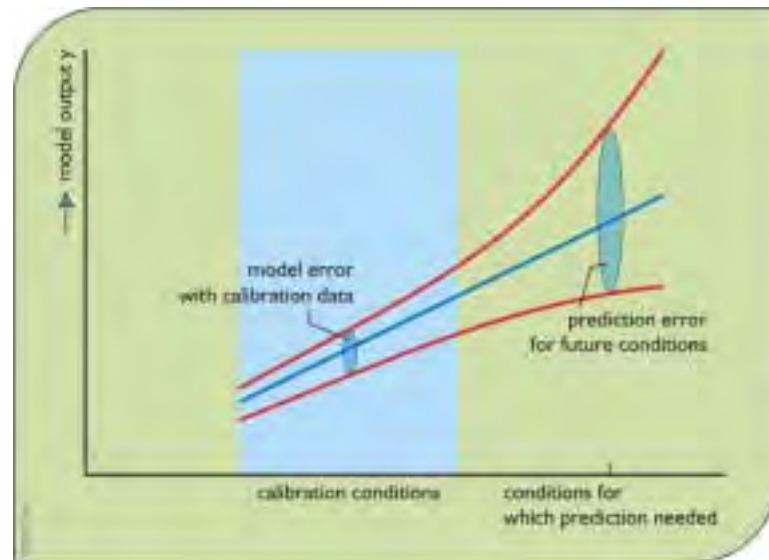


Figure 2. The precision of model predictions is affected by the difference between the conditions or scenarios of interest and the conditions or scenarios for which the model was calibrated.

Clearly a sensitivity analysis needs to consider how well a model can replicate current operations, and how similar the target conditions or scenarios are to those described in the

historical record. The greater the required extrapolation from what has been observed, the greater will be the importance of parameter and model uncertainties.

The relative and absolute importance of different parameters will depend on the system performance indicators of interest. Seepage rates may have a very large local effect, but a small global effect. Changes in system-wide evapotranspiration rates will likely impact system-wide flows. The precision of model projections and the relative importance of errors in different parameters will depend upon the:

- (1) precision with which the model can reproduce observed conditions,
- (2) difference between the conditions predicted and the historical experience included in the knowledge base, and the
- (3) system performance characteristics of interest.

Errors and approximations in input data measurement, parameter values, model structure and model solution algorithms, are all sources of uncertainty. While there are reasonable ways of quantifying and reducing these errors and the resulting range of uncertainty of various system performance indicator values they are impossible to eliminate. Decisions will still have to be made in the face of a risky and uncertain future. Decisions can be modified as new data and knowledge are obtained in a process of adaptive management.

There is also uncertainty with respect to human behavior and reaction related to particular outcomes and their likelihoods, i.e., to their risks and uncertainties. As important as risks and uncertainties associated with human reactions are to particular outcomes, they are not usually part of the models themselves. Social uncertainty may often be the most significant component of the total uncertainty associated with just how a water resource system will perform. For this reason we should seek designs and operating policies that are flexible and adaptable.

When uncertainties associated with system operation under a new operating regime are large, one should anticipate the need to make changes and improvements as experience is gained and new information accumulates. When predictions are highly unreliable, responsible managers should favor actions that are robust (e.g., good under a wide range of situations), gain information through research and experimentation, monitor results to provide feedback for the next decision, update assessments and modify policies in the light of new information, and avoid irreversible actions and commitments.

3. Variability and uncertainty in model output

Differences between model output and observed values can result from either natural variability, say caused by unpredictable rainfall, evapotranspiration, water consumption, and the like, and/or by both known and unknown errors in the input data, the model parameters, or the model itself. The later is sometimes called knowledge uncertainty but it isn't always due to a lack of knowledge. Models are always simplifications of reality and hence 'imprecision' can result. Sometimes imprecision occurs because of a lack of knowledge, such as just how a

particular species will react to various environmental and other habitat conditions. Other times known errors are introduced simply for practical reasons.

Imperfect representation of processes in a model constitutes model structural uncertainty. Imperfect knowledge of the values of parameters associated with these processes constitutes model parameter uncertainty. Natural variability includes both temporal variability and spatial variability, to which model input values may be subject.

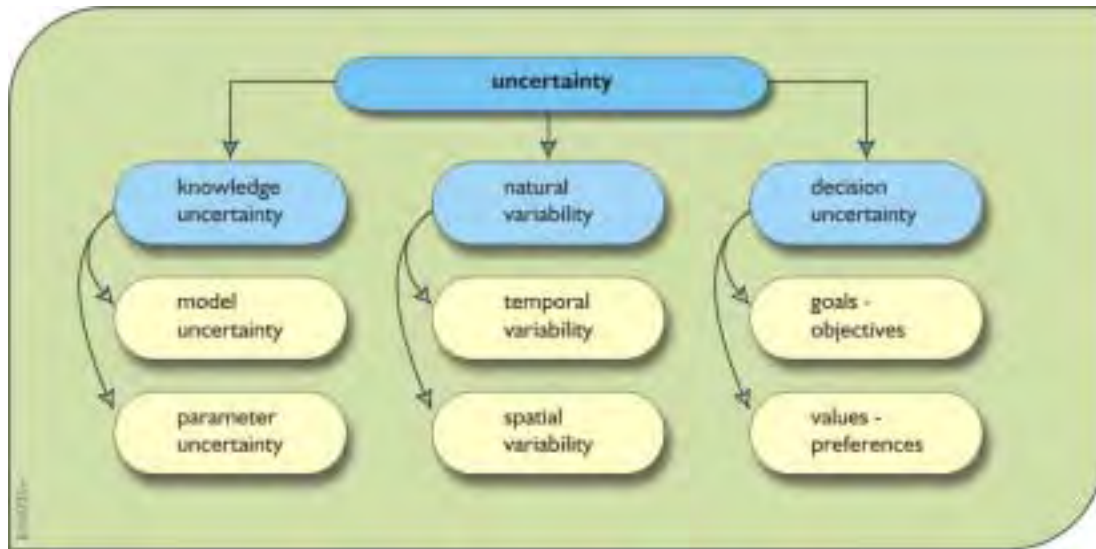


Figure 3. One way of classifying types of uncertainty.

Figure 3 illustrates these different types of uncertainty. For example, the rainfall measured at a weather station within a particular model grid cell may be used as an input value for that cell, but the rainfall may actually vary at different points within that cell and its mean value will vary across the landscape. Knowledge uncertainty can be reduced through further measurement and/or research. Natural variability is a property of the natural system, and is usually not reducible at the scale being used. Decision uncertainty is simply an acknowledgement that we cannot predict ahead of time just what decisions individuals and organizations will make, or even just what particular set of goals or objectives will be considered and the relative importance of each.

Rather than contrasting ‘knowledge’ uncertainty vs. natural variability vs. decision uncertainty, one can classify uncertainty in another way based on specific sources of uncertainty, such as those listed below, and address ways of identifying and dealing with each source of uncertainty.

Informational Uncertainties:

- imprecision in specifying the boundary and initial conditions that impact the output variable values
- imprecision in measuring observed output variable values

Model Uncertainties:

- uncertain model structure and parameter values
- variability of observed input and output values over a region smaller than the spatial scale of the model
- variability of observed model input and output values within a time smaller than the temporal scale of the model. (e.g., rainfall and depths and flows within a day)
- errors in linking models of different spatial and temporal scales

Numerical Errors:

- errors in the model solution algorithm

3.1 Natural variability

The main source of hydrologic model output value variability is the natural variability in hydrological and meteorological input series. Periods of normal precipitation and temperature can be interrupted by periods of extended drought and intense meteorological events such as hurricanes and tornadoes. There is no reason to think such events will not continue to occur and become even more frequent and extreme. Research has demonstrated that climate has been variable in the past and concerns about anthropogenic activities that may increase that variability increase each year. Sensitivity analysis can help assess the affect of errors in predictions if those predictions are based only on past records of historical time-series data describing precipitation, temperature and other exogenous forces across and on the border of the regions being studied.

Time series input data are often actual, or at least based on, historical data. The time-series values typically describe historical conditions including droughts and wet periods. What is distinctive about natural uncertainty, as opposed to errors and uncertainty due to modeling limitations, is that natural variability in meteorological forces cannot be reduced by improving the model's structure, increasing the resolution of the simulation, or by better calibration of model parameters.

Errors result if meteorological values are not measured or recorded accurately, or if mistakes are made in the generation of computer data files. Furthermore, there is no assurance the statistical properties of historical data will accurately represent the statistical properties of future data. Actual future precipitation and temperature scenarios will be different from those in the past, and this difference in many cases may have a larger affect than the uncertainty due to incorrect parameter values. However, the affects of uncertainties in the parameter values

used in stochastic generation models are often much more significant than the affects of using different stochastic generation models (Stedinger and Taylor, 1982).

While variability of model output is a direct result of variability of model input (e.g., hydrologic and meteorological data), the extent of the variability, and the lower and upper limits of that variability, may also be affected by errors in the inputs, the values of parameters, initial boundary conditions, model structure, processes and solution algorithms.

Figure 4 illustrates the distinction between the variability of a system performance indicator due to input data variability, and the extended range of variability due to the total uncertainty associated with any combination of the causes listed in the previous section. This extended range is what is of interest to water resource planners and managers.

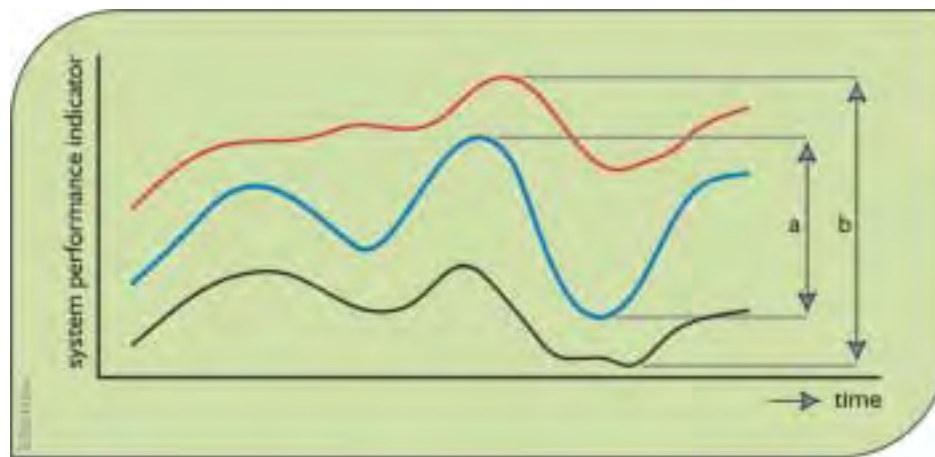


Figure 4. Time-series of model output or system performance showing variability over time. Range "a" results from the natural variability of input data over time. The extended range "b" results from the variability of natural input data as well as from imprecision in input data measurement, parameter value estimation, model structure and errors in model solution algorithms. The extent of this range will depend on the confidence level associated with that range.

What can occur in practice is a time-series of system performance indicator values that can range anywhere within or even outside the extended range, assuming the confidence level of that extended range is less than 100%. The confidence one can have that some future value of a time series will be within a given range is dependent on two factors. The first is the number of measurements used to compute the confidence limits. The second is on the assumption that those measurements are representative of - come from the same statistical or stochastic process yielding - future measurements. Figure 5 illustrates this point. Note that the time series may even contain values outside the range "b" defined in Figure 4 if the confidence level of that range is less than 100%. Confidence intervals associated with less than 100% certainty will not include every possible value that might occur.

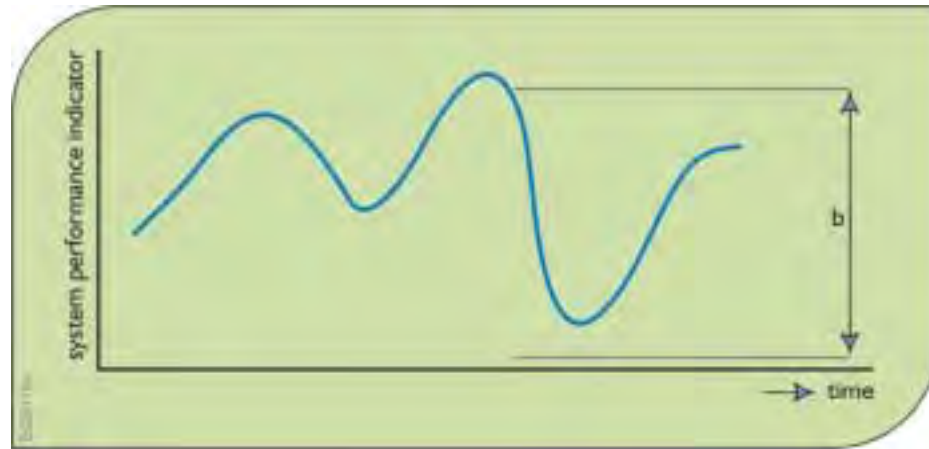


Figure 5. Typical time series of model output or system performance indicator values that are the result of input data variability and possible imprecision in input data measurement, parameter value estimation, model structure and errors in model solution algorithms.

3.2 Knowledge uncertainty

Referring to Figure 3, knowledge uncertainty includes model structure and parameter value uncertainties. First we consider parameter value uncertainty including boundary condition uncertainty, and then model and solution algorithm uncertainty.

3.2.1 Parameter value uncertainty

A possible source of uncertainty in model output results from uncertain estimates of various model parameter values. If the model calibration procedure were repeated using different data sets, different parameter values would result. Those values would yield different simulated system behavior, and thus different predictions. We can call this parameter uncertainty in the predictions because it is caused by imprecise parameter values. If such parameter value imprecision were eliminated, then the prediction would always be the same and so the parameter value uncertainty in the predictions would be zero. But this does not mean that predictions would be perfectly accurate.

In addition to parameter value imprecision, uncertainty in model output can result from imprecise specification of boundary conditions. These boundary conditions can be either fixed or variable. However, because they are not being computed based on the state of the system, their values can be uncertain. These uncertainties can affect the model output, especially in the vicinity of the boundary, in each time step of the simulation.

3.2.2 Model structural and computational errors

Uncertainty in model output can also result from errors in the model structure compared to the real system, and approximations made by numerical methods employed in the simulation. No matter how good our parameter value estimates, our models are not perfect and there is a residual model error. Increasing model complexity to more closely represent the complexity of the real system may not only add to the cost of data collection, but also introduce even more parameters, and thus even more potential sources of error in model output. It is not an easy task to judge the appropriate level of model complexity, and to estimate the resulting levels of uncertainty associated with various assumptions regarding model structure and solution methods. Kuczera (1988) provides an example of a conceptual hydrologic modeling exercise with daily time steps where model uncertainty dominated parameter value uncertainty.

3.3 Decision uncertainty

Uncertainty in model predictions can result from unanticipated changes in what is being modeled. These can include changes in nature, human goals, interests, activities, demands, and impacts. An example of this is the deviation from standard or published operating policies by operators of infrastructure such as canal gates, pumps, and reservoirs in the field, as compared to what is specified in documents and incorporated into the water systems models. Comparing field data with model data for model calibration may yield incorrect calibrations if operating policies actually implemented in the field differ significantly from those built into the models. What do operators do in times of stress? And can anyone identify a place where deviations from published policies do not occur?

What humans will want to achieve in the future may not be the same as what they want today. Predictions of what people will want in the future are clearly sources of uncertainty. A perfect example of this is in the very flat Greater Everglades region of south Florida in the US. Fifty years ago folks wanted the swampy region protected from floods and drained for agricultural and urban development. Today many want just the opposite at least where there are no human settlements. They want to return to a more natural hydrologic system with more wetlands and unobstructed flows, but now for ecological restoration objectives that were not a major concern or much appreciated some half a century ago. Once the mosquitoes return and if the sea level continues to rise, future populations who live there may want more flood control and drainage again. Who knows? Complex changing social and economic processes influence human activities and their demands for water resources and environmental amenities over time. Some of these processes reflect changes in local concerns, interests and activities, but population migration and many economic activities and social attitudes can also reflect changing national and international trends.

Sensitivity scenarios that include human activities can help define the affects of those activities within an area. It is important that careful attention go into the development of these alternative scenarios so that they realistically capture the forces or stresses that the system may face. The history of systems studies are full of examples where the issues studied were rapidly

overwhelmed by much larger social forces resulting from, for example, the relocation of major economic activities, an oil embargo, changes in national demand for natural resources, economic recession, sea-level rise, an act of terrorism, or even war. One thing is sure; the future will be different than the past, and no one is certain just how.

3.3.1 Surprises

Water resource managers may also want to consider how vulnerable a system is to undesirable environmental surprises. What havoc might an introduced species like the zebra mussel invading the Great Lakes of North America have in a particular watershed? Might some introduced disease suddenly threaten key plant or animal species? Might management plans have to be restructured to address the survival of some species such as salmon in the Rhine River in Europe or in the Columbia River in North America? Such uncertainties are hard to anticipate when by their nature they are truly surprises. But surprises should be expected. Hence system flexibility and adaptability should be sought to deal with changing management demands, objectives, and constraints.

4. Sensitivity and uncertainty analyses

An uncertainty analysis is not the same as a sensitivity analysis. An uncertainty analysis attempts to describe the entire set of possible outcomes, together with their associated probabilities of occurrence. A sensitivity analysis attempts to determine the relative change in model output values given modest changes in model input values. A sensitivity analysis thus measures the change in the model output in a localized region of the space of inputs. However, one can often use the same set of model runs for both uncertainty analyses and sensitivity analyses. It is possible to carry out a sensitivity analysis of the model around a current solution and then use it as part of a first order uncertainty analysis.

This discussion begins by focusing on some methods of uncertainty analysis. Then various ways of performing and displaying sensitivity analyses are reviewed.

4.1 Uncertainty Analyses

Recall that uncertainty involves the notion of randomness. If a value of a performance indicator or performance measure, or in fact any variable, like the phosphorus concentration or the depth of water at a particular location varies and this variation over space and time cannot be predicted with certainty, it is called a random variable. One cannot say with certainty what the value of a random variable will be but only the likelihood or probability that it will be within some specified range of values. The probabilities of observing particular ranges of values of a random variable are described or defined by a probability distribution. There are many types of distributions and each can be expressed in several ways as presented in Chapter III.

Suppose the random variable is X . If the observed values of this random variable can be only discrete values, the probability distribution of X can be expressed as a histogram, as shown in Figure 6a. The sum of the probabilities for all possible outcomes must equal 1. If the random variable is a continuous variable that can assume any real value over a range of values, the probability distribution of X can be expressed as a continuous distribution as shown in Figure 6b. The shaded area under the density function for the continuous distribution is 1. The area between two values of the continuous random variable, such as between u and v in Figure 6c, represents the probability that the observed value x of the random variable value X will be within that range of values.

The probability distribution, $P_X(x)$ shown in Figure 6 (a) is called a probability mass function. The probability distributions shown in Figure 6 (b and c) are called a probability density functions (pdf) and are denoted by $f_X(x)$. The subscript X of P_X and f_X represents the random variable, and the variable x is some value of that random variable X .

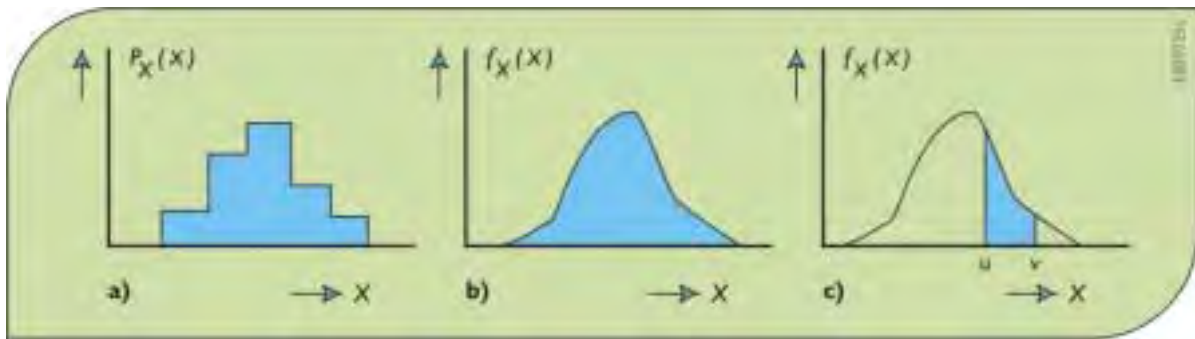


Figure 6. Probability distributions for a discrete or continuous random variable X . The area under the distributions (shaded areas in a and b) is 1, and the shaded area in c is the probability that the observed value x of the random variable X will be between u and v .

Uncertainty analyses involve identifying characteristics of various probability distributions of model input and output variables, and subsequently functions of those random output variables that are performance indicators or measures. Often targets associated with these indicators or measures are themselves uncertain.

A complete uncertainty analysis would involve a comprehensive identification of all sources of uncertainty that contribute to the joint probability distributions of each input or output variable. Assume such analyses were performed for two alternative project plans, A and B , and that the resulting probability density distributions for a specified performance measure were as shown in Figure 7. Figure 7 also identifies the costs of these two projects. The introduction of two performance criteria, cost and probability of exceeding a performance measure target (e.g., a pollutant concentration standard) introduces a conflict where a tradeoff must be made.

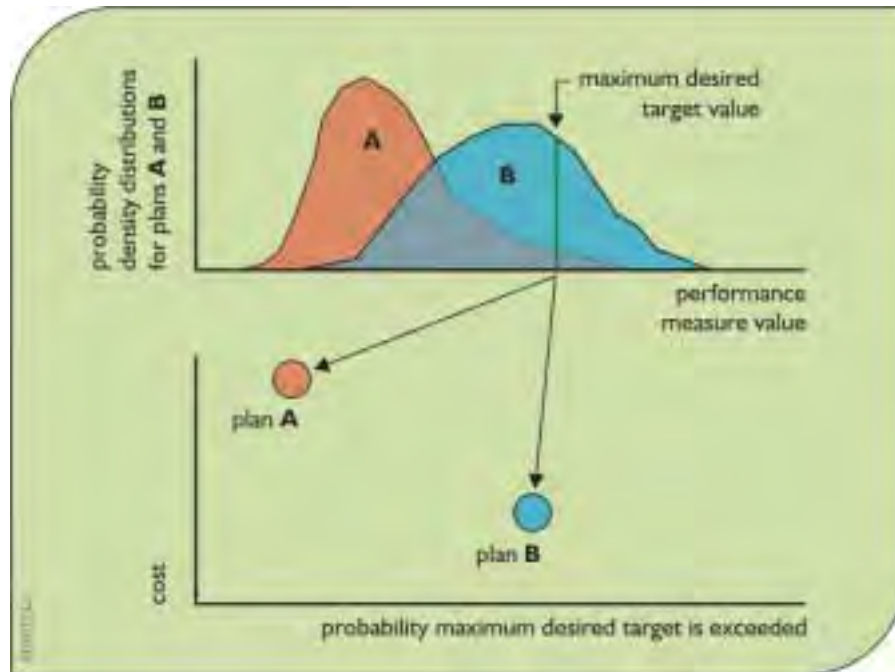


Figure 7. Tradeoffs involving cost and the probability that a maximum desired target value will be exceeded. In this illustration we want the lowest cost (*B* is best) and the lowest probability of exceedance (*A* is best).

4.1.1 Model and model parameter uncertainties

Consider a situation as shown in Figure 8, in which for a specific set of model inputs, the model outputs differ from the observed values, and for those model inputs, the observed values are always the same. Here nothing randomly occurs. The model parameter values or model structure needs to be changed. This is typically done in a model calibration process.

Given specific inputs, the outputs of deterministic models are always going to be the same each time those inputs are simulated. If for specified inputs to any simulation model the predicted output does not agree with the observed value, as shown in Figure 8, this could result from imprecision in the measurement of observed data. It could also result from imprecision in the model parameter values, the model structure, or the algorithm used to solve the model.

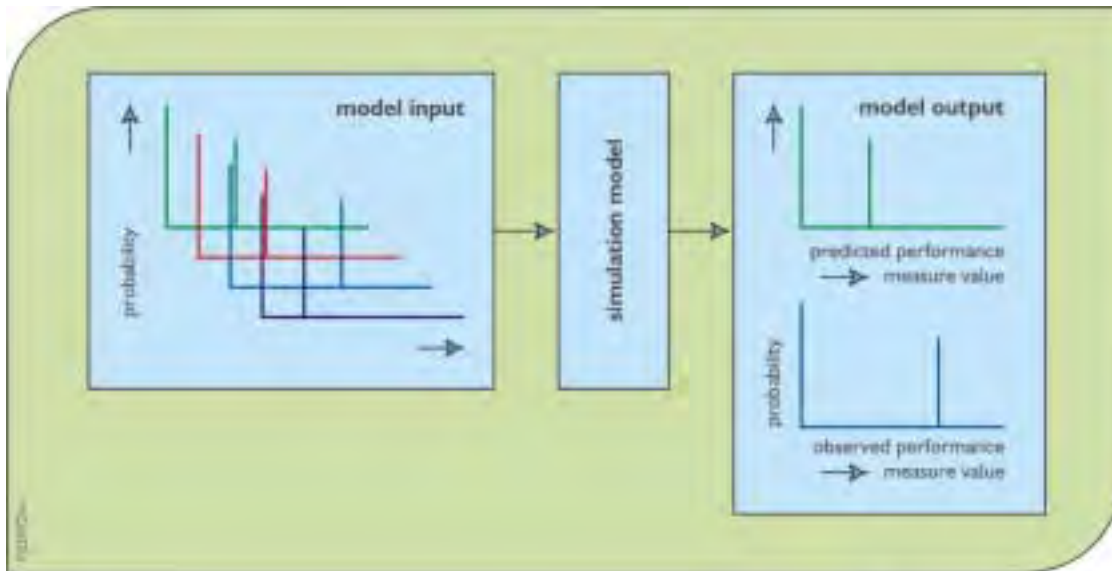


Figure 8. A deterministic system and a simulation model of that system needing calibration or modification in its structure. There is no randomness, only parameter value or model structure errors to be identified and corrected.

Next consider the same deterministic simulation model but now assume at least some of the inputs are random, i.e., not predictable, as may be case when random outputs of one model are used as inputs into another model. Random inputs will yield random outputs. The model input and output values can be described by probability distributions. If the uncertainty in the output is due only to the uncertainty in the input, the situation is similar to that shown in Figure 8. If the distribution of performance measure output values does not fit or is not identical to the distribution of observed performance measure values, then calibration of model parameter values or modification of model structure may be needed.

If a model calibration or ‘identification’ exercise finds the ‘best’ values of the parameters to be outside reasonable ranges of values based on scientific knowledge, then the model structure or algorithm might be in error. Assuming the algorithms used to solve the models are correct and observed measurements of system performance vary for the same model inputs, as shown in Figure 9, it can be assumed that the model structure does not capture all the processes that are taking place that impact the value of the performance measures. This is often the case when relatively simple and low-resolution models are used to estimate the hydrological and ecological impacts of water and land management policies. However, even large and complex models can fail to include or adequately describe important phenomena.

In the presence of informational uncertainties there may be considerable uncertainty about the values of the “best” parameters during calibration. This problem becomes even more pronounced with increases in model complexity.

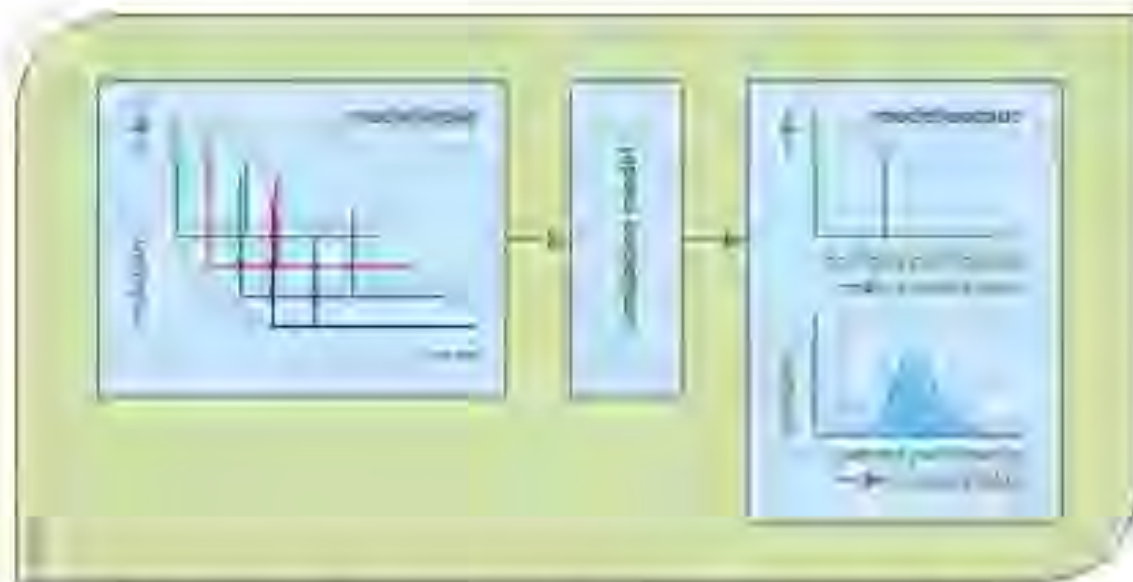


Figure A deterministic simulation model of a 'random or stochastic' system. To produce the variability in the model output that is observed in the real system, even given the same input values, the model's parameter values may need to vary over distributions of values and/or the model structure may need modification along with additional model inputs.

An example: Consider the prediction of a pollutant concentration at some site downstream of a pollutant discharge site. Given a streamflow Q (in units of $1000 \text{ m}^3/\text{day}$), the distance between the discharge site and the monitoring site, X (m), the pollutant decay rate constant k (day^{-1}), and the pollutant discharge W (Kg/day), we can use the following simplified model to predict the concentration of the pollutant C ($\text{g}/\text{m}^3 = \text{mg}/\text{l}$) at the downstream monitoring site:

$$C = (W/Q) \exp\{-k(X/U)\}$$

In the above equation assume the velocity U (m/day) is a known function of the streamflow Q .

In this case the observed value of the pollutant concentration C may differ from the computed value of C even for the same inputs of W , Q , k , X , and U . Furthermore, this difference varies in different time periods. This apparent variability, as illustrated in Figure 9, can be simulated using the same model but by assuming a distribution of values for the decay rate constant k . Alternatively the model structure can be modified to include the impact of streamflow temperature T on the prediction of C .

$$C = (W/Q) \exp\{-k\theta^{T-20}(X/U)\}$$

Now there are two model parameters, the decay rate constant k and the dimensionless temperature correction factor θ and an additional model input, the streamflow temperature, T . It could be that the variation in streamflow temperature was the sole cause of the first

equation's 'uncertainty' and that the assumed parameter distribution of k was simply the result of the distribution of streamflow temperatures on the term $k\theta^{T-20}$.

If the output were still random given constant values of all the inputs, then another source of uncertainty exists. This uncertainty might be due to additional random loadings of the pollutant, possibly from non-point sources. Once again the model could be modified to include these additional loadings if they are knowable. Assuming these additional loadings are not known, a new random parameter could be added to the input variable W or to the right hand side of the equations above that would attempt to capture the impact on C of these additional loadings. A potential problem, however, might be the likely correlation between those additional loadings and the streamflow Q .

While adding model detail removed some 'uncertainty' in the above example, increasing model complexity will not always eliminate or reduce uncertainty in model output. Adding complexity is generally not a good idea when the increased complexity is based on processes whose parameters are difficult to measure, the right equations are not known at the scale of application, or the amount of data for calibration is small compared to the number of parameters.

Even if more detailed models requiring more input data and more parameter values were to be developed, the likelihood of capturing all the processes occurring in a complex system is small. Hence those involved will have to make decisions taking this uncertainty into account. Imprecision will always exist due to less than a complete understanding of the system and the hydrologic processes being modeled. A number of studies have addressed model simplification, but only in some simple cases have statisticians been able to identify just how one might minimize modeling related errors in model output values.

The problem of determining the "optimal" level of modeling detail is particularly important when simulating the hydrologic events at many sites over large areas. Perhaps the best approach for these simulations is to establish confidence levels for alternative sets of models and then statistically compare simulation results. But even this is not a trivial or costless task. Increases in the temporal or spatial resolution typically require considerable data collection and/or processing, model recalibrations, and possibly the solution of stability problems resulting from the numerical methods used in the models. Obtaining and implementing alternative hydrologic simulation models will typically involve considerable investments of money and time for data preparation and model calibration.

What is needed is a way to predict the variability evident in the system shown in Figure 9. Instead of a fixed output vector for each fixed input vector, a distribution of outputs are needed for each performance measure based on fixed inputs (Figure 9) or a distribution of inputs (Figure 10.). Furthermore the model output distribution for each performance measure should 'match' as well as possible the observed distribution of that performance measure.

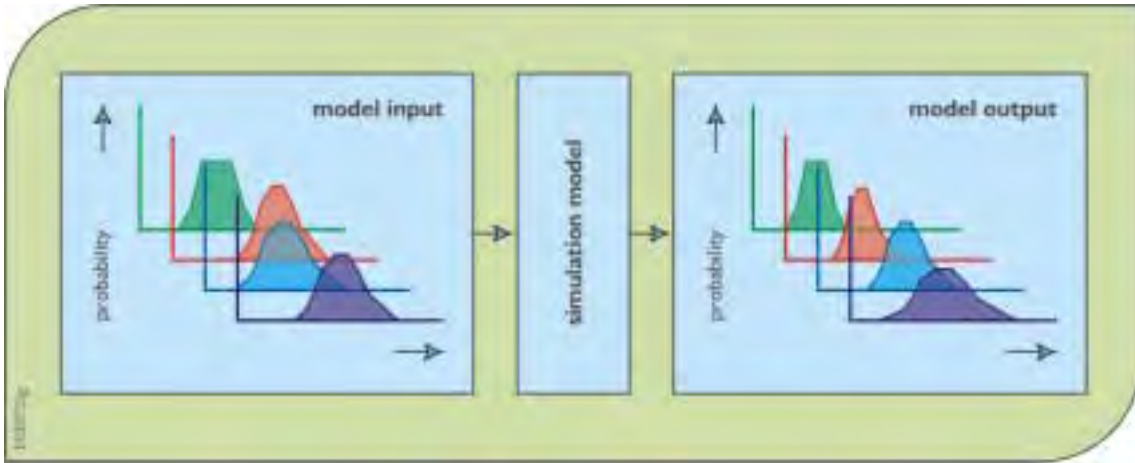


Figure 10. Simulating variable inputs to obtain probability distributions of predicted performance indices that match the probability distributions of observed performance values.

4.1.2 What uncertainty analysis can provide

An uncertainty analysis takes a set of randomly chosen input values (that can include parameter values), passes them through a model (or transfer function) to obtain the distributions (or statistical measures of the distributions) of the resulting outputs. As illustrated in Figure 11, the output distributions can be used to

- Describe the range of potential outputs of the system at some probability level.
- Estimate the probability that the output will exceed a specific threshold or performance measure target value.

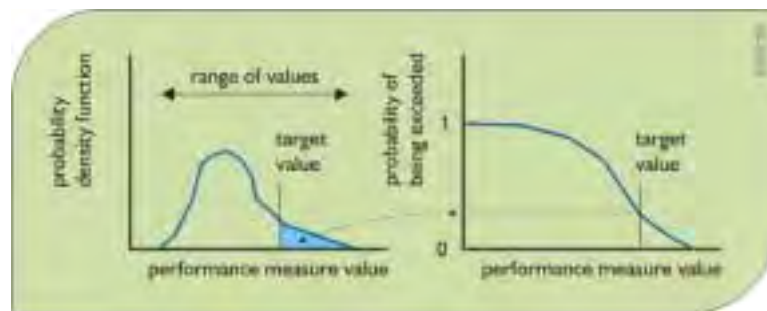


Figure 11. The distribution of performance measures defines range of potential values and the likelihood that a specified target value will be exceeded. The shaded area under the density function on the left represents the probability that the target value will be exceeded. This probability is shown in the probability of exceedance plot on the right.

Common uses for uncertainty analyses are to make general inferences, such as the following:

- Estimating the mean and standard deviation of the outputs.
- Estimating the probability the performance measure will exceed a specific threshold.
- Putting a reliability level on a function of the outputs, e.g., the range of function values that is likely to occur with some probability.
- Describing the likelihood of different potential outputs of the system.

Implicit in any uncertainty analysis are the assumptions that statistical distributions for the input values are correct and that the model is a sufficiently realistic description of the processes taking place in the system. Neither of these assumptions is likely to be entirely correct.

4.2 Sensitivity analyses

“Sensitivity analysis” is aimed at describing how much model output values are affected by changes in model input values. It is the investigation of the importance of imprecision or uncertainty in model inputs in a decision making or modeling process. The exact character of sensitivity analysis depends upon the particular context and the questions of concern. Sensitivity studies can provide a general assessment of model precision when used to assess system performance for alternative scenarios, as well as detailed information addressing the relative significance of errors in various parameters. As a result, sensitivity results should be of interest to the general public, federal and state management agencies, local watershed planners and managers, model users, and model developers.

Clearly, upper level management and the public may be interested in more general statements of model precision, and should be provided such information along with model predictions. On the other hand, detailed studies addressing the significance and interactions among individual parameters would likely be meaningful to model developers and some model users. They can use such data to interpret model results and to identify where efforts to improve models and their input values should be directed.

Initial sensitivity analysis studies could focus on two products:

- (1) detailed results to guide research and assist model development efforts, and
- (2) calculation of general descriptions of uncertainty associated with model predictions so that policy decisions can reflect both the modeling efforts best prediction of system performance and the precision of such predictions.

In the first case, knowing the relative uncertainty in model projections due to possible errors in different sets of parameters and input data should assist in efforts to improve the precision of model projections. This knowledge should also contribute to a better understanding of the relationships between model assumptions, parameters, data and model predictions.

For the second case, knowing the relative precision associated with model predictions should have a significant effect on policy development. For example, the analysis may show that, given data inadequacies, there are very large error bands associated with some model variables. When such large uncertainties exist, predictions should be used with appropriate skepticism.

Incremental strategies should be explored along with monitoring so that greater experience can accumulate to resolve some of those uncertainties.

Sensitivity analysis features are available in many linear and nonlinear programming (optimization) packages. They identify the changes in the values of the objective function and unknown decision variables given a change in the model input values, and a change in levels set for various constraints (Chapter V). Thus sensitivity analysis addresses the change in “optimal” system performance associated with changes in various parameter values, and also how “optimal” decisions would change with changes in resource constraint levels, or target output requirements. This kind of sensitivity analysis provides estimates of how much another unit of resource would be worth, or what “cost” a proposed change in a constraint places on the optimal solution. This information is of value to those making design decisions.

Various techniques have been developed to determine how sensitive model outputs are to changes in model inputs. Most approaches examine the affects of changes in a single parameter value or input variable assuming no changes in all the other inputs. Sensitivity analyses can be extended to examine the combined effects of multiple sources of error, as well.

Changes in particular model input values can affect model output values in different ways. It is generally true that only a relatively few input variables dominate or substantially influence the values of a particular output variable or performance indicator at a particular location and time. If the range of uncertainty of only some of the output data is of interest, then undoubtedly only those input data that significantly impact on the values of those output data need be included in the sensitivity analysis.

If input data estimates are based on repeated measurements, a frequency distribution can be estimated that characterizes natural variability. The shorter the record of measurements, the greater will be the uncertainty regarding the long-term statistical characteristics of that variability. If obtaining a sufficient number of replicate measurements is not possible, subjective estimates of input data ranges and probability distributions are often made. Using a mixture of subjective estimates and actual measurements does not affect the application of various sensitivity analysis methods that can use these sets or distributions of input values, but it may affect the conclusions that can be drawn from the results of these analyses.

It would be nice to have available accurate and easy-to-use analytical methods for relating errors in input data to errors in model outputs, and to errors in system performance indicator values that are derived from model output. Such analytical methods do not exist for complex simulation models. However methods based on simplifying assumptions and approximations can be used to yield useful sensitivity information. Some of these are reviewed in the remainder of this chapter.

4.2.1 Sensitivity coefficients

One measure of sensitivity is the sensitivity coefficient. This is the derivative of a model output variable with respect to an input variable or parameter. A number of sensitivity

analysis methods use these coefficients. First-order and approximate first-order sensitivity analyses are two such methods that will be discussed later. The difficulty of

1. obtaining the derivatives for many models,
2. needing to assume mathematical (usually linear) relationships when obtaining estimates of derivatives by making small changes of input data values near their nominal or most likely values, and
3. having large variances associated with most hydrologic process models have motivated the replacement of analytical methods by numerical and statistical approaches to sensitivity analysis.

Implicit in any sensitivity analysis are the assumptions that statistical distributions for the input values are correct and that the model is a sufficiently realistic description of the processes taking place in the system. Neither of these assumptions is likely to be entirely correct.

The importance of the assumption that the statistical distributions for the input values are correct is easy to check by using different distributions for the input parameters. If the outputs vary significantly, then the output is sensitive to the specification of the input distributions and hence they should be defined with care. A relatively simple deterministic sensitivity analysis can be of value here (Benaman, 2002). A sensitivity coefficient can be used to measure the magnitude of change in an output variable Q per unit change in the magnitude of an input parameter value P from its base value P_o . Let SI_{PQ} be the sensitivity index for an output variable Q with respect to a change ΔP in the value of the input variable P from its base value P_o . Noting that the value of the output $Q(P)$ is a function of P , the sensitivity index could be defined as

$$SI_{PQ} = [Q(P_o + \Delta P) - Q(P_o - \Delta P)] / 2 \Delta P \quad (1)$$

Other sensitivity indices could be defined (McCuen 1973). Letting the index i represent a decrease and j represent an increase in the parameter value from its base value P_o , the sensitivity index SI_{PQ} for parameter P and output variable Q is could be defined as

$$SI_{PQ} = \{ |(Q_o - Q_i) / (P_o - P_i)| + |(Q_o - Q_j) / (P_o - P_j)| \} / 2 \quad (2)$$

or

$$SI_{PQ} = \max \{ |(Q_o - Q_i) / (P_o - P_i)|, |(Q_o - Q_j) / (P_o - P_j)| \} \quad (3)$$

A dimensionless expression of sensitivity is the elasticity index, EI_{PQ} , that measures the relative change in output Q for a relative change in input P could be defined as

$$EI_{PQ} = [P_o / Q(P_o)] SI_{PQ} \quad (4)$$

4.2.2 A simple deterministic sensitivity analysis procedure

This deterministic sensitivity analysis approach is very similar those most often employed in the engineering economics literature. It is based on the idea of varying one uncertain parameter value, or set of parameter values, at a time. The ideas are applied to a water quality example to illustrate their use.

The output variable of interest can be any performance measure or indicator. Thus one does not know if more or less of a given variable is better or worse. Perhaps too much and/or too little is undesirable. The key idea is that, whether employing physical measures or economic metrics of performance, various parameters (or sets of associated parameters) are assigned high and low values. Such ranges may reflect either the differences between the minimum and maximum values for each parameter, the 5 and 95 percentiles of a parameters distribution, or points corresponding to some other criteria. The system model is then run with the various alternatives, one at a time, to evaluate the impact of those errors in various sets of parameter values on the output variable.

Table 1 illustrates the character of the results that one would obtain. Here Y_0 is the nominal value of the model output when all parameters assume the estimated best values, and $Y_{i,L}$ and $Y_{i,H}$ are the values obtained by increasing or decreasing the values of the i^{th} set of parameters.

Table 1. Sensitivity of model output Y to possible errors in four parameter sets containing a single parameter or a group of parameters that vary together.

parameter set	low value	nominal	high value
1	$Y_{1,L}$	Y_0	$Y_{1,H}$
2	$Y_{2,L}$	Y_0	$Y_{2,H}$
3	$Y_{3,L}$	Y_0	$Y_{3,H}$
4	$Y_{4,L}$	Y_0	$Y_{4,H}$

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A simple water quality example is employed to illustrate this deterministic approach to sensitivity analysis. The analysis techniques illustrated here are just as applicable to complex models. The primary difference is that more work would be required to evaluate the various alternatives with a more complex model, and the model responses might be more complicated.

The simple water quality model is provided by Vollenweider's empirical relationship for the average phosphorus concentration in lakes (Vollenweider, 1976). He found that the phosphorus concentration, P (mg/m^3), is a function of the annual phosphorus loading rate, L ($\text{mg}/\text{m}^2 \cdot \text{a}$), the annual hydraulic loading, q (m/a or more exactly $\text{m}^3/\text{m}^2 \cdot \text{a}$), and the mean water depth, z (m).

$$P = (L/q) / [1 + (z/q)^{0.5}] \quad (5)$$

L/q and P have the same units; the denominator is an empirical factor that compensates for nutrient recycling and elimination within the aquatic lake environment.

Data for Lake Ontario in North America would suggest that reasonable values of the parameters are $L = 680 \text{ mg}/\text{m}^2 \cdot \text{a}$; $q = 10.6 \text{ m}/\text{a}$; and $z = 84 \text{ m}$, yielding $P = 16.8 \text{ mg}/\text{m}^3$. Values of phosphorus concentrations less than $10 \text{ mg}/\text{m}^3$ are considered oligotrophic, whereas values greater than $20 \text{ mg}/\text{m}^3$ generally correspond to eutrophic conditions. Reasonable ranges reflecting possible errors in the three parameters yield the values in Table 2.

Table 2. Sensitivity of estimates of phosphorus concentration (mg/m^3) to model parameter values. The two right most values in each row correspond to the Low and High values of the parameter, respectively

	parameter value		phosphorus concentration	
	low	high	P low	P high
L – P loading ($\text{mg}/\text{m}^2 \cdot \text{a}$)	500	900	12.4	22.3
q – hydraulic loading (m/a)	8	13.5	20.0	14.4
z – mean depth (m)	81	87	17.0	16.6

One may want to display these results so they can be readily visualized and understood. A tornado diagram (Eschenbach, 1992) would show the lower and upper values of P obtained from variation of each parameter, with the parameter with the widest limits displayed on top, and the parameter having smallest limits on the bottom. Tornado diagrams (Figure 12) are easy to construct and can include a large number of parameters without becoming crowded.

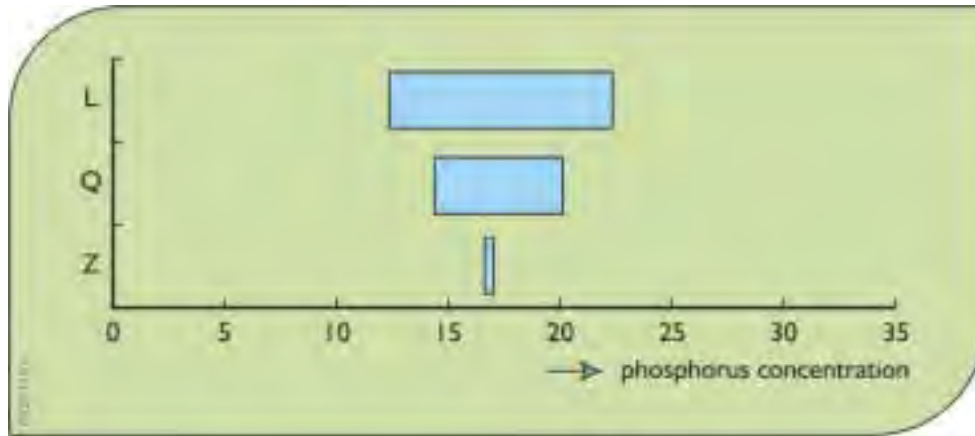


Figure 12. A Tornado diagram showing the range of the output variable representing phosphorus concentrations for high and low values of each of the parameter sets. Parameters are sorted so that the largest range is on top, and the smallest on the bottom.

An alternative to tornado diagrams is a Pareto chart showing the width of the uncertainty range associated with each variable, ordered from largest to smallest. A Pareto chart is illustrated in Figure 13.

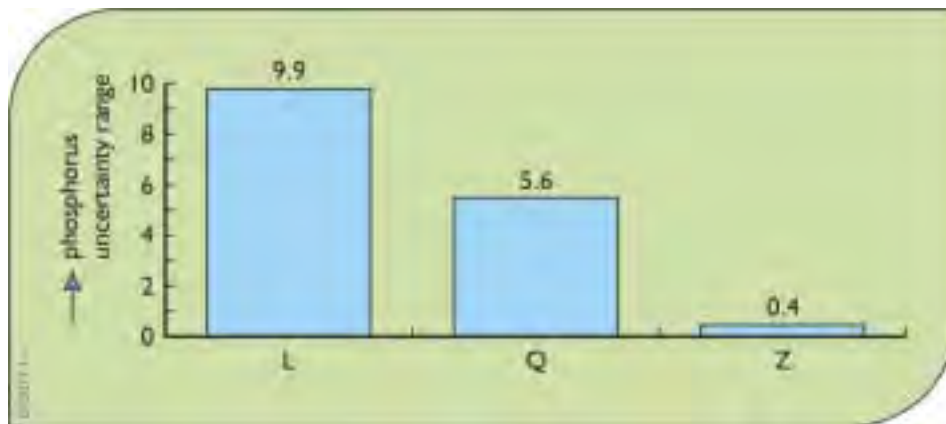


Figure 13. A Pareto Chart showing the range of the output variable representing phosphorus concentrations resulting from high and low values of each parameter set considered.

Another visual presentation is a spider plot showing the impact of uncertainty in each parameter on the variable in question, all on the same graph (Eschenback, 1992; DeGarmo, 1993, p. 401). A spider plot, Figure 14, shows the particular functional response of the output to each parameter on a common scale, so one needs a common metric to represent changes in all of the parameters. Here we use percentage change from the nominal or best values.

Spider plots are a little harder to construct than tornado diagrams, and can generally include only 4 - 5 variables without becoming crowded. However, they provide a more complete view of the relationships between each parameter and the performance measure. In particular, a spider plot reveals nonlinear relationships and the relative sensitivity of the performance measure to (percentage) changes in each variable.

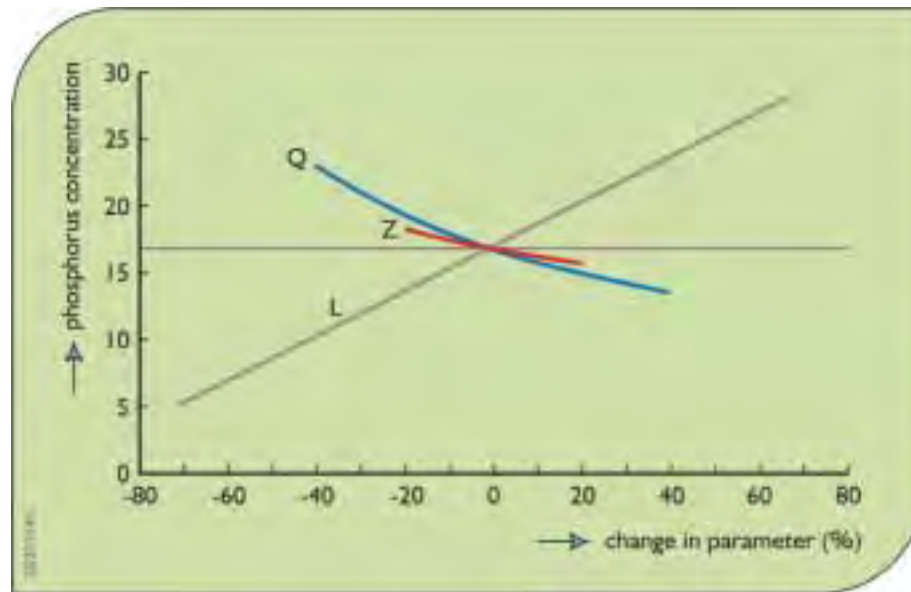


Figure 14. Spider Plot illustrates the relationships between model output describing phosphorus concentrations and variations in each of the parameter sets, expressed as a percentage deviation from their nominal values.

In the spider plot, the linear relationship between P and L and the gentle nonlinear relationship between P and q is illustrated. The range for z has been kept small given the limited uncertainty associated with that parameter.

4.2.3 Multiple errors and interactions

An important issue that should not be ignored is the impact of simultaneous errors in more than one parameter. Probabilistic methods directly address the occurrence of simultaneous errors, but the correct joint distribution needs to be employed. With simple sensitivity analysis procedures, errors in parameters are generally investigated one at a time, or in groups. The idea of considering pairs or sets of parameters is discussed here.

Groups of factors. It is often the case that reasonable error scenarios would have several parameters changing together. For this reason, the alternatives have been called parameter sets. For example, possible errors in water depth would be accompanied with corresponding variations in aquatic vegetation and chemical parameters. Likewise, alternatives related to changes in model structure might be accompanied with variations in several parameters. In other cases, there may be no causal relationship among possible errors (such as model structure

versus inflows at the boundary of the modeled region), but they might still interact to effect the precision of model predictions.

Combinations. If one or more non-grouped parameters interact in significant ways, then combinations of one or more errors should be investigated. However, one immediately runs into a combinatorial problem. If each of m parameters can have 3 values (high, nominal, and low) there are 3^m combinations, as opposed to $2m + 1$ if each parameter is varied separately. [For $m = 5$, the differences are $3^5 = 243$ versus $2(5)+1 = 11$.] These numbers can be reduced by considering instead only combinations of extremes so that only $2^m + 1$ cases need be considered [$2^5 + 1 = 33$], which is a more manageable number. However, all of the parameters would be at one extreme or the other, and such situations would be very unusual.

Two factors at a time. A compromise is to consider all pairs of two parameters at a time. There are $m(m-1)/2$ possible pairs of m parameters. Each parameter has a high and low value. Since there are 4 combinations of high and low values for each pair, there are a total of $2m(m-1)$ combinations. [For $m = 5$ there are 40 combinations of two parameters each having two values.]

The presentation of these results could be simplified by displaying for each case only the maximum error, which would result in $m(m-1)/2$ cases that might be displayed in a Pareto diagram. This would allow identification of those combinations of two parameters that might yield the largest errors and thus are of most concern.

For the water quality example, if one plots the absolute value of the error for all four combinations of high (+) and low (-) values for each pair of parameters, they obtain Figure 15.

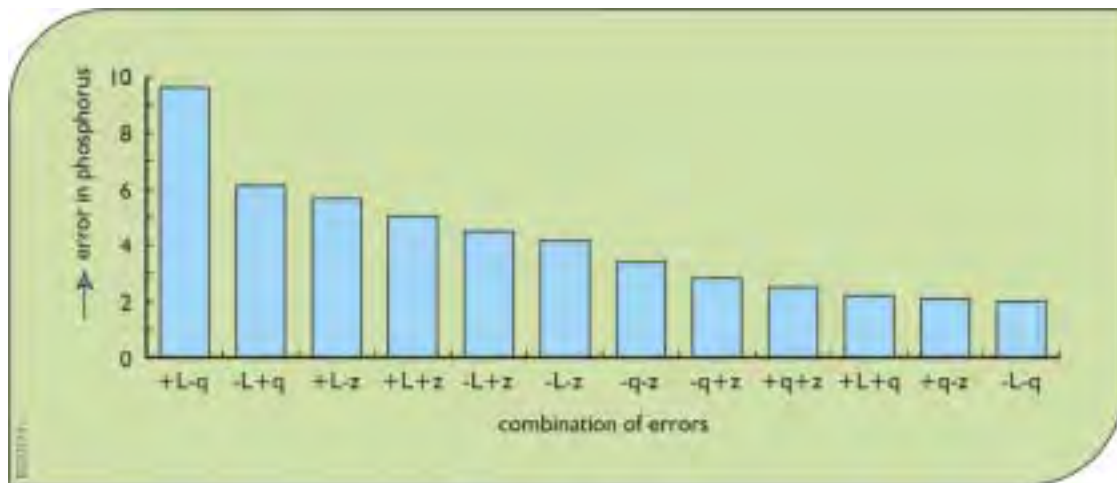


Figure 15. Pareto diagram showing errors in phosphorus concentrations for all combinations of pairs of input parameters errors. A + indicates a high value, and a - indicates a low value for indicated parameter. L is the phosphorus loading rate, q is the hydraulic loading, and z is the mean lake depth.

Considering only the worst error for each pair of variables yields Figure 16.

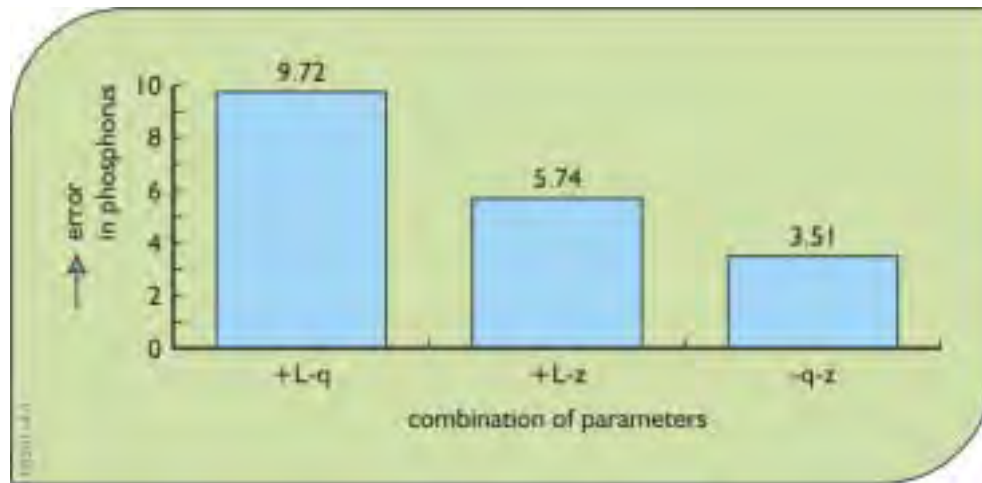


Figure 16. Pareto diagram showing worst error combinations for each pair of input parameters. A '+' indicates a high value, and a '-' indicates a low value for indicated parameter.

Here we see, as is no surprise, that the worst error results from the most unfavorable combination of L and q values. If both parameters have their most unfavorable values, the predicted phosphorus concentration would be 27 mg/m^3 .

Looking for non-linearities. One might also display in a Pareto diagram the maximum error for each pair as a percentage of the sum of the absolute values of the maximum error from each parameter separately. The ratio of the joint error to the individual errors would illustrate potentially important nonlinear interactions. If the model of the system and the physical measure or economic metric were strictly linear, then the individual ratios should add to one.

4.2.4 First-order sensitivity analysis

The above deterministic analysis has trouble representing reasonable combinations of errors in several parameter sets. If the errors are independent, it is highly unlikely that any two sets would actually be at their extreme ranges at the same time. By defining probability distributions of the values of the various parameter sets, and specifying their joint distributions, a probabilistic error analysis can be conducted. In particular, for a given performance indicator, one can use multivariate linear analyses to evaluate the approximate impact on the performance indices of uncertainty in various parameters. As shown below, the impact depends upon the square of the sensitivity coefficients (partial derivatives) and the variances and covariances of the parameter sets.

For a performance indicator $I = F(Y)$, which is a function $F(\bullet)$ of model outputs Y , that are in turn a function $g(P)$ of input parameters P , one can use a multivariate Taylor series approximation of F to obtain the expected value and variance of the indicator:

$$E[I] = F(\text{based on mean values of input parameters}) + (1/2) \{ \sum_i \sum_j [\partial^2 F / \partial P_i \partial P_j] \text{Cov} [P_i, P_j] \} \quad (6)$$

and

$$\text{Var}[I] = \sum_i \sum_j (\partial F / \partial P_i)(\partial F / \partial P_j) \text{Cov} [P_i, P_j] \quad (7)$$

where $(\partial F / \partial P_i)$ are the partial derivative of the function F with respect to P_i evaluated at the mean value of the input parameters P_i , and $\partial^2 F / \partial P_i \partial P_j$ are the second partial derivatives. The covariance of two random input parameters P_i and P_j is the expected value of the product of differences between the values and their means.

$$\text{Cov}[P_i, P_j] = E[(P_i - E[P_i])(P_j - E[P_j])] \quad (8)$$

If all the parameters are independent of each other, and the second-order terms in the expression for the mean $E[I]$ are neglected, one obtains

$$E[I] = F(\text{based on mean values of input parameters}) \quad (9)$$

and

$$\text{Var} [I] = \sum_i [\partial F / \partial P_i]^2 \text{Var} [P_i] \quad (10)$$

(Benjamin and Cornell, 1970). Equation 6 for $E[I]$ shows that in the presence of substantial uncertainty, the mean of the output from nonlinear systems is not simply the system output corresponding to the mean of the parameters (Gaven and Burges, 1981, p. 1523). This is true for any nonlinear function.

Of interest in the analysis of uncertainty is the approximation for the variance $\text{Var}[I]$ of indicator I . In Equation 10 the contribution of P_i to the variance of I equals $\text{Var}[P_i]$ times $[\partial F / \partial P_i]^2$, which are the squares of the sensitivity coefficients for indicator I with respect to each input parameter value P_i .

4.2.4.1 An example of first-order sensitivity analysis

It may appear that first-order analysis is difficult because the partial derivatives of the performance indicator I are needed with respect to the various parameters. However, reasonable approximations of these sensitivity coefficients can be obtained from the simple sensitivity analysis described in Table 3, as shown below. In that table, three different parameter sets, P_i , are defined in which one parameter of the set is at its high value, P_{iH} , and one is at its low value, P_{iL} , to produce corresponding values (called high, I_{iH} , and low, I_{iL}) of a system performance indicator I .

Table 3. Approximate parameter sensitivity coefficients.

parameter set	value		sensitivity coefficient
	low	high	
1	l_{1L}	l_{1H}	$[(l_{1H}-l_{1L})/(P_{1H}-P_{1L})]$
2	l_{2L}	l_{2H}	$[(l_{2H}-l_{2L})/(P_{2H}-P_{2L})]$
3	l_{3L}	l_{3H}	$[(l_{3H}-l_{3L})/(P_{3H}-P_{3L})]$

It is then necessary to estimate some representation of the variances of the various parameters with some consistent procedure. For a normal distribution, the distance between the 5 and 95 percentiles is 1.645 standard deviations on each side of the mean, or $2(1.645) = 3.3$ standard deviations. Thus, if the high/low range is thought of as approximately a 5-95 percentile range for a normally distributed variate, a reasonable approximation of the variance might be

$$\text{Var}[P_i] = \{ [P_{iH}-P_{iL}]/3.3 \}^2. \quad (11)$$

This is all that is needed. Use of these average sensitivity coefficients is very reasonable for modeling the behavior of the system performance indicator I over the indicated ranges.

As an illustration of the method of first-order uncertainty analysis, consider the lake quality problem described above. The "system performance indicator" in this case is the model output, the phosphorus concentration P , and the input parameters, now denoted as $X = L, q, \text{ and } z$. The standard deviation of each parameter is assumed to be the specified range divided by 3.3. Average sensitivity coefficients $\partial P/\partial X$ were calculated. The results are reported in the table below.

Table 4. Calculation of approximate parameter sensitivity coefficients.

variable				$(\partial P/\partial X)^2$	
X	units	$\partial P/\partial X$	St Dev[X]	Var[X]	%
L	mg/m ² .a	0.025	121.21	9.18	75.7
q	m/a	-1.024	1.67	2.92	24.1
z	m	-0.074	1.82	0.02	0.2

Assuming the parameter errors are independent:

$$\text{Var}[P] = 9.18 + 2.92 + 0.02 = 12.12 \quad (12)$$

The square root of 12.12 is the standard deviation and equals 3.48. This agrees well with a Monte Carlo analysis reported below.

Note that $100 \cdot (9.18/12.12)$, or about 76% of the total parameter error variance in the phosphorus concentration P is associated in the phosphorus loading rate L and the remaining 24% is associated with the hydrologic loading q . Eliminating the uncertainty in z would have a negligible impact on the overall model error. Likewise, reducing the error in q would at best have a modest impact on the total error.

Due to these uncertainties, the estimated phosphorus concentration has a standard deviation of 3.48. Assuming the errors are normally distributed, and recalling that ± 1.645 standard deviations around the mean define a 5-95 percentile interval, the 5-95 percentile interval would be about

$$16.8 \pm 1.645 (3.48) \text{ mg/m}^3 = 16.8 \pm 5.7 \text{ mg/m}^3 = 11.1 \text{ to } 22.5 \text{ mg/m}^3. \quad (13)$$

These error bars indicate there is substantial uncertainty associated with the phosphorus concentration P , primarily due to uncertainty in the loading rate L .

The upper bound of 22.6 mg/m^3 is considerably less than the 27 mg/m^3 that would be obtained if both L and q had their most unfavorable values. In a probabilistic analysis with independent errors, such a combination is highly unlikely.

4.2.4.2 Warning on accuracy.

First-order uncertainty analysis is indeed an approximate method based upon a linearization of the response function represented by the full simulation model. It may provide inaccurate estimates of the variance of the response variable for nonlinear systems with large uncertainty in the parameters. In such cases Monte Carlo simulation (discussed below and in Chapter VII) or the use of higher-order approximation may be required. Beck (1987, p. 1426) cites studies that found that Monte Carlo and first-order variances were not appreciably different, and a few studies that found specific differences. Differences are likely to arise when the distributions used for the parameters are bimodal (or otherwise unusual), or some rejection algorithm is used in the Monte Carlo analysis to exclude some parameter combinations. Such errors can result in a distortion in the ranking of predominant sources of uncertainty. However, in most cases very similar results were obtained.

4.2.5 Fractional factorial design method

An extension of first-order sensitivity analysis would be a more complete exploration of the response surface using a careful statistical design. First consider a complete factorial design. Input data are divided into discrete "levels". The simplest case is two levels. These two levels can be defined as a nominal value, and a high (low) value. Simulation runs are made for all combinations of parameter levels. For n different inputs, this would require 2^n simulation runs. Hence for a three-input variable or parameter problem, 8 runs would be required. If 4 discrete levels of each input variable or parameter were allowed to provide a more reasonable description of a continuous variable, the three-input data problem would require 4^3 or 64 simulation runs. Clearly this is not a useful tool for large regional water resources simulation models.

A fractional factorial design involves simulating only a fraction of what is required from a full factorial design method. The loss of information prevents a complete analysis of the impacts of each input variable or parameter on the output.

To illustrate the fractional factorial design method, consider the two-level with three-input variable or parameter problem. Table 5 below shows the 8 simulations required for a full factorial design method. The '+' and the '-' show the upper and lower levels of each input variable or parameter P_i where $i = 1, 2, 3$. If all 8 simulations were performed, seven possible effects could be estimated. These are the individual effects of the three inputs $P_1, P_2,$ and P_3 , the three two-input variable or parameter interactions, $(P_1)(P_2), (P_1)(P_3),$ and $(P_2)(P_3)$, and the one three-input variable or parameter interaction $(P_1)(P_2)(P_3)$.

Table 5. A three-input factorial design.

simulation run	P_1	P_2	P_3	value of output - variable Y
1	-	-	-	Y_1
2	+	-	-	Y_2
3	-	+	-	Y_3
4	+	+	-	Y_4
5	-	-	+	Y_5
6	+	-	+	Y_6
7	-	+	+	Y_7
8	+	+	+	Y_8

Consider an output variable Y , where Y_j is the value of Y in the j th simulation run. Then an estimate of the effect, denoted $\delta(Y|P_i)$, that input variable or parameter P_i has on the output variable Y , is the average of the four separate effects of varying P_i :

For $i = 1$:

$$\delta(Y | P_1) = 0.25 [(Y_2 - Y_1) + (Y_4 - Y_3) + (Y_6 - Y_5) + (Y_8 - Y_7)] \quad (14)$$

Each difference in parentheses is the difference between a run in which P_1 is at its upper level and a run in which P_1 is at its lower level, but the other two parameter values, P_2 and P_3 , are unchanged. If the effect is equal to 0, then, in this case, P_1 has no impact on the output variable Y .

Similarly the effects of P_2 and P_3 , on variable Y can be estimated as:

$$\delta(Y | P_2) = 0.25 \{ (Y_3 - Y_1) + (Y_4 - Y_2) + (Y_7 - Y_5) + (Y_8 - Y_6) \} \quad (15)$$

and

$$\delta(Y | P_3) = 0.25 \{ (Y_5 - Y_1) + (Y_6 - Y_2) + (Y_7 - Y_3) + (Y_8 - Y_4) \} \quad (16)$$

Consider next the interaction effects between P_1 and P_2 . This is estimated as the average of the difference between the average P_1 effect at the upper level of P_2 , and the average P_1 effect at the lower level of P_2 . This is the same as the difference between the average P_2 effect at the upper level of P_1 and the average P_2 effect at the lower level of P_1 :

$$\begin{aligned} \delta(Y | P_1, P_2) &= (1/2) \{ [(Y_8 - Y_7) + (Y_4 - Y_3)] / 2 - [(Y_2 - Y_1) + (Y_6 - Y_5)] / 2 \} \\ &= (1/4) \{ [(Y_8 - Y_6) + (Y_4 - Y_2)] - [(Y_3 - Y_1) + (Y_7 - Y_5)] \} \end{aligned} \quad (17)$$

Similar equations can be derived for looking at the interaction effects between P_1 and P_3 , and between P_2 and P_3 and the interaction effects among all three inputs P_1 , P_2 , and P_3 .

Now assume only half of the simulation runs were performed, perhaps runs 2, 3, 5 and 8 in this example. If only outputs Y_2 , Y_3 , Y_5 , and Y_8 are available, for our example:

$$\delta(Y | P_3) = \square(Y | P_1, P_2) = 0.5 \{ (Y_8 - Y_3) - (Y_2 - Y_5) \} \quad (18)$$

The separate effects of P_3 and of P_1P_2 are not available from the output. This is the loss in information resulting from fractional instead of complete factorial design.

4.2.6 Monte Carlo sampling methods

The Monte Carlo method of performing sensitivity analyses, illustrated in Figure 16, first selects a random set of input data values drawn from their individual probability distributions. These values are then used in the simulation model to obtain some model output variable values. This process is repeated many times, each time making sure the model calibration is

valid for the input data values chosen. The end result is a probability distribution of model output variables and system performance indices that results from variations and possible errors in all of the input values.

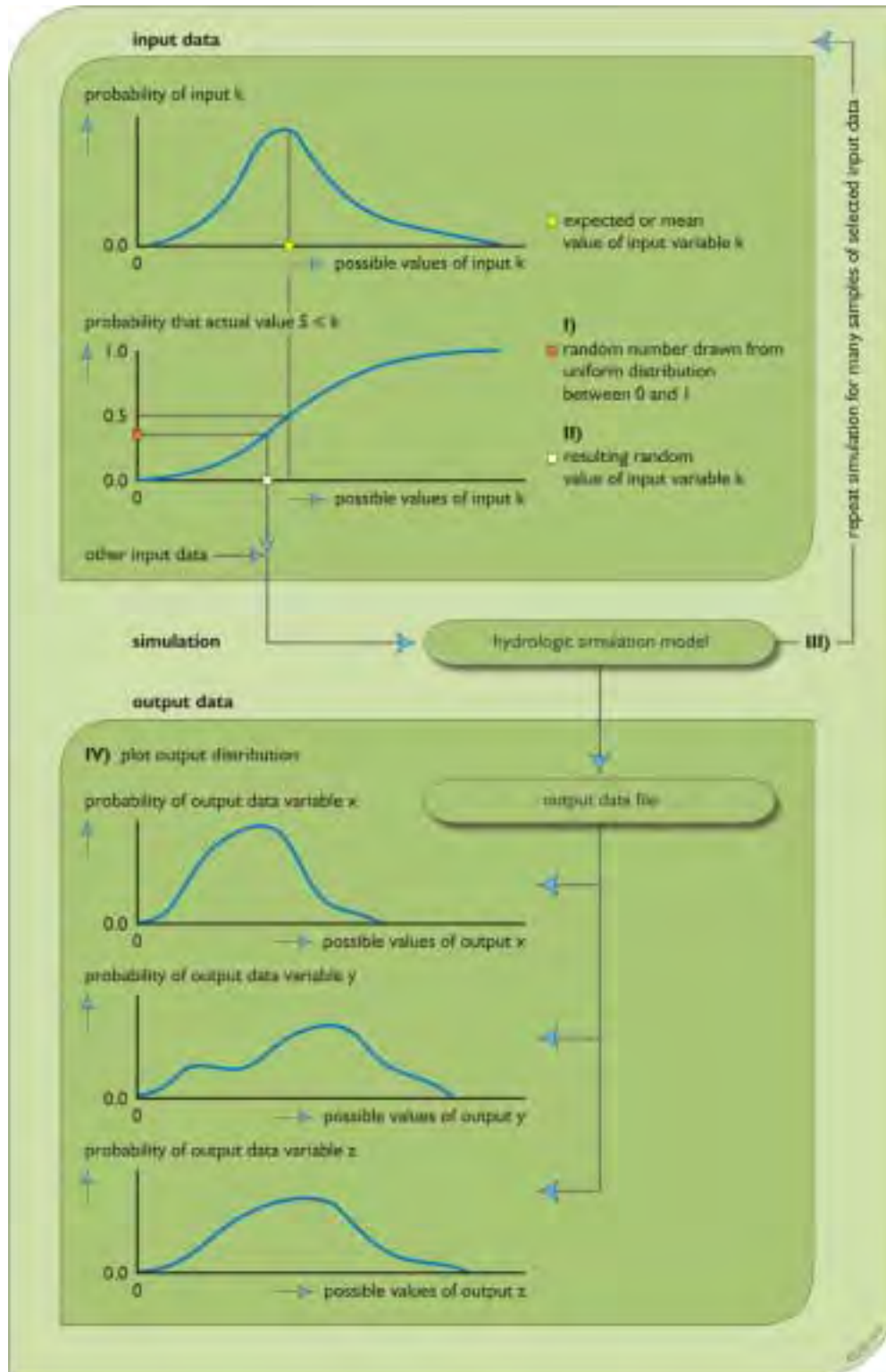


Figure 16. Monte Carlo sampling and simulation procedure for finding distributions of output variable values based on distributions, for specified reliability levels, of input data values. This technique can be applied to one or more uncertain input variables at a time. The output distributions will reflect the combined effects of this input uncertainty over the specified ranges.

Using a simple Monte Carlo analysis, values of all of the parameter sets are selected randomly from distributions describing the individual and joint uncertainty in each, and then the modeled system is simulated to obtain estimates of the selected performance indices. This must be done many times (often well over 100) to obtain a statistical description of system performance variability. The number of replications needed is generally not dependent on the number of parameters whose errors are to be analyzed. One can include in the simulation the uncertainty in parameters as well as natural variability. This method can evaluate the impact of single or multiple uncertain parameters.

A significant problem that arises in such simulations is that some combinations of parameter values result in unreasonable models. For example, model performance with calibration data sets might be inconsistent with available data sets. The calibration process places interesting constraints on different sets of parameter values. Thus, such Monte Carlo experiments often contain checks that exclude combinations of parameter values that are unreasonable. In these cases the generated results are conditioned on this validity check.

Whenever sampling methods are used, one must consider possible correlations among input data values. Sampling methods can handle spatial and temporal correlations that may exist among input data values, but the existence of correlation requires defining appropriate conditional distributions.

One major limitation of applying Monte Carlo methods to estimate ranges of risk and uncertainty for model output variable values, and system performance indicator values based on these output variable values, is the computing time required. To reduce the computing times needed to perform sensitivity analyses using sampling methods, some tricks and as well as stratified sampling methods are available. The discussion below illustrates the idea of a simple modification (or trick) using a “standardized” Monte Carlo analysis. The more general Latin Hypercube Sampling procedure is also discussed.

4.2.6.1 Simple Monte Carlo sampling

To illustrate the use of Monte Carlo sampling methods consider again Vollenweider’s empirical relationship, Equation 5, for the average phosphorus concentration in lakes (Vollenweider, 1976). Two hundred values of each parameter were generated independently from normal distributions with the means and variances as shown in Table 6.

The table contains the specified means and variances for the generated values of L , q and z , and also the actual values of the means and variances of the 200 generated values of L , q , z and also of the 200 corresponding generated output phosphorus concentrations, P . Figure 17 displays the distribution of the generated values of P .

Table 6. Monte Carlo analysis of lake phosphorus levels.

parameter	L	q	z	P
specified means and standard deviations				
mean	680.00	10.60	84.00	—
standard deviations	121.21	1.67	1.82	---
generated means and standard deviations				
mean	674.18	10.41	84.06	17.07
standard deviations	130.25	1.73	1.82	3.61

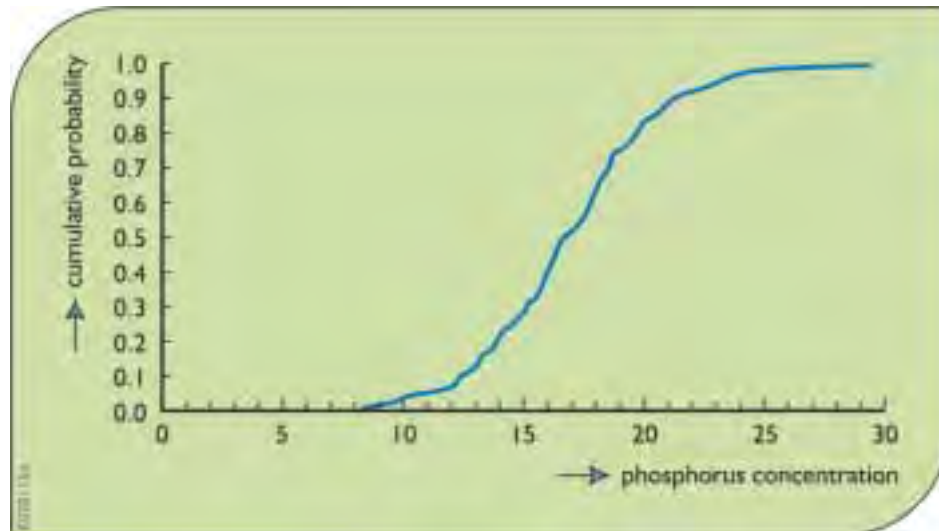


Figure 17. Distribution of lake phosphorus concentrations from Monte Carlo analysis

One can see that given the estimated levels of uncertainty, phosphorus levels could reasonably range from below 10 to above 25. The probability of generating a value greater than 20 mg/m³ was 12.5%. The 5% to 95 percentile range was 11.1 to 23.4 mg/m³. In the figure, the cumulative probability curve is rough because only 200 values of the phosphorus concentration were generated, but these are clearly enough to give a good impression of the overall impact of the errors.

4.2.6.2 Sampling uncertainty.

In this example, the mean of the 200 generated values of the phosphorus concentration, P , was 17.07. However a different set of random values would have generated a different set of P values as well. Thus it is appropriate to estimate the standard error, SE, of this average. The standard error equals the standard deviation σ of the P values divided by the square root of the sample size n :

$$SE = \sigma / (n)^{0.5} = 3.61 / (200)^{0.5} = 0.25. \quad (19)$$

From the central limit theorem of mathematical statistics, the average of a large number of independent values should have very nearly a normal distribution. Thus, 95% of the time, the true mean of P should be in the interval $17.1 \pm 1.96 (0.25)$, or 16.6 to 17.6 mg/m³. This level of uncertainty reflects the observed variability of P and the fact that only 200 values were generated.

4.2.6.3 Making sense of the results.

A significant challenge with complex models is to determine from the Monte Carlo simulation which parameter errors are important. Calculating the correlation between each generated input parameter value and the output variable value is one way of doing this. As Table 7 below shows, based upon the magnitudes of the correlation coefficients, errors in L were most important, and those in q second in importance.

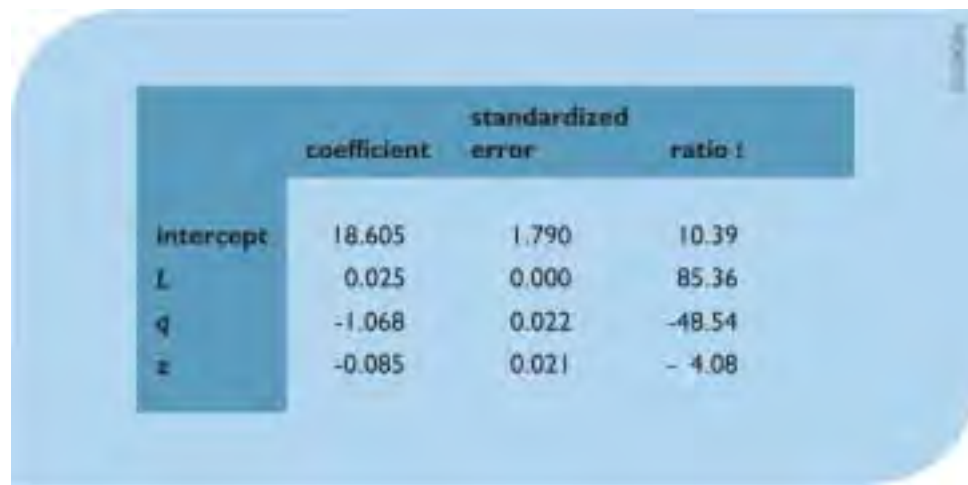
Table 7. Correlation analysis of Monte Carlo results.

variable	L	q	z	P
L	1			
q	0.079	1		
z	0.1297	-0.139	1	
P	0.051	-0.434	0.144	1

One can also use regression to develop a linear model defining variations in the output based on errors in the various parameters. The results are shown in the Table 8. The fit is very good, and $R^2 = 98\%$. If the model for P had been linear, a R^2 value of 100% should have resulted. All of the coefficients are significantly different from zero.

Note that the correlation between P and z was positive in Table 7, but the regression coefficient for z is negative. This occurred because there is a modest negative correlation between the generated z and q values. Use of partial correlation coefficients can also correct for such spurious correlations among input parameters.

Table 8. Results of Regression Analysis on Monte Carlo Results



	coefficient	standardized error	ratio t
Intercept	18.605	1.790	10.39
L	0.025	0.000	85.36
Q	-1.068	0.022	-48.54
z	-0.085	0.021	-4.08

Finally we display a plot, Figure 18, based on this regression model illustrating the reduction in the variance of P that is due to dropping each variable individually. Clearly L has the biggest impact on the uncertainty in P , and z the least.

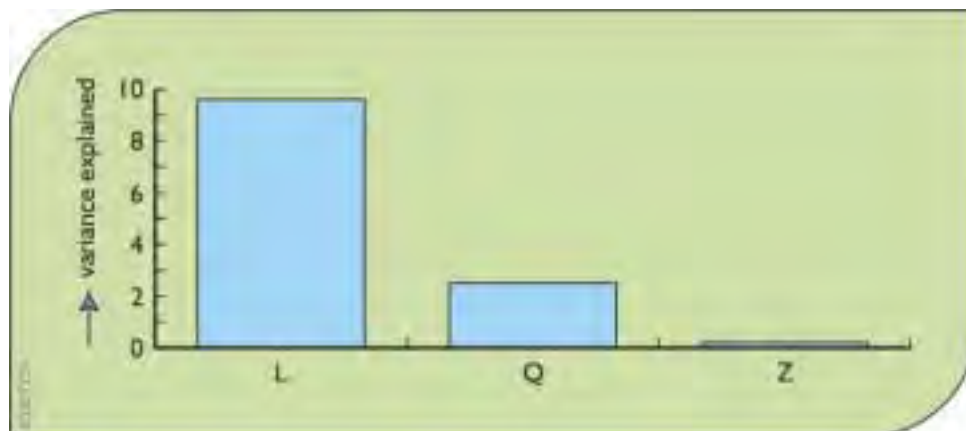


Figure 18. Reduction in the variance of P that is due to dropping from the regression model each variable individually. Clearly L has the biggest impact on the uncertainty in P , and z the least.

4.2.6.4 Standardized Monte Carlo analysis

Using a “standardized” Monte Carlo analysis, one could adjust the generated values of L , q and z above so that the generated samples actually have the desired mean and variance. While making that correction, one can also shuffle their values so that the correlations among the generated values for the different parameters are near zero, as is desired. This was done for the 200 generated values to obtain the statistics shown in Table 9.

Table 9. Standardized Monte Carlo analysis of lake phosphorus levels

parameter	L	q	z	P
specified means and standard deviations				
Mean	680.00	10.60	84.00	—
Standard deviations	121.21	1.67	1.82	—
generated means and standard deviations				
Mean	680.00	10.60	84.00	17.03
Standard deviations	121.21	1.67	1.82	3.44

Repeating the correlation analysis from before (shown in Table 10) now yields much clearer results that are in agreement with the regression analysis. The correlation between P and both q and z are now negative as they should be. Because the generated values of the three parameters have been adjusted to be uncorrelated, the signal from one is not confused with the signal from another.

Table 10. Correlation analysis of standardized Monte Carlo results

	P	K	c
P	1.000		
K	0.999	1.000	
c	0.999	0.999	1.000

The mean phosphorus concentration c changed very little. It is now 17.0 instead of 17.1 mg/m^3 .

Using control variates with a linear predictive model in conjunction with the standardized Monte Carlo variates, the standard deviation of the errors associated with the 200 observations is only 0.45. Thus the standard error for this estimate of the mean of P is $0.45/(200)^{0.5}$ or just 0.03. Thus this is a highly accurate result. The regressions were also repeated and yielded very similar results. The only real difference was that the parameter estimates had small standard errors and were more significant because of the elimination of correlation between the generated parameters.

4.2.6.5 Generalized likelihood estimation

Beven (1993) and Binley and Beven (1991) suggest a Generalized Likelihood Uncertainty Estimation (GLUE) technique for assessment of parameter error uncertainty using Monte Carlo simulation. It is described as a "formal methodology for some of the subjective elements of model calibration" (Beven, 1989, p. 47). The basic idea is to begin by assigning reasonable ranges for the various parameters and then to draw parameter sets from those ranges using a uniform or some similar (and flat) distribution. These generated parameter sets are then used on a calibration data set so that unreasonable combinations can be rejected, while reasonable values are assigned a posterior probability based upon a likelihood measure which may reflect several dimensions and characteristics of model performance.

Let $L(P_i) \geq 0$ be the value of the likelihood measure assigned to the i^{th} parameter set's calibration sequence. Then the model predictions generated with parameter set combination P_i are assigned posterior probability, $p(P_i)$.

$$p(P_i) = L(P_i) / \sum_j L(P_j) \quad (20)$$

These probabilities reflect the form of Bayes theorem, which is well supported by probability theory (Devore, 1991). This procedure should capture reasonably well the dependence or correlation among parameters, because *reasonable* sequences will all be assigned larger probabilities, whereas sequences that are unable to reproduce the system response over the calibration period will be rejected or assigned small probabilities.

However, in a rigorous probabilistic framework, the L would be the likelihood function for the calibration series for particular error distributions. (This could be checked with available goodness-of-fit procedures; for example, Kuczera, 1988.) When relatively ad hoc measures are adopted for the likelihood measure with little statistical validity, the $p(P_i)$ probabilities are best described as pseudo probabilities or “likelihood” weights.

Another concern with this method is the potential efficiency. If the parameter ranges are too wide, a large number of unreasonable or very unlikely parameter combinations will be generated. These will either be rejected or else will have small probabilities and thus little effect on the analysis. In this case the associated processing would be a waste of effort. A compromise is to use some data to calibrate the model and to generate a prior or initial distribution for the parameters that is at least centered in the best range (Beven 1993, p. 48). Then use of a different calibration period to generate the $p(P_i)$ allows an updating of those initial probabilities to reflect the information provided by the additional calibration period with the adopted likelihood measures.

After the accepted sequences are used to generate sets of predictions, the likelihood weights would be used in the calculation of means, variances and quantiles, rather than the customary procedure of giving all the generated realizations equal weight. The resulting conditional distribution of system output reflects the initial probability distributions assigned to parameters, the rejection criteria, and the likelihood measure adopted to assign “likelihood” weights.

4.2.7 Latin hypercube sampling

For the simple Monte Carlo simulations described above, with independent errors, a probability distribution is assumed for each input parameter or variable. In each simulation run, values of all input data are obtained from sampling those individual and independent distributions. The value generated for an input parameter or variable is usually independent of what that value was in any previous run, or what other input parameter or variable values are in the same run. This simple sampling approach can result in a clustering of parameter values and hence both redundancy of information from repeated sampling in the same regions of a distribution and lack of information from no sampling in other regions of the distributions.

A stratified sampling approach ensures more even coverage of the range of input parameter or variable values with the same number of simulation runs. This can be accomplished by dividing the input parameter or variable space into sections and sampling from each section with the appropriate probability.

One such approach, Latin hypercube sampling (LHS), divides each input distribution into sections of equal probability for the specified the probability distribution, and draws one observation randomly from each range. Hence the ranges of input values within each section actually occur with equal frequency in the experiment. These values from each interval for each distribution are randomly assigned to those from other intervals to construct sets of input values for the simulation analysis. Figure 19 shows the steps in constructing a LHS for six simulations involving three inputs P_j (P_1 , P_2 , and P_3) and six intervals of their respective normal, uniform and triangular probability distributions.

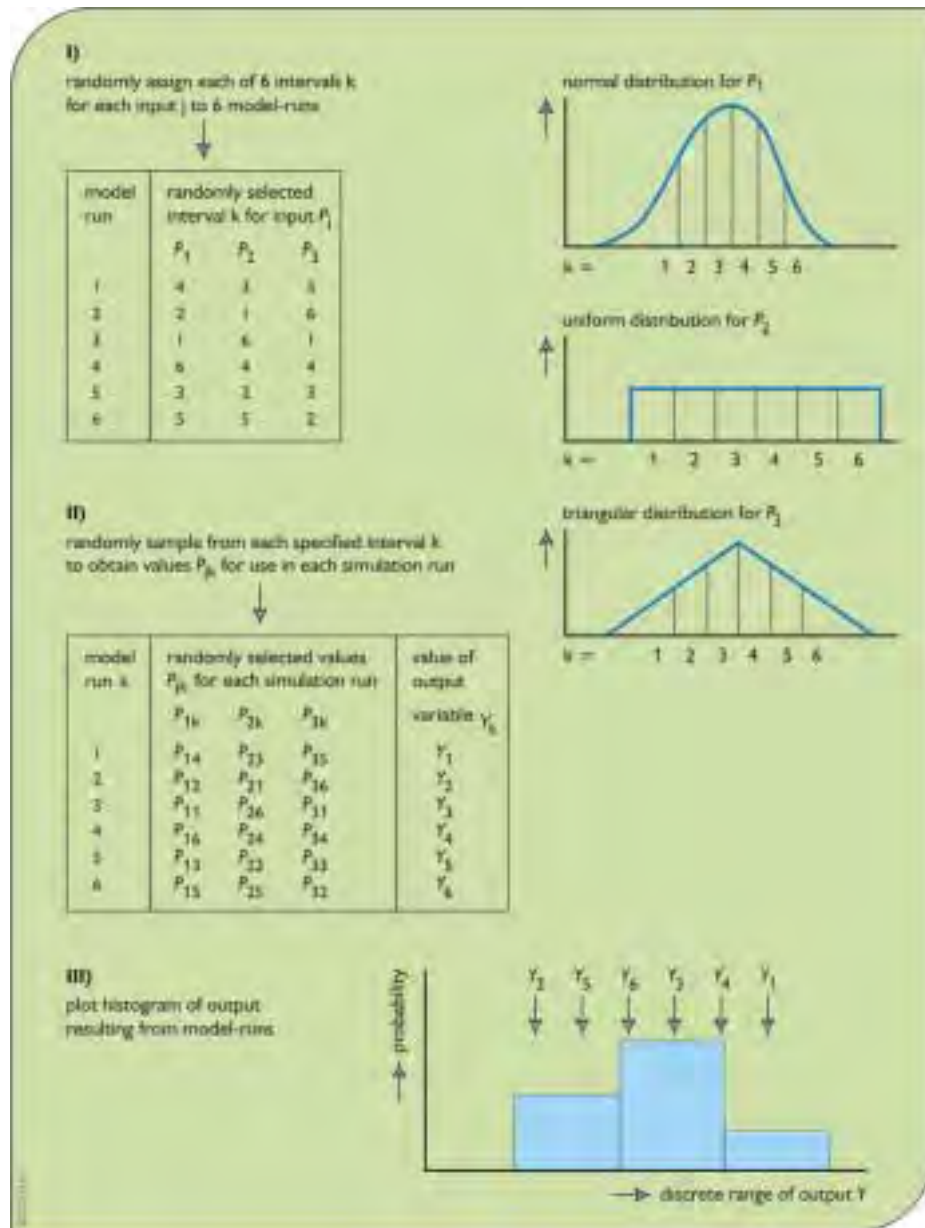


Figure 19. Schematic representation of a Latin hypercube sampling procedure for six simulation runs.

5. Performance indicator uncertainties

5.1 Performance measure target uncertainty

Another possible source of uncertainty is the selection of performance measure target values. For example, consider a target value for a pollutant concentration based on the effect of exceeding it in an ecosystem. Which target value is best or correct? When this is not clear, there are various ways of expressing the uncertainty associated with any target value. One such method is the use of fuzzy sets (Chapter VI). Use of 'grey' numbers or intervals instead of 'white' or fixed target values is another. When some uncertainty or disagreement exists over the selection of the best target value for a particular performance measure it seems to us the most direct and transparent way to do this is to subjectively assume a distribution over a range of possible target values. Then this subjective probability distribution can be factored into the tradeoff analysis, as outlined in Figure 20.

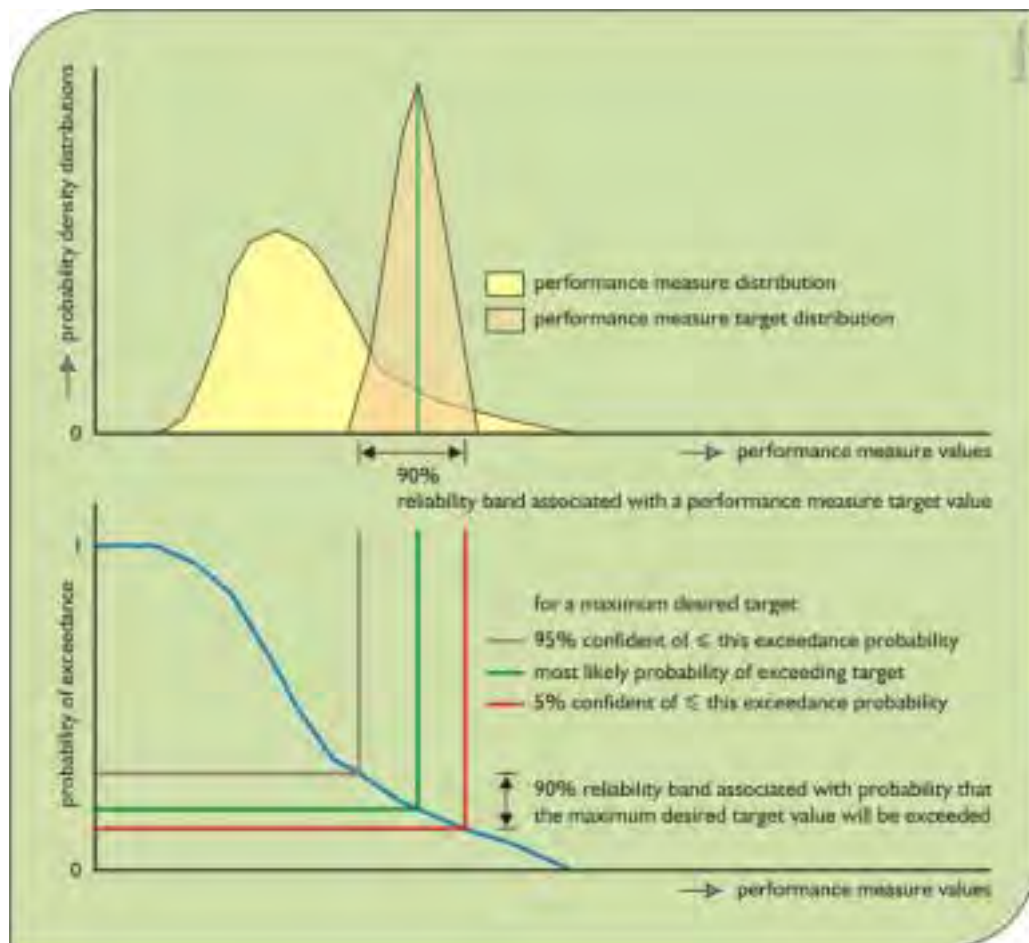


Figure 20. Combining the probability distribution of performance measure values with the probability distribution of performance measure target values to estimate the confidence one has in the probability of exceeding a maximum desired target value.

One of the challenges associated with defining and including in an analysis the uncertainty associated with a target or threshold value for a performance measure is that of communicating just what the result of such an analysis means. Referring to Figure 20, suppose the target value represents some maximum limit of a pollutant, say phosphorus, concentration in the flow during a given period of time at a given site or region, and it is not certain just what that maximum limit should be. Subjectively defining the distribution of that maximum limit, and considering that uncertainty along with the uncertainty (probability of exceedance function) of pollutant concentrations – the performance measure – one can attach a confidence to any probability of exceeding the maximum desired concentration value.

The 95% probability of exceedance shown on Figure 20, say $P_{0.95}$, should be interpreted as “we can be 95% confident that the probability of the maximum desired pollutant concentration being exceeded will be no greater than $P_{0.95}$.” We can be only 5% confident that the probability of exceeding the desired maximum concentration will be no greater than the lower $P_{0.05}$ value. Depending on whether the middle line through the subjective distribution of target values in Figure 20 represents the most likely or median target value, the associated probability of exceedance is either the most likely, as indicated in Figure 20, or that for which we are only 50% confident.

Figure 21 attempts to show how to interpret the reliabilities when the uncertain performance targets are

- minimum acceptable levels that are to be maximized,
- maximum acceptable levels that are to be minimized or
- optimum levels.

An example of a minimum acceptable target level might be the population of wading birds in an area. An example of a maximum acceptable target level might be, again, the phosphorus concentration of the flow in a specific wetland or lake. An example of an optimum target level might be the depth of water most suitable for selected species of aquatic vegetation during a particular period of the year.

For performance measure targets that are not expressed as minimum or maximum limits but that are the ‘best’ values, referring to Figure 21, one can state that one is 90% confident that the probability of achieving the desired target is no more than B. The 90% confidence level probability of not achieving the desired target is at least A+C. The probability of the performance measure being too low is at least A and the probability of the performance measure being too high is at least C, again at the 90% confidence levels. As the confidence level decreases the bandwidth decreases, and the probability of not meeting the target increases.

Now, clearly there is uncertainty associated with each of these uncertainty estimations, and this raises the question of how valuable is the quantification of the uncertainty of each additional component of the plan in an evaluation process. Will plan evaluators and decision makers

benefit from this additional information, and just how much additional uncertainty information is useful?

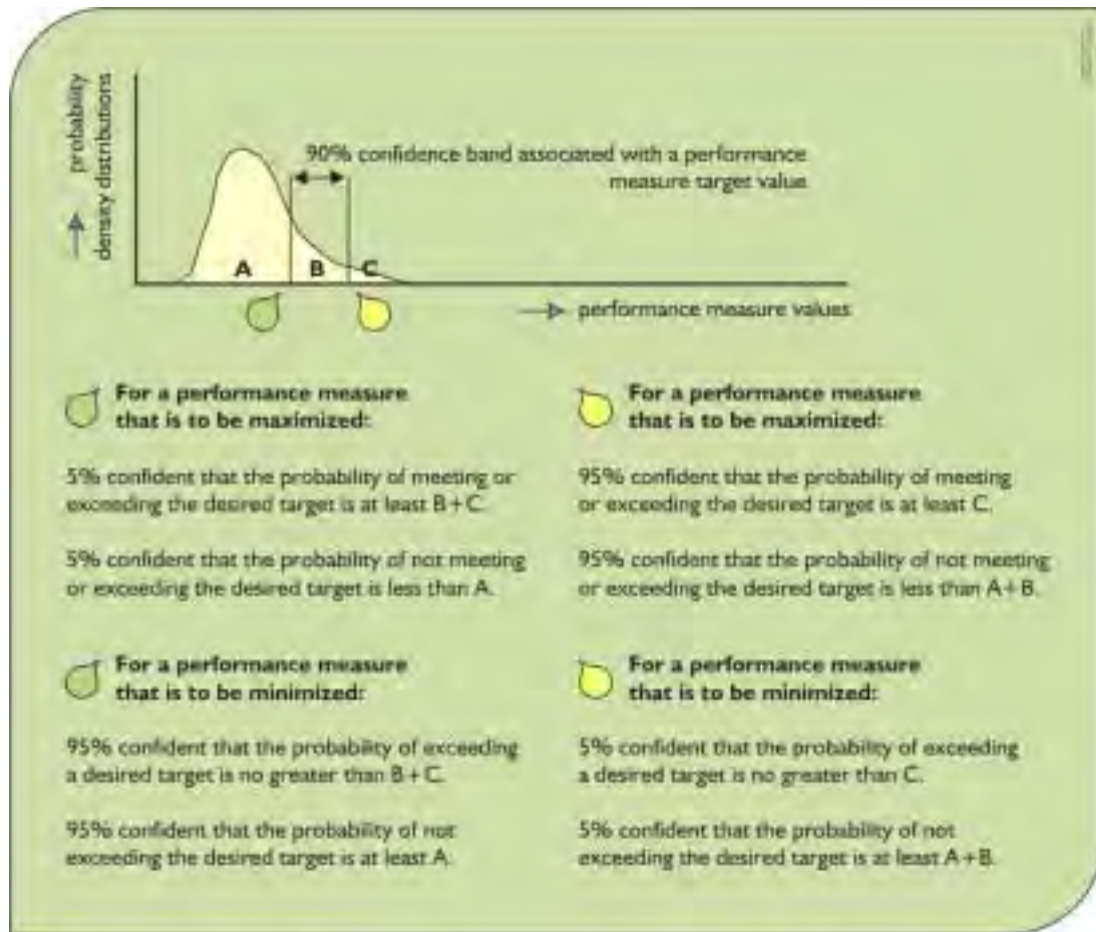


Figure 21. Interpreting the results of combining performance measure probabilities with performance measure target probabilities depends on the type of performance measure. The letters A, B, and C represent proportions of the probability density function of performance measure values. (Hence probabilities $A + B + C = 1$.)

Now consider again the tradeoffs that need to be made as illustrated in Figure 7. Instead of considering a single target value as shown on Figure 7, assume there is a 90% confidence range associated with that single performance measure target value. Also assume that the target is a maximum desired upper limit (e.g., of some pollutant concentration).

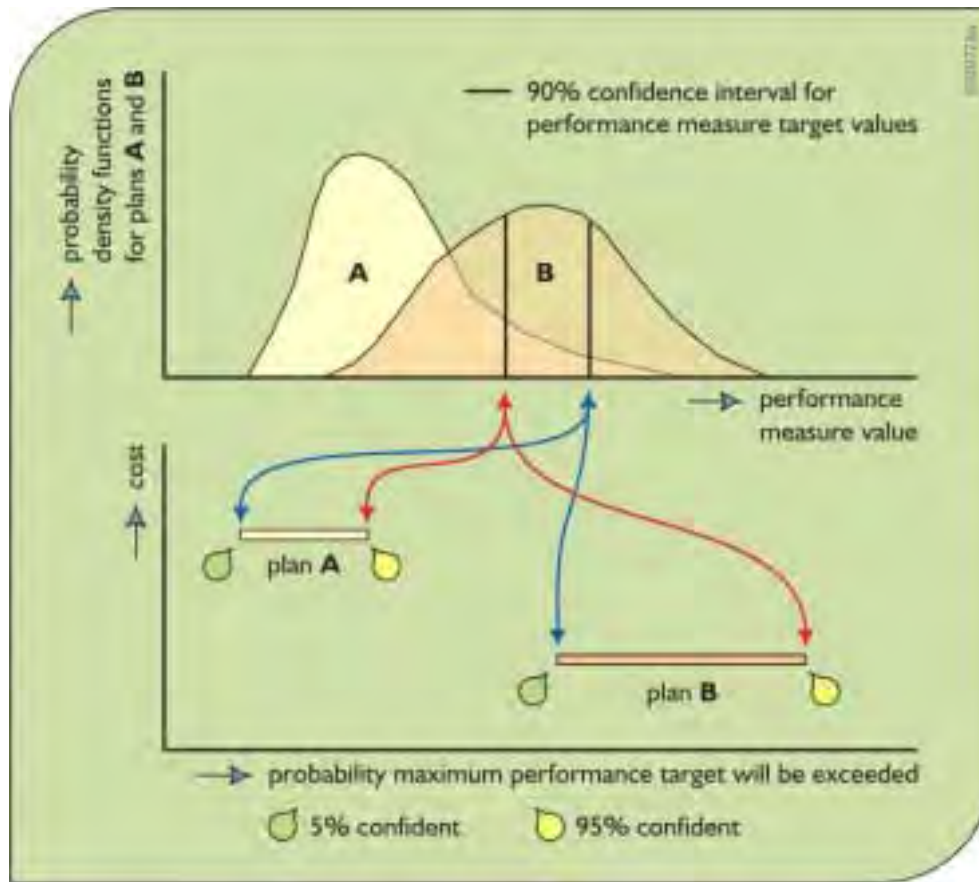


Figure 22. Two plans showing ranges of probabilities, depending on one's confidence, that an uncertain desired maximum (upper limit) performance target value will be exceeded. The 95% confidence levels are associated with the higher probabilities of exceeding the desired maximum target. The 5% confident levels are associated with the more desirable lower probabilities of exceeding the desired maximum target. Plan A with reduced probabilities of exceeding the upper limit costs more than Plan B.

In the case shown in Figure 22, the tradeoff is clearly between cost and reliability. In this example, no matter what confidence one chooses, Plan A is preferred to Plan B with respect to reliability, but Plan B is preferred to Plan A with respect to cost. The tradeoff is only between these two performance indicators or measures.

Consider however a third plan, as shown in Figure 23. This situation adds to the complexity of making appropriate tradeoffs. Now there are three criteria: cost, probability of exceedance (reliability) and the confidence in those reliabilities or probabilities. Add to this the fact that there will be multiple performance measure targets, each expressed in terms of their maximum probabilities of exceedance and the confidence in those probabilities.



Figure 23. Tradeoffs among cost, reliabilities, and the confidence level of those reliabilities. The relative ranking of plans with respect to the probability of exceeding the desired (maximum limit) target may depend on the confidence given to that probability.

In Figure 23, in terms of cost the plans are ranked, from best to worst, B, C, and A. In terms of reliability at the 90 percent confidence level, they are ranked A, B, and C but at the 50 percent confidence level the ranking is A, C and B.

If the plan evaluation process has difficulty handling all this it may indicate the need to focus the uncertainty analysis effort on just what is deemed important, achievable, and beneficial. Then when the number of alternatives has been narrowed down to only a few that appear to be the better ones, a more complete uncertainty analysis can be performed. There is no need nor benefit in performing sensitivity and uncertainty analyses on all possible management alternatives. Rather one can focus on those alternatives that look the most promising, and then carry out additional uncertainty and sensitivity analyses only when important uncertain performance indicator values demands more scrutiny. Otherwise the work is not likely to affect the decision anyway.

5.2 Distinguishing differences between performance indicator distributions

Simulations of alternative water management infrastructure designs and operating policies require a comparison of the simulation outputs – the performance measures or indicators – associated with each alternative. A reasonable question to ask is are the observed differences statistically significant. Can one really tell if one alternative is better than another or are the observed differences explainable by random variations attributable to variations in the inputs and how the system responds?

This is a common statistical issue that is addressed by standard hypothesis tests (Devore, 1991; Benjamin and Cornell, 1970). Selection of an appropriate test requires that one first resolve what type of change one expects in the variables. To illustrate, consider the comparison of two

different operating policies. Let Y_1 denote the set of output performance variable values with the first policy, and Y_2 the set of output performance variable values of the second policy. In many cases, one would expect one policy to be better than the other. One measure might be the difference in the mean of the variables; for example is $E[Y_1] < E[Y_2]$?. Alternatively one could check the difference in the median (50 percentile) of the two distributions.

In addition, one could look for a change in the variability or variance, or a shift in both the mean and the variance. Changes described by a difference in the mean or median often make the most sense and many statistical tests are available that are sensitive to such changes. For such investigations parametric and non-parametric tests for paired and unpaired data can be employed.

Consider the differences between “paired” and “unpaired” data. Suppose that the meteorological data for 1941-1990 is used to drive a simulation model generating data as described in Table 11:

Table 11. Possible flow data from a 50-year simulation

1941	$Y_1 (1)$	$Y_2 (1)$
1942	$Y_1 (2)$	$Y_2 (2)$
1943	$Y_1 (3)$	$Y_2 (3)$
1944	$Y_1 (4)$	$Y_2 (4)$
1989	$Y_1 (49)$	$Y_2 (49)$
1990	$Y_1 (50)$	$Y_2 (50)$

Here there is one sample, $Y_1(1)$ through $Y_1(50)$, for policy 1, and another sample, $Y_2(1)$ through $Y_2(50)$, for policy 2. However, the two sets of observations are not independent. For example, if 1943 was a very dry year, then we would expect both $Y_1(3)$ for policy 1 in that year and $Y_2(3)$ for policy 2 to be unusually small. With such paired data, one can use a paired hypothesis test to check for differences. Paired tests are usually easier than the corresponding unpaired tests that are appropriate in other cases. (For example, if one were checking for a difference in average rainfall depth between 1941-1960, and 1961-1990, they would have two sets of independent measurements for the two periods. With such data, one should use a two-sample unpaired test.)

Paired tests are generally based on the differences between the two sets of output, $Y_1(i) - Y_2(i)$. These are viewed as a single independent sample. The question is then are the differences

positive (say Y_1 tends to be larger than Y_2), or negative (Y_1 tends to be smaller), or are positive and negative differences are equally likely (there is no difference between Y_1 and Y_2).

Both parametric and non-parametric families of statistical tests are available for paired data. The common parametric test for paired data (a one-sample t test) assumes that the mean of the differences

$$X(i) = Y_1(i) - Y_2(i) \quad (21)$$

are normally distributed. Then the hypothesis of no difference is rejected if the t statistic is sufficiently large, given the sample size n .

Alternatively, one can employ a nonparametric test and avoid the assumption that the differences $X(i)$ are normally distributed. In such a case, one can use the Wilcoxon Signed Rank test. This nonparametric test ranks the absolute values $|X(i)|$ of the differences. If the sum S of the ranks of the positive differences deviates sufficiently from its expected value, $n(n+1)/4$ (were there no difference between the two distributions), one can conclude that there is a statistically significant difference between the $Y_1(i)$ and $Y_2(i)$ series. Standard statistical texts have tables of the distribution of the sum S as a function of the sample size n , and provide a good analytical approximation for $n > 20$ (for example, Devore, 1991). Both the parametric t test and the nonparametric Wilcoxon Signed Rank test require that the differences between the simulated values for each year be computed.

6. Communicating model output uncertainty

Spending money on reducing uncertainty would seem preferable to spending it on ways of calculating and describing it better. Yet attention to uncertainty communication is critically important if uncertainty analyses and characterizations are to be of value in a decision making process. In spite considerable efforts by those involved in risk assessment and management, we know very little about how to ensure effective risk communication to gain the confidence of stakeholders, incorporate their views and knowledge, and influence favorably the acceptability of risk assessments and risk-management decisions.

The best way to communicate concepts of uncertainty may well depend on what the audiences already know about risk and the various types of probability distributions (e.g., density, cumulative, exceedance) based on objective and subjective data, and the distinction between mean or average values and the most likely values. Undoubtedly graphical representations of these ways of describing uncertainty considerably facilitate communication.

The National Research Council (NRC 1994) addressed the extensive uncertainty and variability associated with estimating risk and concluded that risk characterizations should not be reduced to a single number or even to a range of numbers intended to portray uncertainty. Instead, the report recommended managers and the interested public should be given risk characterizations that are both qualitative and quantitative and both verbal and mathematical.

In some cases communicating qualitative information about uncertainty to stakeholders and the public in general may be more effective than quantitative information. There are, of course, situations in which quantitative uncertainty analyses are likely to provide information that is useful in a decision-making process. How else can tradeoffs such as illustrated in Figures 10 and 27 be identified? Quantitative uncertainty analysis often can be used as the basis of qualitative information about uncertainty, even if the quantitative information is not what is communicated to the public.

One should acknowledge to the public the widespread confusion regarding the differences between variability and uncertainty. Variability does not change through further measurement or study, although better sampling can improve our knowledge about variability. Uncertainty reflects gaps in information about scientifically observable phenomena.

While it is important to communicate uncertainties and confidence in predictions, it is equally important to clarify who or what is at risk, possible consequences, and the severity and irreversibility of an adverse effect should a target value, for example, not be met. This qualitative information is often critical to informed decision-making. Risk and uncertainty communication is always complicated by the reliability and amounts of available relevant information as well as how that information is presented. Effective communication between people receiving information about who or what is at risk, or what might happen and just how severe and irreversible an adverse effect might be should a target value not be met, is just as important as the level of uncertainty and the confidence associated with such predictions. A two-way dialog between those receiving such information and those giving it can help identify just what seems best for a particular audience.

Risk and uncertainty communication is a two-way street. It involves learning and teaching. Communicators dealing with uncertainty should learn about the concerns and values of their audience, their relevant knowledge, and their experience with uncertainty issues. Stakeholders' knowledge of the sources and reasons for uncertainty needs to be incorporated into assessment and management and communication decisions. By listening, communicators can craft risk messages that better reflect the perspectives, technical knowledge, and concerns of the audience.

Effective communication should begin before important decisions have been made. It can be facilitated in communities by citizen advisory panels. Citizen advisory panels can give planners and decision makers a better understanding of the questions and concerns of the community and an opportunity to test its effectiveness in communicating concepts and specific issues regarding uncertainty.

One approach to make uncertainty more meaningful is to make risk comparisons. For example, a ten parts per billion target for a particular pollutant concentration is equivalent to 10 seconds in over 31 years. If this is an average daily concentration target that is to be satisfied "99 percent," of the time, this is equivalent to an expected violation of less than one day every three months.

Many perceive the reduction of risk by an order of magnitude as though it were a linear reduction. A better way to illustrate orders of magnitude of risk reduction is shown in Figure 24, in which a bar graph depicts better than words that a reduction in risk from one in a 1,000 (10^{-3}) to one in 10,000 (10^{-4}) is a reduction of 90% and that a further reduction to one in 100,000 (10^{-5}) is a reduction 10-fold less than the first reduction of 90%. The percent of the risk that is reduced by whatever measures is a much easier concept to communicate than reductions expressed in terms of estimated absolute risk levels, such as 10^{-5} .

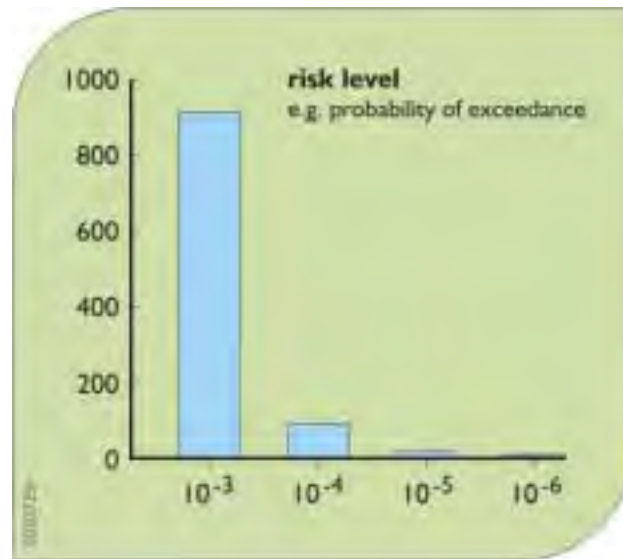


Figure 24. Reducing risk by orders of magnitude is not equivalent to linear reductions.

Risk comparisons can be helpful, but they should be used cautiously and tested if possible. There are dangers in comparing risks of diverse character, especially when the intent of the comparison is seen as minimizing a risk (NRC 1989). One difficulty in using risk comparisons is that it is not always easy to find risks that are sufficiently similar to make a comparison meaningful. How is someone able to compare two alternatives having two different costs and two different risk levels, for example, as is shown in Figure 7? One way is to perform an indifference analysis (Chapter X), but that can lead to different results depending who performs it. Another way is to develop utility functions using weights, where, for example reduced phosphorus load by half is equivalent to a 25 percent shorter hydroperiod in that area, but again each person's utility or tradeoff may differ.

At a minimum, graphical displays of uncertainty can be helpful. Consider the common system performance indicators that include:

- Time-series plots for continuous time-dependent indicators (Figure 25 upper left)
- Probability exceedance distributions for continuous indicators (Figure 25 upper right),
- Histograms for discrete event indicators (Figure 25 lower left), and
- Overlays on maps for space-dependent discrete events (Figure 25 lower right).

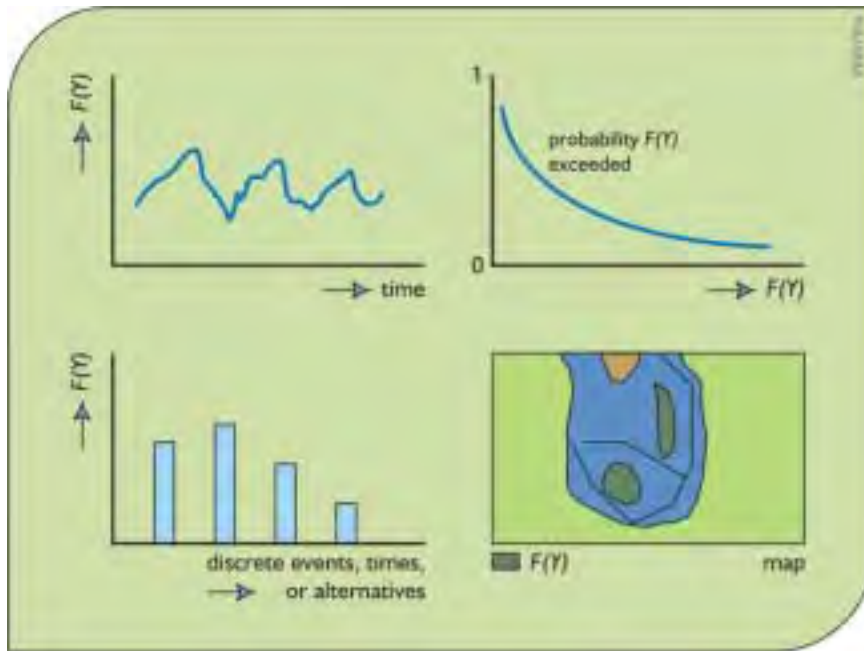


Figure 25. Different types of displays used to show model output Y or system performance indicator values $F(Y)$.

The first three graphs in Figure 25 could show, in addition to the single curve or bar that represents the most likely output, a range of outcomes associated with a given confidence interval. For overlays of information on maps, different colors could represent the spatial extents of events associated with different ranges of risk or uncertainty. Figure 26, corresponding to Figure 25, illustrates these approaches for displaying these ranges.

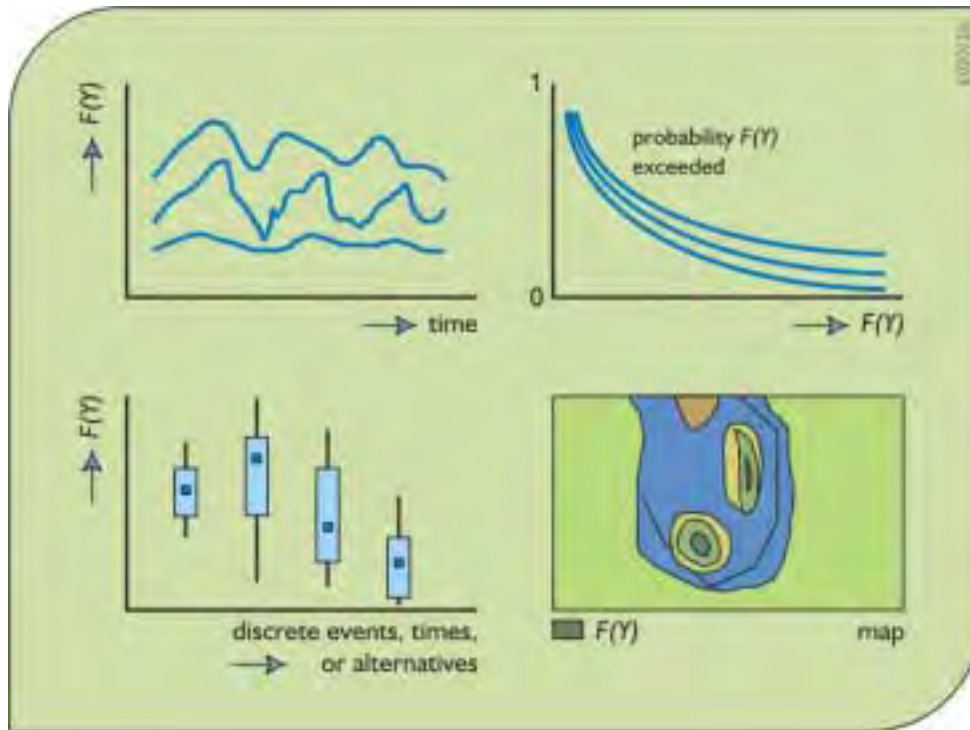


Figure 26. Plots of ranges of possible model output Y or system indicator values $F(Y)$ for different types of displays.

7. Conclusions

This chapter provides an overview of uncertainty and sensitivity analyses in the context of hydrologic or water resources systems simulation modeling. A broad range of tools are available to explore, display, and quantify the sensitivity and uncertainty in predictions of key output variables and system performance indices with respect to imprecise and random model inputs and to assumptions concerning model structure. They range from relatively simple deterministic sensitivity analysis methods to more involved first-order analyses and Monte Carlo sampling methods.

Because of the complexity of many watersheds or river basins, Monte Carlo methods for uncertainty analyses may be a very major and unattractive undertaking. Therefore it is often prudent begin with the relatively simple deterministic procedures. This coupled with a probabilistically based first-order uncertainty analysis method can help quantify the uncertainty in key output variables and system performance indices, and the relative contributions of uncertainty in different input variables to the uncertainty in different output variables and system performance indices. These relative contributions may differ depending upon which output variables and indices are of interest.

A sensitivity analysis can provide a systematic assessment of the impact of parameter value imprecision on output variable values and performance indices, and of the relative contribution of errors in different parameter values to that output uncertainty. Once the key variables are identified, it should be possible to determine the extent to which parameter value uncertainty can be reduced through field investigations, development of better models, and other efforts.

Model calibration procedures can be applied to individual catchments and subsystems, as well as to composite systems. Automated calibration procedures have several advantages including the explicit use of an appropriate statistical objective function, identification of those parameters that best reproduce the calibration data set with the given objective function, and the estimations of the statistical precision of the estimated parameters.

All of these tasks together can represent a formidable effort. However, knowledge of the uncertainty associated with model predictions can be as important to management decision and policy formulation as are the predictions themselves.

No matter how much attention is given to quantifying and reducing uncertainties in model outputs, uncertainties will remain. Professionals who analyze risk, managers and decision makers who must manage risk, and the public who must live with risk and uncertainty, have different information needs and attitudes regarding risk and uncertainty. It is clear that information needs differ among those who model or use models, those who make substantial investment or social decisions, and those who are likely to be impacted by those decisions. Meeting those needs should result in more informed decision making. But it comes at a cost that should be considered along with the benefits of having this sensitivity and uncertainty information.

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Appendix I: Model Calibration Examples

- *Calibration of models in the Murray-Darling Basin*

In the Murray-Darling Basin, in order to preserve water quality, water reliability and the environment, a decision was made in 1995 to restrict water use to the 1993/94 level of development. Computer models of the major tributary streams are now used at the end of each year to determine the annual use target for the previous season based on that level of development. Rules are in place to ensure that long term usage is maintained at the agreed level. Because the models now define the overall water rights of each valley, there are legal requirements to calibrate models and each model is independently audited and certified as being unbiased before being approved as fit for purpose. The key model output of interest is water use but emphasis is also placed on the modeling of downstream flow which impacts the rights of downstream regions. Each model must be calibrated over at least ten years and this often means that changes in infrastructure, operating rules and growth in demand have to be incorporated into the calibration run. Calibration reports contain plots of modeled and observed water use, storage behavior and flow and statistics such as mean error, correlation coefficients and standard errors. The aim of calibration is to ensure that the model is unbiased and to give confidence to stakeholders.

An issue that is sometimes raised with model development is the role of calibration, where the model is fine-tuned to match the observed data, and validation where the model is tested against data that was not used in the calibration process to get an independent assessment of the model's accuracy. For the Murray River, because of the variability of our climate, we like to calibrate our model against a long period of data including the most recent years when the current operating rules were being used and the historical data is generally the most reliable. Validation is considered to be less important and is typically carried out using the two or three years of data available following the completion of model calibration.

- *Use of models for Allocating Water in Texas*

Recent legislation in Texas revised the State Water Planning process and mandated the development of water allocation models for every river basin in the state (<http://www.tnrcc.state.tx.us/permitting/waterperm/wrpa/permits.html>). Similar to the Murray – Darling situation, these models are used to provide estimates of reliability for all permitted water diversions in the state as well as analysis of the effects of all permit applications. Naturalized, or predevelopment, time series of flows were constructed for the basins, and then the effects of developments were added in to achieve models of the current situation. The process of developing the basin models was an iterative, peer reviewed calibration process subject to stakeholder comment at several critical junctures. The naturalized flows and subsequent development of the basins now form an accepted and legal basis for future water allocations. Currently, similar activities are ongoing to provide calibrated and verified models of the state's groundwater aquifers and usage.

AQUALLIANCE

DEFENDING NORTHERN CALIFORNIA WATERS



California Sportfishing
Protection Alliance

"An Advocate for Fisheries, Habitat and Water Quality"



January 19, 2010

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Subject: Comments on the Draft Environmental Assessment and Findings of No Significant Impact for the 2010-2011 Water Transfer Program

Dear Messrs. Hubbard and Messer:

AquAlliance, the California Sportfishing Protection Alliance, and the California Water Impact Network ("the Coalition") submit the following comments and questions for the Draft Environmental Assessment ("EA") and Findings of No Significant Impact ("FONSI"), for the *2010-2011 Water Transfer Program* ("Project"). We also provide comments about the purpose and need for the 2010-2011 state and federal water transfer programs that are mirror images of the 2009 Drought Water Bank.

The Bureau of Reclamation's draft environmental review of the Project does not comply with the requirements of National Environmental Policy Act ("NEPA"), 42 U.S.C. §4321 *et seq.* First, we believe that the Bureau needs to prepare an environmental impact statement ("EIS") on this proposal, as we believed for the 2009 Drought Water Bank ("DWB") that allowed up to 600,000 acre-feet (AF) of surface water transfers, up to 340,000 AF of groundwater substitution, and significant crop idling. The *2010-2011 Water Transfer Program* seeks approval for 200,000 AF of CVP related water and suggests that the EA covers non-CVP transfer water. Unfortunately, the non-CVP water appears late in the EA (section 3.18 Cumulative impacts), where the table identifies the non-CVP water (p. 3-107), but does not supply a sub-total. When added, non-CVP water equals 195,910 AF of additional water for transfers. The EA reveals that "the cumulative total amount potentially transferred from all sources would be up to 392,000 acre feet," (p. 3-108) but the actual cumulative number is 395,910 AF of CVP and non-CVP water. The failure to

supply sub-totals and the mathematical carelessness leaves the reader wondering what other liberties have been taken within the 2010-2011 Water Transfer Program.

Bureau reliance on the EA itself violates NEPA requirements because, among other things, the EA fails to provide a reasoned analysis and explanation to support the Bureau's proposed finding of no significant impact. The EA contains a fundamentally flawed alternatives analysis, and treatment of the chain of cause and effect extending from project implementation leading to inadequate analyses of nearly every resource, growth inducing impacts, and cumulative impacts. An EIS would afford the Bureau, DWR, the State Water Resources Control Board, and the California public far clearer insight into how, where, and why the *2010-2011 Water Transfer Program* might or might not be needed. The draft EA/FONSI as released this month fails to provide adequate disclosure of these impacts.

Second, California Environmental Quality Act (CEQA) analysis of the 2010-2011 Water Transfer Program is completely absent at the programmatic level. Is the negligence in this regard due to the present litigation that challenges the 2009 Drought Water Bank exemption? The Project's actual environmental effects—which are similar to the 2009 DWB, the Sacramento Valley Water Management Agreement, and the proposed 1994 Drought Water Bank (for which a final Program Environmental Impact Report was completed in November 1993) – are not presented in the EA, FONSI, or in any CEQA document. The Sacramento Valley Water Management Agreement was signed in 2002 and the need for a programmatic EIS/EIR was clear and initiated, but never completed. In 2000, the Governor's Advisory Drought Planning Panel report, *Critical Water Shortage Contingency Plan* promised a program EIR on a drought-response water transfer program, but was never undertaken. Twice in recent history, the state readily acknowledged that CEQA review for a major drought water banking program was appropriate. So, the Bureau's failure to conduct scientifically supported environmental review in an EIS and DWR's negligence to provide CEQA review reflects an end-run around established law through the use of water transfers, and is therefore vulnerable to legal challenge under the National Environmental Protection Act ("NEPA") and CEQA.

Finally, we also question the merits of and need for the Project itself. The existence of drought conditions at this point in time is highly questionable and reflects the state's abandonment of a sensible water policy framework. Our organizations believe the Bureau's EA/FONSI and the absence of DWR's programmatic review go too far to help a few junior water right holders at the expense of agriculture, communities, and the environment north of the Delta. The 2010-2011 Water Transfer Program will directly benefit the areas of California whose water supplies are the least reliable by operation of state water law. Though their unreliable supplies have long been public knowledge, local, state, and federal agencies in these areas have failed to stop blatantly wasteful uses and diversions of water and to pursue aggressive planning for regional water self-sufficiency.

The proposed Project will have significant effects on the environment—both standing alone and when reviewed in conjunction with the multitude of other plans and programs (including the

non-CVP water that is mentioned in the EA cumulative impacts section) that incorporate and are dependent on Sacramento Valley water. Ironically, the Bureau appears to recognize in its cumulative impacts discussion that there is potential for significant adverse impacts associated with the Project, but instead of conducting an EIS as required, attempts to assure the public that the 2010-2011 Water Transfer Program will be deferred to the “willing sellers” through individual “monitoring and mitigation programs” as well as through constraining actions taken by both DWR and Bureau professional staff whose criteria ought instead be incorporated into the Proposed Action Alternative (EA at p. 2-1, FONSI at p. 1-9). It is impossible to evaluate whether or not the mitigation and monitoring plans will be adequate to relieve the Bureau and DWR of responsibility for impacts from the Project (including the non-CVP water transfers). The language used in the EA (p.3-25) and the *Draft Technical Information for Water Transfers in 2010* (November 2009) (p. 26-31) fail to pass the blush test (details below). Of course, this is not a permissible approach under NEPA; significant adverse impacts should be mitigated—or avoided altogether as CEQA normally requires.¹ Moreover, in light of the wholly inadequate monitoring and mitigation planned for the 2010-2011 Water Transfer Program’s extensive water transfer program, the suggestion that the public should be required to depend on the insufficient monitoring to provide the necessary advance notice of “significant adverse impacts” is an unacceptable position.

We incorporate by reference the following documents:

- Butte Environmental Council’s comments on the Supplemental Environmental Water Account EIR/EIR, 2006.
- Butte Environmental Council’s letter to DWR regarding the Drought Water Bank Addendum from Lippe Gaffney Wagner LLP, 2009.
- Butte Environmental Council’s letter to DWR regarding the Drought Water Bank Addendum.
- Multi-Signatories letter regarding the Drought Water Bank, 2008.
- Professor Kyran Mish’s White Paper, 2008.
- Professor Karin Hoover’s Declaration, 2008.

¹ Perhaps even more telling, the Bureau actually began its own Programmatic EIS to facilitate water transfers from the Sacramento Valley and the interconnected actions that are integrally related to it, but never completed that EIS and now has impermissibly broken out this current segment of the overall Program for piecemeal review in the present draft EA. See 68 Federal Register 46218 (Aug 5, 2003) (promising a Programmatic EIS on these related activities, “include[ing] groundwater substitution in lieu of surface water supplies, conjunctive use of groundwater and surface water, refurbish existing groundwater extraction wells, install groundwater monitoring stations, install new groundwater extraction wells...” *Id.* At 46219. See also http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=788 (current Bureau website on “Short-term Sacramento Valley Water Management Program EIS/EIR”).

**I. The Bureau and DWR Must Prepare an Environmental Impact Statement/
Environmental Impact Report on the Proposed 2010-2011 Water Transfer Program**

We strongly urge the Bureau to withdraw this inadequate environmental document and instead prepare a joint EIS/R on the 2010-2011 Water Transfer Program, before approval by the State Water Resources Control Board (SWRCB), in order to comply with both NEPA and CEQA requirements for full disclosure of human and natural environmental effects.

NEPA requires federal agencies to prepare a detailed environmental impact statement on all “major Federal actions significantly affecting the quality of the human environment” 42 U.S.C. §4332(2)(C). This requirement is to ensure that detailed information concerning potential environmental impacts is made available to agency decision makers and the public before the agency makes a decision. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989). CEQA has similar requirements and criteria.

Under NEPA’s procedures, an agency may prepare an EA in order to decide whether the environmental impacts of a proposed agency action are significant enough to warrant preparation of an EIS. 40 C.F.R. §1508.9. An EA must “provide sufficient evidence and analysis for determining whether to prepare an [EIS]” (*id.*), and must demonstrate that it has taken a “‘hard look’ at the potential environmental impact of a project.” *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1212 (9th Cir. 1998) (internal quotation marks omitted). However, the U.S. Court of Appeals for the Ninth Circuit has cautioned that “[i]f an agency decides not to prepare an EIS, it must supply a convincing statement of reasons to explain why a project’s impacts are insignificant.” *Id.* (internal quotation marks omitted). The Bureau has not provided a convincing statement of reasons explaining why the DWB’s impacts are not significant. So long as there are “substantial questions whether a project *may* have a significant effect on the environment,” an EIS must be prepared. *Id.* (emphasis added and internal quotation marks omitted). Thus, “the threshold for requiring an EIS is quite low.” *NRDC v. Duvall*, 777 F. Supp. 1533, 1538 (E.D. Cal. 1991). Put another way, as will be shown through our comments, the bar for sustaining an EA/FONSI under NEPA procedures is set quite high, and the Bureau fails to surmount it on the 2010-2011 Water Transfer Program.

NEPA regulations promulgated by the Council on Environmental Quality identify factors that the Bureau must consider in assessing whether a project may have significant environmental effects, including:

- (1) “The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.” 40 C.F.R. §1508.27(b)(5).
- (2) “The degree to which the effects on the quality of the human environment are likely to be highly controversial.” *Id.* §1508.27(b)(4).
- (3) “Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate on a cumulatively significant impact on the environment. Significance

- cannot be avoided by terming an action temporary or by breaking it down into small component parts.” *Id.* §1508.27(b)(7).
- (4) “The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.” *Id.* §1508.27(b)(6).
 - (5) “The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.” *Id.* §1508.27(b)(9).

Here, the Bureau has failed to take a hard look at the environmental impacts of the Project. As detailed below, there are substantial questions about whether the 2010-2011 Water Transfer Program’s proposed water transfers will have significant effects on the region’s environmental and hydrological conditions especially groundwater, the interactions between groundwater and surface streams of interest in the Sacramento Valley region, and the species dependent on aquatic and terrestrial habitat. There are also substantial questions about whether the 2010-2011 Water Transfer Program will have significant adverse environmental impacts when considered in conjunction with the other related water projects that have occurred in the last decade and that are underway and proposed in the region. The Bureau simply cannot rely on the EA/FONSI for the foreseeable environmental impacts of the proposed 2010-2011 Water Transfer Program and still comply with NEPA’s requirements.

A. The Proposed Action Alternative is poorly specified making it difficult to identify chains of cause and effect necessary to analyze adequately the alternative’s environmental effects.

The Proposed Action Alternative is poorly specified and needs additional clarity before decision makers and the public can understand the human and environmental consequences of the 2010-2011 Water Transfer Program. The EA describes the Proposed Action Alternative as one reflecting the Bureau’s intention to approve transfers of Central Valley Project water from willing sellers who contract with the Bureau ordinarily to use surface water on their croplands. Up to 200,000 AF of CVP water are offered from these sellers, according to Table 2-1 of the EA. In contrast to the EA/FONSI for the 2009 Drought Water Bank, the EA contains no “priority criteria” to determine water deliveries and simply acknowledges that water will be transferred to agricultural and urban interests (p. 3-88). The EA fails to indicate how much water has been requested by the buyers of CVP or non-CVP water, which is also in contrast to the EA/FONSI and DWR’s addendum for the 2009 Drought Water Bank. This denial of information further obfuscates the need for the Project.

The EA/FONSI’s statement of purpose and need (p. 1-1) states specifically that, “To help facilitate the transfer of water throughout the State, Reclamation and the Department of Water Resources (DWR) are considering whether they should approve and facilitate water transfers between willing sellers and buyers.” This paragraph omits coherent discussion of need. Merely stating that, “The transfer water would be conveyed, using CVP or SWP facilities, to water users

that are at risk of experiencing water shortages in 2010 and 2011 due to drought conditions and that require supplemental water supplies to meet anticipated demands,” lacks specificity and rigor. The purpose and need should also state that this transfer program would be subject to specific criteria for prioritizing transfers.

The EA’s description of the proposed action alternative needs to make clear what would occur if sale criteria are in fact applied and if exceptions will be allowed, and if so, by what criteria would exceptions be made.. Do both Project agencies lack criteria to prioritize water transfers? What is the legal or policy basis to act without providing priority criteria? Without foundational criteria, the public is not provided with even a basic understanding of the need for the Project.

There is considerable ambiguity over just how many potential sellers there are and how much water they would make available. The EA states that, “Entities that are not listed in this table [2-1] may decide that they are interested in selling CVP water, but those transfers may require supplemental NEPA analysis to allow Reclamation to complete the evaluation of the transfers,” (p. 2-3 and 2-4). Allowing a roving Project location is not permissible and avoids accurate analysis of all impacts including growth inducing and cumulative impacts.

Absent buyers’ request numbers and the potential for the participation of unknown additional sellers signals that neither the Bureau nor DWR have a clear idea what the 2010-2011 Water Transfer Program is intended to be. This problem contributes greatly to and helps explain the poorly rendered treatment of causes and effects that permeate the Bureau’s EA. The project agencies, decision-makers, and the public all face a moving target with the 2010-2011 Water Transfer Program. Such discrepancies reflect hasty consideration and poor planning by project proponents. Nor can the agencies reasonably attribute their inadequate environmental reviews on lack of warning. The Governor, Senator Dianne Feinstein, and congressional representatives from the San Joaquin Valley have all made fear of drought a centerpiece of their water statements in 2008 and 2009. Yet DWR and the Bureau apparently are not able to present a stable Project with clear needs and criteria.

From data available in the EA and the Addendum, it is not possible to determine with confidence just how much water is requested by potential urban and agricultural buyers. There is no attempt to describe how firmly tendered are offers of water to sell or requests to purchase. Guessing at the possible requests based on the 2009 DWB where there were between 400,000 and 500,000 AF of presumably urban buyer requests² alone (which had priority over agricultural purchases, according to the 2009 DWB priorities) and a cumulative total of less than 400 TAF from willing sellers, which is also true for the 2010-2011 Water Transfer Program (with just over half that coming from CVP water), it would appear that many buyers are not likely to have their needs addressed by the 2010-2011 Water Transfer Program. If so, the Bureau and DWR should state

² Neither DWR’s Addendum nor the Bureau’s EA specify numerical requests for the cities of Huron, Avenal, Coalinga, and the Avenal State Prison making it impossible to have a firmer number for the amount of urban request for water. Our estimate assumes SCVWD’s 30,000 AF and MWD’s 300,000 AF requests are for entirely urban uses of DWB-purchased water.

the likelihood that many requests will not be fulfilled in order to achieve a full and correct environmental compliance treatment of the proposed action. Such an estimate is necessary for accurate explication of the chains of cause and effect associated with the 2010-2011 Water Transfer Program—and which must propagate throughout a NEPA document for it to be adequate as an analysis of potential natural and human environmental effects of the proposed project. We have additional specific questions:

- What are the requests of the San Luis and Delta Mendota Water Authority (SLDMWA)? Is the request for an agricultural use or an urban use of Project water? If it is entirely for agricultural uses, how likely is it to be fulfilled under the non-stated Project priorities for water sales?
- What are the specific urban requests for water made by Avenal State Prison, and the cities of Avenal, Huron, and Coalinga, nested within the SLDMWA request?
- Will sale criteria be premised on full compliance with all applicable environmental and water rights laws? If so, how will cumulative impacts be analyzed under CEQA?

If priority criteria were revealed, how will intervening economic factors beyond the control of the Project be analyzed? Given the added uncertainty, an EIS should be prepared to provide the agencies with advance information and insight into what the sensitivity of the program's sellers and buyers are to the influences of prices—prices for water as well as crops such as rice, orchard and vineyard commodities, and other field crops. It is plausible that crop idling will occur more in field crops, while groundwater substitution would be more likely for orchard and vineyard crops. However, high prices for rice—the Sacramento Valley's largest field crop—would undermine this logic, and could lead to substantial groundwater substitution. These potential issues and impacts should be recognized as part of the 2010-2011 Water Transfer Program description and should directly apply to the Agriculture and Land Use, and Socioeconomic sections of the EA, because crop prices are key factors in choices potential water sellers would weigh in deciding whether to idle crops, substitute groundwater, or decline to participate in the DWB altogether. The EA is inadequate because it fails to identify and analyze the market context for crops as well as water that would ultimately influence the size and scope of the 2010-2011 Water Transfer Program.

Rice prices are high because of conditions for the grain in the world market. Drought elsewhere is a factor in reduced yields, but growing populations in south and east Asia demand more rice and the rice industry has struggled to meet that demand.³

This is very important. The Bureau tacitly admits that the Bureau—and by logical extension, DWR—has no idea how many sales of what type (public health, urban, agricultural) can be expected to occur. Put another way, there is a range of potential outcomes for the 2010-2011 Water Transfer Program, and yet the Bureau has failed utterly to use the EA to examine a

³ "Panic over rice prices hits California," *AZCentral.com*, April 24, 2008; UN News Service, "Bumper rice harvests could bring down prices but poor may not benefit, warns UN," 25 February 2009; "Era of cheap rice at an end in Taiwan: COA," *The China Post*, March 5, 2009; Jim Downing, "Sacramento Valley growers see rice prices soar," *Sacramento Bee*, 18 January 2009.

reasonable and representative range of alternatives as it concerns how the priority criteria would be established and affect Project transfers. And DWR has not bothered to conduct an appropriate level of review under CEQA...

Nor does the 2010-2011 Water Transfer Program prevent rice growers (or other farmers) from “double-dipping.” It appears to us they could opt to turn back their surface supplies from the CVP and the State Water Project and substitute groundwater to cultivate their rice crop—thereby receiving premiums on both their CVP contract surface water as well as their rice crop this fall when it goes to market. There appear to be no caps on water sale prices to prevent windfall profits to sellers of Sacramento Valley water in the event that groundwater is substituted in producing crops—especially for crops where market prices are high, such as in rice. The DWB in the 1990s capped water prices at \$125/acre-foot, much to the disappointment of some water sellers at that time. Why are the state and federal projects encouraging such potential windfall profits at a time when many others suffer through this recession?

As stated, neither the Bureau nor DWR state how much of these transfers would go to public health, urban or agricultural buyers. The EA must also (but fails to) address the ability and willingness of potential buyers to pay for Project water given the supplies that may be available. Historically, complaints from agricultural water districts were registered in the comments on the Draft EWA EIS/R and reported in the Final EIS/R in January 2004 indicating that they could not compete on price with urban areas buying water from the EWA. Given the DWB’s priority criteria, will agricultural water buyers identified in Table 2-2 of the EA be able to buy water when competing with the likes of the Santa Clara Valley Water District and the Metropolitan Water District, representing two of the wealthiest regions of California? As a matter of statewide water, infrastructure, and economic policy, is it wise to foment urban versus agricultural sector competition for water based solely on price? Shouldn’t other factors be considered in allocating water among our state’s regions? This fails dramatically to encourage regions to develop their own water supplies more efficiently and cost-effectively without damage to resources of other regions.

Full disclosure of each offer of and each request for 2010-2011 Water Transfer Program water should be provided as part of the EA. This is necessary so the public can understand and have confidence in the efficacy of the Project’s purpose and need, benefit from full disclosure of who requests what quantity of water and for what uses, and so that the public may easily verify chains of cause and effect. Urban application of transferred surface water is not examined in the EA/FONSI, as though how urban buyers would use their purchased water had no environmental effects. Since the dry period in California has lasted for over three years, how will purchased water be used and conserved? What growth inducing impacts will transferred water facilitate?

Nor is a hierarchy of priority uses among urban users for purchasing Project water presented. Could purchased water be used for any kind of landscaping, rather than clearly domestic purposes or strictly for drought-tolerant landscaping? We cannot tell from the EA/FONSI narrative. How can the citizens of California be assured that water purchased through the 2010-

2011 Water Transfer Program will not be used wastefully, in violation of the California Constitution, Article X, Section 2?

Will urban users need their Project purchased water only in July through September, or is that the delivery period preferred in the DWB because of ecological and fishery impact constraints on conveyance of purchased water?

Should agricultural water users be able to buy any Project water, how will DWR and the Bureau assure that transferred water for irrigation is used efficiently? Many questions are embedded within these concerns that DWR and the Bureau should address, especially when they approach the State Water Resources Control Board to justify consolidating their places of use in their respective water rights permits:

- How much can be expected to be purchased by agricultural water users, given the absence of any criteria, let alone priority criteria, in the 2010-2011 Water Transfer Program?
- How much can be expected to be consumptively used by agricultural water buyers?
- How much can be expected to result in tailwater and ag drainage?
- How much can be expected to add to the already high water table in the western San Joaquin Valley?
- What selenium and boron loads in Mud Slough and other tributaries to the San Joaquin River may be expected from application of this water to WSJ lands?
- What mitigation measures are needed to limit such impacts consistent with the public trust doctrine, Article X, Section 2 of the California Constitution, the Porter-Cologne Water Quality Control Act, and California Fish and Game Code Section 5937?

In other words, the most important chains of cause and effect—extending from the potential for groundwater resource impacts in the Sacramento Valley to potential for contaminated drainage water from farm lands in the western San Joaquin Valley where much of the agricultural buyers are located—are ignored in the Bureau’s EA/FONSI and completely missing due to DWR’s failure to comply with CEQA.

Will more of surface water transfers go to urban users than to ag users? The EA’s silence on this is disturbing, and highlights the absence of priority criteria. What assurances will the Bureau and DWR provide that criteria exist or will be developed and how will these criteria be presented to the public and closely followed?

- The more that goes to urban water agencies the less environmental impacts there would be on drainage impaired lands of the San Joaquin Valley, a neutral to beneficial impact of the Project’s operation on high groundwater and drainage to the SJR.
- However, the more Project water goes to agricultural users than to urban users, the higher would be groundwater levels, and more contaminated the groundwater would be in the western San Joaquin Valley and the more the San Joaquin River would be negatively affected from contaminated seepage and tailwater by operation of the Project.

The EA fails to provide a map indicating where the cumulative sources of the Project are located, and where the service areas are to which water would be transferred under the 2010-2011 Water Transfer Program.

Two issues concerning water rights are raised by this EA/FONSI:

- **Consolidated Place of Use.** Full disclosure of what the consolidated places of use for DWR and USBR would be, since the permit request to SWRCB will need NEPA coverage. Why is the flexibility claimed for the consolidated place of use necessary to this year's water transfer program? Couldn't the transfers be facilitated through transfer provisions of the Central Valley Project Improvement Act? Will the consolidation be a permanent or temporary request be limited to the duration of the governor's 2009 emergency declaration or of just the 2010-2011 Water Transfer Program? When is the 2010-2011 Water Transfer Program scheduled to sunset? How do the consolidated place of use permit amendments to the SWP and CVP permits relate to their joint point of diversion? Why doesn't simply having the joint point of diversion in place under D-1641 suffice for the purpose of the Project?
- **Description of the water rights of both sellers and buyers.** This would necessarily show that buyers clearly possess junior water rights as compared with those of willing sellers. Lack of full disclosure of these disparate rights is needed to help explain the actions and motivations of buyers and sellers in the 2010-2011 Water Transfer Program, otherwise the public and decision makers have insufficient information on which to support and make informed choices.
 - **Sacramento Valley water rights** – correlative groundwater rights, riparian rights and CVP settlement contract rights
 - **San Joaquin Valley water rights** – CVP contract rights only, junior-most contractors within the CVP priority system (especially Westlands Water District).
 - **Priority of allocations among water contractors within the CVP and SWP.**

To establish a proper legal context for these water rights, the Project Action Alternative section of the EA/FONSI should also describe more extensively the applicable California Water Code sections about the treatment of water rights involved in water transfers.

Thus, there are many avenues by which the 2010-2011 Water Transfer Program is a poorly specified program for NEPA and CEQA purposes, leaving assessment of its environmental effects at best murky, and at worst, risky to all involved, especially users of Sacramento Valley groundwater resources.

B. Correcting the EA's poorly specified chains of cause and effect forces consideration of an expanded range of alternatives.

The Proposed Action Alternative need not have sophisticated forecasts of prices for rice and other commodities. Instead, for an adequate treatment of alternatives, the EA should have examined several reasonable scenarios beyond simply the 2010-2011 Water Transfer Program

and a “no action” alternative. Three reasonable permutations would have considered relative proportions of crop idling versus groundwater substitution (e.g., high/low, low/high, and equal proportions of crop idled water and groundwater substitution). Other reasonable drought response alternatives that can meet operational and physical concerns merit consideration and analysis by the Bureau includes:

- Planned permanent retirement of upslope lands in the western San Joaquin Valley where CVP-delivered irrigation water is applied to lands contaminated with high concentrations of selenium, boron and mercury, and which contribute to high water table and drainage problems for lowland farmers, wetlands and tributaries of the San Joaquin River. Retirement of these lands would permanently free up an estimated 3 million acre-feet of state and federal water during non-critical water years. Ending irrigation of these lands would also result in substantial human environmental benefits for the San Joaquin River, the Bay-Delta Estuary, and the Suisun Marsh from removal of selenium, boron, and salt contamination. Having such reasonable and pragmatic practices in place would go a long way to eliminate the need for drought water banks in the foreseeable future.
- More aggressive investment in agricultural and urban water conservation and demand management among CVP and SWP contractors even on good agricultural lands, including metering of all water supply hook-ups by all municipal contractors, statewide investment in low-flush toilets and other household and other buildings’ plumbing fixtures, and increased capture and reuse of recycled water. Jobs created from such savings and investments would represent an economic stimulus that would have lasting job and community stability benefits as well as lasting benefits for water supply reliability and environmental stabilization.

C. The 2010-2011 Water Transfer Program EA fails to specify adequate environmental baselines, or existing conditions, against which impacts would be assessed and mitigation measures designed to reduce or avoid impacts.

The 2010-2011 Water Transfer Program environmental review by the Bureau incorporate by reference for specific facets of their review the 2003/2004 and 2007/2008 Environmental Water Account EIS/R documents. In both cases, these environmental reviews were conducted on a program whose essential purpose is to “provide protection to at-risk native fish species of the Bay-Delta estuary through environmental beneficial changes in State Water Project/Central Valley Project operations at no uncompensated water cost to the Projects’ water users. This approach to fish protection involves changing Project operations to benefit fish and the acquisition of alternative sources of project water supply, called the ‘EWA assets,’ which the EWA agencies use to replace the regular Project water supply lost by pumping reductions.”

The two basic sets of actions of the EWA were to:

- Implement fish actions that protect species of concern (e.g., reduction of export pumping at the CVP and SWP pumps in the Delta); and

- Increase water supply reliability by acquiring and managing assets to compensate for the effects of the fish actions (such as by purchasing water from willing sellers for instream flows that compensates the sellers for foregone consumptive use of water).

Without going into further detail on the EWA program, there is no attempt by the EWA agencies to characterize its environmental review as reflective of water transfer programs generally; the EWA was a specific set of strategies whose purpose was protection of fish species of concern in the Delta, not drought aid for junior water right-holding areas of California. One consequence of this attempt to rely on the EWA EIS/R is that it makes the public's ability to understand the environmental baseline of the 2010-2011 Water Transfer Program impossible, because environmental baselines, differing purpose and need for the project, and many relevant mitigation measures are not readily available to the public. Merely referring to the EWA documents (e.g.) p. 3-47) mocks NEPA and CEQA missions to inform the public adequately about the environmental setting and potential impacts of the proposed project's actions. Moreover, a Water Transfer Program for urban and agricultural sectors is plainly not the same thing as an Environmental Water Account.

Another consequence is that the chains of cause and effect of an EWA versus a 2010-2011 Water Transfer Program are entirely different because of their different purposes. While the presence of water purchases, willing sellers, and requesting buyers is similar, the timing of EWA water flows are geared to enhancing and protecting fish populations; the water was to flow in Delta channels to San Francisco Bay and the Pacific Ocean. In stark contrast, the DWB's water flows focus water releases from the SWP and CVP reservoirs to be exported for deliveries in the July through September period, whereas EWA assets would be "spent" year-round depending on the specific need to protect fish. EWA was about purchasing water to provide instream flows in the Delta, while the DWB is to acquire water to serve consumptive uses outside of the Delta.

Furthermore, to tease out the various ways in which the EWA review—itsself a two-binder document consisting of well over 1,000 pages—could be used to provide appropriate environmental compliance for the DWB is not even attempted by DWR and the Bureau which at least has staff that could have been assigned to undertake it; yet they do not. It is therefore well beyond the reach of non-expert decision-makers and the public, and the use of the EWA EIS/R as the basic environmental review for the DWB therefore violates both NEPA and CEQA.

Nor is any attempt made in the EWA EIS/R to characterize the EWA as a "program level" environmental review off of which a Water Transfer Program-like project could perhaps legitimately tier. In our view, this reliance on the EWA EIS/R obscures the environmental baselines of the DWB from public view, inappropriately conflates the purposes of two distinct environmental reviews, and flagrantly violates NEPA and CEQA. This could only be redressed by preparation of an EIS/R on the 2010-2011 Water Transfer Program.

Finally, the most significant baseline condition omitted in the Bureau's inadequate and DWR's negligent reporting relates to Sacramento Valley groundwater resources, discussed in the next section.

D. Scientific uncertainties and controversy about Sacramento Valley groundwater resources merit consideration that only an EIS can provide.

There is substantial evidence that the 2010-2011 Water Transfer Program may have significant impacts on the aquifer system underlying the project and the adjacent region that overlies the Tuscan Formation. This alone warrants the preparation of an EIS.

Additionally, an EIS is necessary where “[a] project[’s] ... effects are ‘highly uncertain or involve unique or unknown risks.’” *Blue Mountains Biodiversity Project*, 161 F.3d at 1213 (quoting 40 C.F.R. §1508.27(b)(5)). Here, the draft EA/FONSI fails to adequately address gaps in existing scientific research on the hydrology of the aquifer system and the extent to which these gaps affect the Bureau's ability—and by logical extension, DWR's ability—to assess accurately the Project's environmental impacts.

1. Existing research on groundwater conditions indicates that the 2010-2011 Water Transfer Program may have significant impacts on the aquifer system.

The EA fails to describe significant characteristics of the aquifers that the 2010-2011 Water Transfer Program proposes to exploit. These characteristics are relevant to an understanding of the potential environmental effects associated with the 2010-2011 Water Transfer Program's potential extraction of up to 154,237 AF of groundwater (p, 2-4 and 3-107). First, the draft EA/FONSI fails to describe a significant saline portion of the aquifer stratigraphy of the 2010-2011 Water Transfer Program area. According to Toccoy Dudley, former Groundwater Geologist with the Department of Water Resources and former director of the Butte County Water and Resources Department, saline groundwater aquifer systems of marine origin underlie the various freshwater strata in the northern counties of Butte, Colusa, Glenn, and Tehama (“northern counties”). The approximate contact between fresh and saline groundwater occurs at a depth ranging from 1500 to 3000 feet. (Dudley 2005) (A list of all references cited in these comments can be found at the end of this letter.)

Second, the EA fails to discuss the pressurized condition of the down-gradient portion of the Tuscan formation, which underlies the northern counties Project area. Dudley finds that the lower Tuscan aquifer located in the Butte Basin is under pressure. “It is interesting to note that groundwater elevations up gradient of the Butte Basin, in the lower Tuscan aquifer system, are higher than the ground surface elevations in the south-central portion of Butte Basin. This creates an artesian flow condition when wells in the central Butte Basin are drilled into the lower Tuscan aquifer.” (Dudley 2005). The artesian pressure indicates recharge is occurring in the up-gradient portions of the aquifer located along the eastern margin of the Sacramento Valley.

Third, the EA fails to describe the direction of movement of water through the Lower Tuscan Formation that underlies the northern counties. According to Dudley: “From Tehama County south to the city of Chico, the groundwater flow direction in the lower Tuscan is westerly toward the Sacramento River. South of Chico, the groundwater flow changes to a southwesterly direction along the eastern margin of the valley and to a southerly direction in the central portion of the Butte Basin.” (Dudley 2005)

Fourth, the draft EA fails to disclose that the majority of wells used in the Sacramento Valley are individual wells that pump from varying strata in the aquifers. The thousands of domestic wells in the target export area that are vulnerable to groundwater manipulation and lack historic monitoring. The Bureau’s 2009 DWB EA elaborated on this point regarding Natomas Central MWC (p. 39) stating that, “Shallow domestic wells would be most susceptible to adverse effects. Fifty percent of the domestic wells are 150 feet deep or less. Increased groundwater pumping could cause localized declines of groundwater levels, or cones of depression, near pumping wells, possibly causing effects to wells within the cone of depression. As previously described, the well review data, mitigation and monitoring plans that will be required from sellers during the transfer approval process will reduce the potential for this effect.”

As the latter statement makes clear (even though this information was excluded from the Project EA), the Bureau hopes that individual mitigation and monitoring plans created by the sellers will reduce the potential for impact, but there is no assurance in the EA that it will reduce it to a level of insignificance for the thousands of well owners in the Sacramento Valley. The Coalition questions the adequacy of individual mitigation and monitoring plans and suggests that an independent third party, such as USGS, oversee the mitigation and monitoring program and not the Bureau and DWR. After the fiasco in Butte County during the 1994 Drought Water Bank and with the flimsy, imprecise proposal for mitigation and monitoring in the 2010-2011 Water Transfer Program (see details below), the agencies lack credibility as oversight agencies.

Fifth, the draft EA fails to provide recharge data for the aquifers. Professor Karin Hoover, Assistant Professor of hydrology, hydrogeology, and surficial processes from CSU Chico, found in 2008 that, “Although regional measured groundwater levels are purported to ‘recover’ during the winter months (Technical Memorandum 3), data from Spangler (2002) indicate that recovery levels are somewhat less than levels of drawdown, suggesting that, in general, water levels are declining.” According to Dudley, “Test results indicate that the ‘age’ of the groundwater samples ranges from less than 100 years to tens of thousands of years. In general, the more shallow wells in the Lower Tuscan Formation along the eastern margin of the valley have the ‘youngest’ water and the deeper wells in the western and southern portions of the valley have the ‘oldest’ water,” adding that “the youngest groundwater in the Lower Tuscan Formation is probably nearest to recharge areas.” (Dudley 2005). “This implies that there is currently no active recharge to the Lower Tuscan aquifer system (M.D. Sullivan, personal communication, 2004),” explains Dr. Hoover. “If this is the case, then water in the Lower Tuscan system may constitute fossil water

with no known modern recharge mechanism, and, once it is extracted, it is gone as a resource,” (Hoover 2008).

All of these aquifer characteristics are important to a full understanding of the environmental impacts of the 2010-2011 Water Transfer Program because there are numerous indications that other aquifer strata associated with the Lower Tuscan Formation are being operated near the limit of overdraft and could be affected by the 2010-2011 Water Transfer Program (Butte County 2007). The Bureau has not considered this important historic information in the draft EA. According to Dudley, the Chico area has a “*long term average decline in the static groundwater level of about 0.35 feet-per-year.*” (2007) (emphasis added.) Declining aquifer levels are not limited to the Chico Municipal area. This trend of declining aquifer levels in Chico, Durham and the Cherokee Strip is illustrated in a map submitted with this comment letter (CH2M Hill 2006).

Declining groundwater elevations have been observed specifically in Butte County. A 2007 Butte Basin Groundwater Status Report describes the “historical trend” in the Esquon Ranch area as showing “seasonal fluctuation (spring to fall) in groundwater levels of about 10 to 15 feet during years of normal precipitation and less than 5 feet during years of drought.” The report further notes: “Long-term comparison of spring-to-spring groundwater levels shows a decline of approximately 15 feet associated with the 1976-77 and 1986-94 droughts (Butte Basin Water Users Association, 2007). The 2008 report indicates that, “The spring 2008 groundwater level measurement was approximately three feet higher than the 2007 measurement, however it was still four feet lower than the average of the previous ten spring measurements. Fall groundwater levels are approximately nine feet lower than the averages of those measured during either of the previous drought periods on the hydrograph. At this time it appears that there may be a downward trend in groundwater levels in this well,” (Butte Basin Water Users Association, 2008). Thus, “*it appears that there may be a downward trend in groundwater levels in this well.*” *Id.* (emphasis added).

Groundwater elevations in the Pentz sub-area in Butte County also reveal significant historical declines. The historical trend for this sub-area “...shows that the average seasonal fluctuation (spring to fall) in groundwater levels averages about 3 to 10 feet during years of normal precipitation and approximately 3 to 5 feet during years of drought. Long-term comparison of spring-to-spring groundwater levels shows a decline in groundwater levels during the period of 1971-1981, perhaps associated with the 1976-77 drought. Since a groundwater elevation high of approximately 145 feet in 1985 the measured groundwater levels in this well have continued to decline. Recent groundwater level measurements indicate that the groundwater elevation in this well is approximately 15-25 feet lower than the historical high in 1985. *Id.* Water elevations at the Pentz sub-area well have been monitored since 1967. “Since 1985 spring groundwater levels in this well have been declining and the spring 2009 measurement hit an historic low level ten feet below historical high levels and continues the downward trend on the hydrograph.” *Id.* The Pentz area is located east of U.S. 99, in the eastern, upslope portion of the Tuscan aquifer. Further evidence of changing groundwater levels appear in the Vina sub-region of Butte County, where water elevations have been monitored since 1947 at well 23N/01W09E001M . The

historical averages, including 2008 data, are; Spring=156 feet and Fall=150 feet (Butte County p. 37-38). Unfortunately, the groundwater level measurement at this well in 2008 was the lowest recorded since 1994 (Butte County p. 38). Rock Creek, which is also in the Vina sub-unit once held water all year and salmon fishing was robust prior to the 1930s (Hennigan 2010). Declining groundwater levels have caused the valley portion of Rock Creek to run completely dry each year and have also been noticed with Hennigan Farms' wells since the 1960s. For example, a 1968 well had to be lowered 40 feet in 1974, another well constructed in 1978 had to be lowered 20 feet in 2009, and an old 1940s flood pump was lowered in the early 1960s, lowered again in 1976 when it was converted to a pressure pump, and lowered again in 1997 (Hennigan 2010).

In light of this downward trend in regional groundwater levels, the Bureau's EA should closely analyze replenishment of the aquifers affected by the proposed 2010-2011 Water Transfer Program. The draft EA fails to provide any in-depth assessment of these issues. For example, the EA fails to discuss the best available estimates of where groundwater replenishment occurs. Lawrence Livermore National Laboratory analyzed the age of the groundwater in the northern counties to shed light on this process: "Utilizing the Tritium (H3) Helium-3 (He3) ratio, the age of each sample was estimated. Test results indicate that the "age" of the groundwater samples ranges from less than 100 years to tens of thousands of years, (Dudley et al. 2005). As mentioned above, Dudley opines that the youngest groundwater in the Lower Tuscan Formation is probably nearest to recharge areas. (2005).

Are isotopic groundwater data available for other regions in the Sacramento Valley? If so, they would be crucial for all concerned to understand the potential impacts from the proposed 2010-2011 Water Transfer Program. For example, the EA states, "The WFA area that could be affected by the proposed action includes only the 'North Area' bounded on the north and east by the Sacramento County line, by the Sacramento River on the west, and by the American River on the south." EA at p. 34. If this is the area in Sacramento County that is identified as most vulnerable to groundwater impacts, yet two major rivers surround it, shouldn't the Bureau understand the hydrologic relationship between the groundwater basin and the rivers? If that understanding exists, where is it presented in the EA? It is well known that the Sacramento River is already a losing river south of Princeton.

The City of Sacramento proposes to transfer surface water into the state water market and substitute 3,000 AF of groundwater (EA p.2-4), but the *Sacramento County Water Agency Water Management Plan* indicates that intensive use of this groundwater basin has resulted in a general lowering of groundwater elevations that will require extensive conservation measures to remediate. The Sacramento County Water Agency has devised a plan to help lead the city to a sustainable groundwater use to avoid problems associated with unrestrained overuse. The most reliable strategy is to reduce demand. Integrating the City's water supply into the state water supply would obviously increase demand and make the SCWA goals impossible to achieve.

The Bureau should prepare an EIS that discloses the fallacies inherent in its policies and actions. The need for almost 400,000 AF of water south of the Delta springs from failed business

planning. The Bureau and DWR must acknowledge this and further disclose that their agencies are willing to socialize the risks taken by corporate agribusiness and developers while facilitating private profit. Instead of asking northern California water districts and municipal water purveyors to place their own water at risk as well as the water of their neighboring communities and thousands of residential well owners, water quality, fisheries, recreation, stream flow, terrestrial habitat, and geologic stability, the Bureau and DWR must disclose all the uncertainty in the 2010-2011 Water Transfer Program and then evaluate the risks with scientific methodology. This has clearly not been done.

2. The 2010-2011 Water Transfer Program proposes to rely on inadequate monitoring and mitigation to avoid the acknowledged possibility of significant adverse environmental impacts.

The draft EA and the Draft Technical Information for Water Transfers in 2010 referenced in the EA (Bureau and DWR 2009) require “willing sellers” to prepare individual monitoring and mitigation plans and to conduct the monitoring with oversight provided by the Bureau and DWR (p. 3-24 and 3-25). This fails to provide the most basic framework for governmental authority to enforce the state’s role as trustee of the public’s water in California, let alone a comprehensive and coordinated structure, for a very significant program that could transfer up to 154,239 AF of water from the Sacramento Valley. (Recall that DWR believes it has environmental compliance coverage for up to 600,000 AF of water sales from the Sacramento Valley, including 340,000 AF in groundwater substitution alone under the Governor’s 2009 emergency exemption) The draft EA further defers responsibility to “willing sellers” for compliance with local groundwater management plans and ordinances to determine when the effects of the proposed extraction become “adverse,” (p. 3-25). “Each district will be required to confirm that the proposed groundwater pumping will be compatible with state and local regulations and groundwater management plans,” (EA at p. 3-25). It is not acceptable that the draft EA and the Draft Technical Information for Water Transfers in 2010 merely provide monitoring direction to “willing sellers” without identifying rigorous standards for the risks at hand, specific actions, acceptable monitoring and reporting entities, or funding that will be necessary for this oversight.

The Coalition proposes instead that the Bureau and DWR require, at a minimum, that local governments select independent third-party monitors, who are funded by surcharges on Project transfers paid by the buyers, to oversee the monitoring that is proposed in lieu of Bureaus and DWR staff, and that peer reviewed methods for monitoring be required. If this is not done, the Project’s proposed monitoring is insufficient and cannot justify the significant risk of adverse environmental impacts.

For example, the EA and the Draft Technical Information for Water Transfers in 2010 fail to identify standards that would be used to monitor the 2010-2011 Water Transfer Program’s impacts. It fails to identify any specific monitoring protocols, locations (particularly in up-gradient recharge portions of the groundwater basins), and why chosen locations should be deemed effective for monitoring the effects of the proposed groundwater extraction. It also fails

to describe how the objectives in the Draft Technical Information for Water Transfers in 2010 will be met and by whom (EA at p.3-24 and 3-25). Moreover, it fails to provide a mitigation strategy for review and comment by the public, but defers this vital mitigation planning effort to future documents created by “willing sellers,” (EA at p.3-24 and 3-25) despite the fact that the EA acknowledges the potential for significant impacts. For example:

- Surface water and groundwater interact on a regional basis, and, as such, gains and losses to groundwater vary significantly geographically and temporally. In areas where groundwater levels have declined, such as in Sacramento County, streams that formerly gained water from groundwater now lose water to the groundwater system through seepage (EA at p. 3-12).
- *Groundwater substitution transfers would alter ground water levels and potentially affect natural and managed seasonal wetlands and riparian communities, upland habitats and wildlife species depending on these habitats.* As a part of groundwater substitution transfers, the willing sellers would use groundwater to irrigate crops and decrease use of surface water. Pumping additional groundwater would decrease groundwater levels in the vicinity of the sellers’ pumps. Natural and managed seasonal wetlands and riparian communities often depend on surface water/groundwater interactions for part or all of their water supply. Under the Proposed Action, subsurface drawdown related to groundwater substitution transfers could result in hydrologic changes to nearby streams and marshes, potentially affecting these habitats. Reduced groundwater elevations could also affect trees that access groundwater as a source of water through taproots in addition to extensive horizontal roots that use soil moisture as a water source. Decreasing groundwater levels could reduce part of the water base for species within these habitats (EA at p. 3-53 and 3-54).

The reader is directed to the Draft Technical Information for Water Transfers in 2010 to discover the minimal objectives and required elements of the monitoring and mitigation component of the Project. “The seller must implement an effective mitigation program to verify and correct problems that could arise due to transfer-related groundwater pumping,” but the reader and possibly the sellers are left wondering what exactly is an “effective mitigation plan” since there is no particular guidance to manage and analyze the very complex hydrologic relationships internal to groundwater and connected to surface waters. Certainly the public has no idea or ability to comment, which fails the full disclosure mandate in NEPA and CEQA. Located on pages 30 and 31 of the Draft Technical Information for Water Transfers in 2010 is a brief list of a “number of potential impacts [that] are sufficiently serious that they must be avoided or mitigated for a project to continue.”

- Contribution to long-term conditions of overdraft;
- Dewatering or substantially reducing water levels in nonparticipating wells;
- Measurable contribution to land subsidence;
- Degradation of groundwater quality that substantially impairs beneficial uses or violates water quality standards; and
- Affecting the hydrologic regime of wetlands and/or streams to the extent that ecological integrity is impaired.

The Draft Technical Information for Water Transfers in 2010 continues with suggestions to curtail pumping lower bowls, and pay higher energy costs to ease the impacts to third party wells owners (p. 30 and 31). While this bone thrown at mitigation is appreciated, the glaring omissions are notable. The Draft Technical Information for Water Transfers in 2010 completely fails to mention, even at a very general level, how individual well owners will determine and prove where the impacts to their wells are coming from, that water quality and health could become a significant impact for impacted wells and users and streams, and that there are no mitigation measures even mentioned for streams and wetlands. There also appears to be no consideration for species monitoring, just “practices” or “conservation measures” to “minimize impacts to terrestrial wildlife and waterfowl,” (Draft Technical Information p. 16). And please disclose why the 2009 DWB Biological Opinion is a reference to guide “specific practices on page 17 of the Draft Technical Information for Water Transfers in 2010.

Another example of the inadequacy of the proposed monitoring is that the draft EA fails to include any coordinated, programmatic plan to monitor stream flow of creeks and rivers located in proximity to the “willing sellers” that will evacuate more water than used historically. The potential for immediate impacts would be very close to water sellers’ wells, but the long term impacts could be more subtle and more geographically diverse. What precautions has the Bureau and DWR made for the cumulative impacts that come not only from this two-year Project, but in combination with the water sales from the last three years and those that are planned by the Bureau into the future (see list in g, iv below)? Bureau and DWR water transfers are not just one or two year transfers, but many serial actions in multiple years by the agencies, sellers, and buyers without the benefit of comprehensive environmental analysis under NEPA and CEQA.

As discussed above, adequate monitoring is vital to limit the significant risks posed by the Project to the health of the region’s groundwater, streams, and fisheries (more discussion below). One unfortunate example is the EA’s focus on groundwater substitution impacts that reflect the priority for water accounting and payment accuracy as opposed to the impacts to the groundwater system and streams. “The implementation of groundwater substitution pumping can lower the groundwater table and may change the relative difference between the groundwater and surface water levels. This change has a direct impact on the volume that a seller receives credit for being transferred,” (EA p.3-22 and 3-23). Moreover, to the extent this Project is conceived as a two-year drought or hardship program that will provide knowledge for future groundwater extraction and fallowing, its failure to include adequate monitoring protocols is even more disturbing and creates the risk of significant long-term and even irreversible impacts from the Project.

a. The Bureau’s assertion that the Project may be modified or halted in the event of significant adverse impacts to hydrologic resources is an empty promise in light of the wholly inadequate monitoring provided for in the 2010-2011 Water Transfer Program. Knowing that the Bureau and DWR knowingly violated the X2 standard in the Delta in February 2009 does little to instill confidence from the Coalition in non-specific program and mitigation criteria.

The EA repeatedly illustrates that there is potential for significant injury to other groundwater users, water quality, streams, flora and fauna, and the soil profile (p. 3-12, 3-23, 3-24, 3-53, 3-54). Chapter three contains numerous examples that illustrate the need for an EIS since there is insufficient, comprehensive planning for, let alone preparation to mitigate, adverse environmental impacts:

- *Acquisition of water via groundwater substitution or cropland idling would change the rate and timing of flows in the Sacramento River compared to the No Action Alternative.*
- *In Figure 3.2-2, groundwater substitution pumping results in a change in the groundwater/surface water interaction characteristics. In this case, the water pumped from a groundwater well may have two impacts that reduce the amount of surface water compared to pre-pumping conditions. These mechanisms are:*
 - *Induced leakage. The lowering of the groundwater table causes a condition where the groundwater table is lower than that the water level in the surface water. This conditions causes leakage out of the surface water.*
 - *Interception of groundwater. The placement of groundwater substitution pumping may intercept groundwater that may normally have discharged to the surface water (i.e., water that has already percolated into the ground may be pumped out prior the water reaching the surface water and being allowed to enter the “gaining” stream).*
- *The changes in groundwater flow patterns (e.g., direction, gradient) due to increased groundwater substitution pumping may result in changes in groundwater quality from the migration of reduced quality water.*
- *Groundwater substitution transfers would alter ground water levels and potentially affect natural and managed seasonal wetlands and riparian communities, upland habitats and wildlife species depending on these habitats.*
- *Rice land idling transfers would reduce habitat and forage for resident and migratory wildlife populations.*
- *Water transfers could change reservoir releases and river flows and potentially affect special status fish species and essential fish habitat.*
- *Water transfers could affect fisheries and aquatic ecosystems in water bodies, including Sacramento and American River systems, the Sacramento-San Joaquin Delta, San Luis Reservoir, and DWR and Metropolitan WD reservoirs in southern California.*
- *Increased groundwater pumping for groundwater substitution transfers would increase emissions of air pollutants.*

The Bureau thus recognizes the potential for significant decline in groundwater levels as a result of the proposed activity (EA at p. 3-23, 3-24, 3-53, 3-54). This acknowledgement alone is sufficient to require a full EIS. Moreover, as detailed below, the monitoring proposed by the 2010-2011 Water Transfer Program is so inadequate that there can be no guarantee that adverse impacts will be discovered, or that they will be discovered in time to avoid significant environmental impacts.

Glenn County will have groundwater substitution if the Project moves forward. The County realizes that its management plan may not be sufficient for the challenges presented by this Project and the myriad others and cautions that “[s]ince the groundwater management plan is relatively new and not fully implemented, the enforcement and conflict resolution process has not been vigorously tested,” (http://www.glenncountywater.org/management_plan.aspx). Moreover, the Glenn County Groundwater Management Plan does not have any provisions to monitor or protect the environment. The 2010-2011 Water Transfer Program EA fails to disclose the inadequacies of this and other local ordinances and plans.

b. Monitoring based on the Glenn County Groundwater Management Plan is inadequate. Since the Bureau omitted discussion of the Glenn County Groundwater Management Plan in the 2010-2011 Water Transfer Program, we refer to the language used in the 2008 Stony Creek Fan EA/FONSI that explained that the existing Glenn County groundwater management plan will ensure the testing project will have no significant adverse effects on groundwater levels: “This Finding of No Significant Impact (FONSI) is based upon the following: ... Implementation of the Glenn County Groundwater Management Plan during the aquifer performance testing plan will ensure that the proposed action will not result in any significant adverse effect to existing groundwater levels.” Stony Creek Fan EA/FONSI at p. 2.

But the Butte County Department of Water and Resource Conservation explains that local plans are simply not up to the task of managing a regional resource:

Glenn County does not have an export ordinance because it relies on Basin Management Objectives (BMO) to manage the groundwater resource, and subsequently to protect third parties from transfer related impacts. Recently, Butte County also adopted a BMO type of groundwater management ordinance. Butte County, Tehama County and several irrigation districts in each of the four counties have adopted AB3030 groundwater management plans. All of these groundwater management activities were initiated prior to recognizing that a regional aquifer system exists that extends over more than one county and that certain activities in one county could adversely impact another. Clearly the current ordinances, AB3030 plans, and local BMO activities, which were intended for localized groundwater management, are not well suited for management of a regional groundwater resource like that theorized of the Lower Tuscan aquifer system.

(Butte County DWRC 2007)⁴

c. The EA fails to propose real time monitoring for land subsidence. Third-party independent verification, perhaps by scientists from the U.S. Geological Survey, should be incorporated by DWR and the Bureau into the project description of the 2010-2011 Water Transfer Program. We applaud the initiation of a regional GPS network in the Sacramento

Valley, but remain concerned about the 13 existing extensometers in the Sacramento Valley that measure land subsidence, and a Global Positioning System land subsidence network established by one county (EA p. 13). The remaining responsibility is again deferred to the “willing sellers.” Unfortunately, voluntary monitoring by pumpers does not strike us as a responsible assurance given the substantial uncertainties involved in regional aquifer responses to extensive groundwater pumping in the Sacramento Valley.

Not only is there a failure to discuss real time monitoring for subsidence, there also is no discussion regarding delayed subsidence that should also be monitored according to the findings of Dr. Kyran Mish, Presidential Professor, School of Civil Engineering and Environmental Science at the University of Oklahoma. Dr. Mish notes: “It is important to understand that *all* pumping operations have the potential to produce such settlement, and when it occurs with a settlement magnitude sufficient enough for us to notice at the surface, we call it *subsidence*, and we recognize that it is a serious problem (since such settlements can wreak havoc on roads, rivers, canals, pipelines, and other critical infrastructure),” (Mish 2008).. Dr. Mish further explains that “[b]ecause the clay soils that tend to contribute the most to ground settlement are highly impermeable, their subsidence behavior can continue well into the future, as the rate at which they settle is governed by their low permeability.” *Id.* “Thus simple real-time monitoring of ground settlement can be viewed as an *unconservative* measure of the potential for subsidence, as it will generally tend to underestimate the long-term settlement of the ground surface.” *Id.* (emphasis added).

The EA acknowledges the existence and cause of serious subsidence in one area of the valley. “The area between Zamora, Knights Landing, and Woodland has been most affected (Yolo County 2009). Subsidence in this region is generally related to groundwater pumping and subsequent consolidation of aquifer sediments,” (EA p. 3-13). This fact alone illustrates the need for more extensive analysis throughout the export area in an EIS.

d. The 2010-2011 Water Transfer Program EA fails to require streamflow monitoring. The 2009 DWB EA/FONSI deferred the monitoring and mitigation planning to “willing sellers,” but even that requirement has been completely eliminated. We can’t emphasize enough the importance of frequent and regular streamflow monitoring by either staff of the project agencies or a third, independent party such as the USGS, paid for by Project transfer surcharges mentioned above. It is clear from existing scientific studies and the EA that the Project may have significant impacts on the aquifers replenishment and recharging of the aquifers, so the 2010-2011 Water Transfer Program should therefore require extensive monitoring of regional streams. The radius for monitoring should be large, not the typical two to three miles as usually used by DWR and the Bureau. Though not presented for the 2010-2011 Water Transfers Program, the *Stony Creek Fan Aquifer Performance Testing Plan*, which is a much smaller project, recognized that there may be a drawdown effect on the aquifer by considering results from a DWR Northern District spring 2007 production well test (EA/FONSI p. 28). However, it did not assess the anticipated scope of that effect—or even what level of effect would be considered acceptable. Moreover, the results from that test well indicate that the recharge source for the solitary

production well “is most likely from the foothills and mountains, to the east and north”—which at a minimum is more than fifteen miles away. (DWR, Glenn-Colusa Irrigation District Aquifer Performance Testing Glenn County, California).

The Butte County Department of Water and Resource Conservation have identified streams that must be monitored to determine impacts to stream flows that would be associated with pumping the Lower Tuscan Aquifer. These “[s]treams of interest” are located on the eastern edge of the Sacramento Valley and include: Mill Creek, Deer Creek, Big Chico Creek, Butte Creek, and Little Dry Creek (The Butte County DWRC 2007). The department described the need and methodology for stream flow gauging:

The objective of the stream flow gaging is to determine the volume of surface water entering into or exiting the Lower Tuscan Aquifer along perennial streams that transect the aquifer formation outcropping for characterization of stream-aquifer interactions and monitoring of riparian habitat. Measurement of water movement into or out of the aquifer will allow for testing of the accuracy of the Integrated Water Flow Model, an integrated surface water-groundwater finite differential model developed for the eastern extent of the Lower Tuscan aquifer.

Two stream gages will be installed on each of five perennial streams crossing the Lower Tuscan Formation to establish baseline stream flow and infiltration information. The differences between stream flow measurements taking upstream and downstream of the Lower Tuscan Formation are indications of the stream-aquifer behavior. Losses or gains in stream volume can indicate aquifer recharge or discharge to or from the surface waters.

Id.

As evident in the following conclusory assertions, the draft EA/FONSI fails to define the radius of influence associated with the aquifer testing and thus entirely fails to identify potential significant impacts to salmon:

“An objective in planning a groundwater substitution transfer is to ensure that groundwater levels recover to their typical spring high levels under average hydrologic conditions. Because groundwater levels generally recover at the expense of stream flow, the wells used in a transfer should be sited and pumped in such a manner that the stream flow losses resulting from pumping peak during the wet season, when losses to stream flow minimally affect other legal users of water,” (EA p. 2-7).

As mentioned above, streamflow monitoring is not a requirement of the Project, which is unfathomable. Monitoring of flow on streams associated with the Lower Tuscan Formation is particularly important to the survival of Chinook salmon which use these “streams of interest” to spawn and where salmon fry rear. Intensive groundwater pumping would likely lower water table elevations near these streams of interest, decreasing surface flows, and therefore reducing

salmon spawning and rearing habitat through dewatering of stream channels in these northern counties. This would be a significant adverse impact of the Project and is ignored by the EA.

A similar effect has been observed in the Cosumnes River, where “[d]eclining fall flows are limiting the ability of the Cosumnes River to support large fall runs of Chinook salmon,” (Fleckenstein, et al 2004). This is a river that historically supported a large fall run of Chinook Salmon. *Id.* Indeed, “[a]n early study by the California Department of Fish and Game . . . estimated that the river could support up to 17,000 returning salmon under suitable flow conditions.” *Id.*, citing CDFG 1957 & USFWS 1995. But “[o]ver the past 40 years fall runs ranged from 0 to 5,000 fish according to fish counts by the CDFG (USFWS 1995),” and “[i]n recent years, estimated fall runs have consistently been below 600 fish, according to Keith Whitener,” (Fleckenstein, *et al.* 2004). Indeed, “[f]all flows in the Cosumnes have been so low in recent years that the entire lower river has frequently been completely dry throughout most of the salmon migration period (October to December).” *Id.*

Research indicates that “groundwater overdraft in the basin has converted the [Cosumnes River] to a predominantly losing stream, practically eliminating base flows. . . .” (Fleckenstein, *et al.* 2004). And “investigations of stream-aquifer interactions along the lower Cosumnes River suggest that loss of base flow support as a result of groundwater overdraft is at least partly responsible for the decline in fall flows.” *Id.* Increased groundwater withdrawals in the Sacramento basin since the 1950s have substantially lowered groundwater levels throughout the county.” *Id.*

The draft EA acknowledges the potential for impacts to special status fish species from altered river flows and commits to maintaining flow and temperature requirements already in place (p. 3-59). The coalition would like to have greater assurance of a commitment considering that the Bureau and DWR failed to meet the X2 standard in February 2009. The Bureau and DWR should make X2 compliance and streams of interest monitoring in real time part of their permit amendment applications to the SWRCB this spring. If stream levels are affected by groundwater pumping, then pumping would cease.

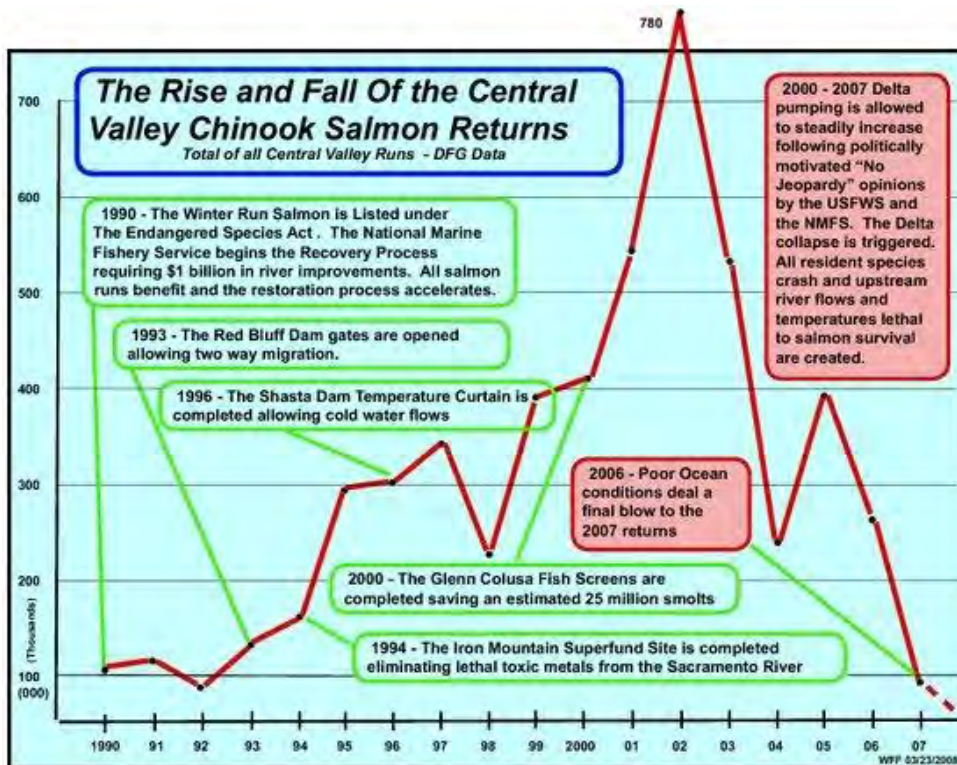
Unfortunately, the draft EA fails to anticipate possible stream flow declines in important salmon rearing habitat in the 2010-2011 Water Transfer Program area. Many important streams, such as Mud Creek, are located within the 2010-2011 Water Transfer Program and flows through probable Tuscan recharge zones, yet are not mentioned in the EA (also see comments above regarding Rock Creek). While a charged aquifer is likely to add to base flow of this stream, a dewatered aquifer would pull water from the stream. According to research conducted by Dr. Paul Maslin, Mud Creek provides advantageous rearing habitat for out-migrating Chinook salmon (1996). Salmon fry feeding in Mud Creek grew at over twice the rate by length as did fry feeding in the main stem of the Sacramento River. *Id.*

Another tributary to the Sacramento River, Butte Creek, hosts spring-run Chinook salmon, a threatened species under the Endangered Species Act. 64 Fed. Reg. 50,394 (Sept. 16, 1999).

Butte Creek contains the largest remaining population of the spring-run Chinook and is designated as critical habitat for the species. *Id.* at 50,399; 70 Fed. Reg. 52,488, 52,590-91 (Sept. 2, 2005). Additionally, Butte Creek provides habitat for the threatened Central Valley steelhead. *See* 63 Fed. Reg. 13,347 (Mar. 19, 1998); 70 Fed. Reg. at 52,518. While Butte Creek is mentioned in the EA (p. 2-11, 3-4, 3-49, 3-57), the only protection afforded this vital tributary are statements that cropland idling will not occur adjacent to it, yet that is contradicted on page 3-19. The Bureau should not overlook the importance of rearing streams, and should not proceed with this Project unless and until adequate monitoring and mitigation protocols are established.

Existing mismanagement of water in California's rivers, creeks, and groundwater has already caused a precipitous decline in salmon abundance. There is no mention of the fall-run salmon numbers in the main stem Sacramento River or its essential tributaries despite the fact that their numbers dropped precipitously in 2007 (see graphic below) 2008, and 2009. After the commercial salmon fishery was closed for two years for fear of pushing these fish to extinction, scientists are waiting until February 2010 to determine if the commercial and sport fishing seasons will open this year. As noted above, the EA casually asserts that maintaining flow and temperature requirements in the main stem will be sufficient to protect aquatic species, but it fails to consider the impacts of almost 400,000 AF of water transfers, fallowing, and groundwater substitution on the tributaries. How much additional pumping does the Project represent, given CVP and SWP contractual commitments, available reservoir supplies, and other environmental restrictions south of the Delta? The EA and DWR's missing environmental review are silent on this.

Where are the data to support assertions that impacts to aquatic species will be below a level of significance? Habitat values are also essential to many other special status species that utilize the aquatic and/or riparian landscape including, but not limited to, giant garter snake, bank swallow, greater sandhill crane, American shad, etc. Where is the documentation of the potential impacts to these species?



Graphic is courtesy of Dick Pool.

In addition to the direct decline in the salmon populations is the food chain affect that will influence species such as killer whales.

3. The EA fails to address the significant unknown risks raised by the 2010-2011 Water Transfer Program's proposed groundwater extraction.

The EA fails to identify and address the significant unknown risks associated with this Project. There are substantial gaps in scientists' understanding of how the aquifer system recharges.

The EA fails to reveal the scientifically known and unknown characteristics of the Lower Tuscan aquifer. Expert opinion and experience is offered by Professor Karin Hoover from CSU Chico who asserts that: "[T]o date there exists no detailed hydrostratigraphic analysis capable of distinguishing the permeable (water-bearing) units from the less permeable units within the subsurface of the Northern Sacramento Valley. In essence, the thickness and extent of the water-bearing units has not been adequately characterized." (p. 1)

Though the Project fails to disclose the limitations in knowledge of the geology and hydrology of the northern counties, it was disclosed in 2008 in the EA for the *Stony Creek Fan Aquifer Performance Testing Plan* (Testing Plan EA). It revealed that there is also limited understanding of the interaction between the affected aquifers, and how that interaction will affect the ability of the aquifers to recharge. The Testing Plan EA provides:

The Pliocene Tuscan Formation lies beneath the Tehama Formation in places in the eastern portion of the SCF Program Study Area, although its extent is not well defined. Based on best available information, it is believed to occur at depths ranging between approximately 300 and 1,000 feet below ground surface. It is thought to extend and slope upward toward the east and north, and to outcrop in the Sierra Nevada foothills. The Tuscan Formation is comprised of four distinct units: A, B C and D (although Unit D is not present within the general project area). Unit A, or Upper Tuscan Formation, is composed of mudflow deposits with very low permeability and therefore is not important as a water source. Units B and C together are referred to as the Lower Tuscan Formation. Very few wells penetrate the Lower Tuscan Formation within the SCF Program study area.

(The Testing Plan EA/FONSI at p. 23). The Tehama Formation, however, generally behaves as a semi-confined aquifer system and the EA contains no discussion of its relationship with the adjoining formations. Nor is there any discussion of the role of the Pliocene Tehama Formation as "the primary source of groundwater produced in the area," (DWR 2003).

The EA fails to offer any in-depth analysis of which strata in the aquifers will be most likely affected by the 2010-2011 Water Transfer Program's proposed extraction of groundwater. Thousands of domestic wells in the upper layers of the aquifers are not even considered in the EA. In addition, the EA provides no assessment of the interrelationship of varying strata in the aquifers in the Sacramento Valley or between the aquifers themselves.

The EA fails to provide basic background information regarding the recharge of groundwater. The documents states, "Groundwater is recharged by deep percolation of applied water and rainfall infiltration from streambeds and lateral inflow along the basin boundaries," (EA p. 3-10). How was the conclusion reached that applied water leads to recharge of the aquifer? Where are the supporting data? This claim is unsubstantiated by any of the work that has been performed to date. For example, the RootZone water balance model used by a consultant with Glenn Colusa Irrigation District, Davids Engineering, was designed to simulate root zone soil moisture. It balances incoming precipitation and irrigation against crop water usage and evaporation, and whatever is left over is assigned to "deep percolation." Deep percolation in this case means below the root zone, which is anywhere from a few inches to several feet below the surface, depending on the crop. There is absolutely no analysis that has been performed to insure that applied water does, indeed, recharge the aquifer. For example, if the surface soils were to dry out, water that had previously migrated below the root zone might be pulled back up to the surface by capillary forces. In any case, the most likely target of the "deep percolation" water in the Sacramento Valley is the unconfined, upper strata of the aquifer and possibly the Sacramento River. The EA has not demonstrated otherwise.

A public hearing concerning the Monterey Agreement was held in Quincy on November 29, 2007 and hosted by DWR. At the hearing Barbara Hennigan presented the following testimony: "So for the issues of protecting the water quality, protecting the stream flow in the Sacramento, one of the things that we have learned is that the Sacramento River becomes a permanently losing stream at the Sutter buttes. When I first started looking at the water issues that point was at Grimes south of the [Sutter B]uttles, now it is at Princeton, moving north of the buttes. As the Sacramento becomes a losing stream farther and farther north because of loss of the Lower Tuscan Aquifer, that means that it, there will be less water that the rest of the State relies on," (http://www.water.ca.gov/environmentalservices/docs/mntry_plus/comments/Quincy.txt). How and when will the Bureau and DWR address this enormously important condition and amplify the risk to not only the northstate, but the entire State of California?

4. The EA contains numerous errors and omissions regarding groundwater resources.

There are numerous errors, omissions, and negligence in addressing existing conditions before and with the Project in Section 3.2 Groundwater Resources. The failure to address stated problematic conditions and the lack of accuracy in this section of so many elemental issues and

facts raises questions about the content of the entire EA and FOSI. A partial list of statements and questions follows.

- On pages 3-10, 3-12, and 3-13 of the EA the Sierra Nevada [mountain range] and “Coast ranges” are identified, but there is no mention of the southern Cascade Range that is a prominent geologic feature of the northern Sacramento Valley and a significant contributor to the hydrology of the region.
- Page 3-12 mentions “major tributaries” to the Sacramento River, but omits the northern rivers the McCloud and the Pit. It also mentions “Stony, Cache, and Putah Creeks,” but fails to mention Battle, Mill, Big Chico, and Butte creeks. These omissions again reflect an odd lack of understanding of the Cascade Range.
- The EA states quite straightforwardly on page 3-12 that, “Surface water and groundwater interact on a regional basis, and, as such, gains and losses to groundwater vary significantly geographically and temporally. In areas where groundwater levels have declined, such as in Sacramento County, streams that formerly gained water from groundwater now lose water to the groundwater system through seepage.” This knowledge alone requires substantive environmental review under NEPA and CEQA.
- Page 3-12. “Groundwater production in the basin has recently been estimated to be about 2.5 million acre-feet or more in dry years.” What is the citation for this assertion?
- Page 3-12. “Historically, groundwater levels in the Basin have remained steady, declining moderately during extended droughts and recovering to pre-drought levels after subsequent wet periods. DWR extensively monitors groundwater levels in the basin. The groundwater level monitoring grid includes active and inactive wells that were drilled by different methods, with different designs, for different uses. Types of well use include domestic, irrigation, observation, and other wells. The total depth of monitoring grid wells ranges from 18 to 1,380 feet below ground surface.” As presented above, groundwater levels have been changing, historically. Since the Bureau and DWR have access to a monitoring grid, for NEPA and CEQA compliance, they must present current facts, not general statements that relate to social science.
- Page 3-12. “In general, groundwater flows inward from the edges of the basin and south parallel to the Sacramento River. In some areas there are groundwater depressions associated with extraction that influence local groundwater gradients.” Where are the groundwater depressions? How have they affected groundwater gradients? How will the Project exacerbate a negative existing condition?
- Page 3-12. “Prior to the completion of CVP facilities in the area (1964-1971), pumping along the west side of the basin caused groundwater levels to decline. Following construction of the Tehama-Colusa Canal, the delivery of surface water and reduction in groundwater extraction resulted in a recovery to historic groundwater levels by the mid to late-1990s.” Please provide the citation(s).
- Pg 3-15 "According to the SWRCB, there are no elevated concentrations of arsenic or selenium in the Sacramento Groundwater Basin." The GAMA domestic well Project, Tehama County Focus Area, 2009, Arsenic in Domestic and Public Wells indicates variable levels of arsenic in the cited basin. The study found that, "Fourteen percent of

the wells [in the Tehema County focus area] had concentrations of both arsenic and iron above their associated CDPH MCLs or secondary MCLs."

- Page 3-15. "The State Water Code (Section 1745.10) requires that for short term water transfers, the transferred water may not be replaced with groundwater unless the following criteria are met (SWRCB 1999)..." The Project is not a short term water transfer, but a set of serial actions in multiple years by the agencies, sellers, and buyers without the benefit of comprehensive environmental analysis under NEPA and CEQA.
- Page 3-16. "California Water Code Section 1810 and the CVPIA protect against injury to third parties as a result of water transfers. Three fundamental principles include (1) no injury to other legal users of water; (2) no unreasonable effects on fish, wildlife or other in-stream beneficial uses of water; and (3) no unreasonable effects on the overall economy or the environment in the counties from which the water is transferred. These principles must be met for approval of water transfers." The disclosures and analyses contained in the EA, FONSI, and its appendices are inadequate to satisfy the California Water Code requirements and the Bureau's requirements under NEPA. DWR has clearly failed its obligations under CEQA by providing no disclosure or analysis.

E. Other resource impacts flowing from corrected chains of cause and effect are unrecognized in the EA and should be considered in an EIS instead.

Regarding surface water reservoir operations in support of the 2010-2011 Water Transfer Program, we have several questions and concerns:

- Regarding fisheries, we note that the Bureau intends to comply with the State Water Resources Control Board's Water Rights Orders 90-05 and 91-01 in order to provide temperature control at or below 56 degrees Fahrenheit for anadromous fish, their redds, and hatching wild salmonid fry, and to provide minimum instream flows of 3,250 cubic feet per second (cfs) between September 1 and February 28, and 2,300 cfs between March 1 and August 31. How will the Bureau and DWR comply with Fish and Game Code Section 5937—to keep fish populations below and above their dams in good condition, as they approve transfers of CVP water from willing CVP contractors to willing buyers? We urge this compliance effort be integrated with the streams of interest and groundwater monitoring programs we recommended above.
- We also find confusing the EA's treatment of instream flows for fisheries. On one hand, minimum flows and temperature criteria established in the above-mentioned water rights orders is to be adhered to by the Bureau for the Sacramento River. The necessity for April and May storage is not well explained.
- Concerning the social and economic effects of the proposed 2010-2011 Water Transfer Program, crop idling transfers will delete fields from production and result in employment impacts on Sacramento Valley's agricultural labor market at a time when the

national recession is at its worst. The lack of descriptive information about what crops are to be idled by specific "willing sellers" means that a reasonably plausible estimate of employment impacts in the Sacramento Valley are unavailable, rendering the EA inadequate from this standpoint. Has the Bureau reviewed the President's policies on economic recovery to be certain that its water transfer program that would shift employment impacts from one Valley to another rather than work to increase employment generally is consistent with the intent of the President and Congress? What would be the effects of employment shifting on the poverty rates of Sacramento Valley counties? Such an estimate, provided with basic information about what acreages of specific crops are to be idled, is within the reach of the Bureau to make.

- On its own terms, the Bureau's EA makes no attempt to establish baseline agricultural crop acreages for each agricultural county offering or seeking DWB water in order to calculate and apply its 20 percent threshold for limiting economic impacts to agriculture in selling counties. Moreover, this 20 percent threshold needs to be incorporated into the description of the Proposed Action Alternative, since it appears to be an integral part of DWB actions.
- Regarding public health and safety, the EA negligently denies the potential for impacts (p.3-1). Fluctuating domestic wells can lead to serious contamination from heavy metals and non-aqueous fluids. Additionally, there are numerous hazardous waste plumes in Butte County, which could easily migrate with the potential increased groundwater pumping proposed for the Project. All of this must be disclosed and analyzed.

In general, the 2010-2011 Water Transfer Program EA/FONSI—and by logical implication, DWR's actions—consistently avoids full disclosure of existing conditions and baseline data, rendering their justifications for the 2010-2011 Water Transfer Program at best incoherent, and at worst, dangerous to groundwater users and resources, and to vulnerable fisheries in tributary streams of the Sacramento River.

F. The 2010-2011 Water Transfer Program is likely to have a cumulatively significant impact on the environment.

The draft EA/FONSI does not reveal that the current Project is part of a much larger set of plans to develop groundwater in the region, to develop a "conjunctive" system for the region, and to integrate northern California's groundwater into the state's water supply. These are plans that the Bureau, together with DWR and others, have pursued and developed for many years. Indeed, one of the plans—the short-term phase of the Sacramento Valley Water Management Program—is the subject of an ongoing scoping process for a Programmatic EIS that has not yet been completed.

In assessing the significance of a project's impact, the Bureau must consider "[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts

and should therefore be discussed in the same impact statement.” 40 C.F.R. §1508.25(a)(2). A “cumulative impact” includes “the impact on the environment which results from the incremental impact of the action when added to *other past, present and reasonably foreseeable future actions* regardless of what agency (Federal or non-Federal) or person undertakes such other actions.” *Id.* §1508.7. The regulations warn that “[s]ignificance cannot be avoided by terming an action temporary or by breaking it down into small component parts.” *Id.* §1508.27(b)(7).

An environmental impact statement should also consider “[c]onnected actions.” *Id.* §1508.25(a)(1). Actions are connected where they “[a]re interdependent parts of a larger action and depend on the larger action for their justification.” *Id.* §1508.25(a)(1)(iii). Further, an environmental impact statement should consider “[s]imilar actions, which when viewed together with other *reasonably foreseeable or proposed agency actions*, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography.” *Id.* §1508.25(a)(3) (emphasis added).

As detailed below, instead of assessing the cumulative impacts of the proposed action as part of the larger program that even the Bureau has recognized should be subject to a programmatic EIS (but for which no programmatic EIS has been completed), the Bureau has attempted to separate this program and approve it through an inadequate EA. Further, the Bureau has failed to take into account the cumulative effects of other groundwater and surface water projects in the region, the development of “conjunctive” water systems, and the anticipated further integration of Sacramento Valley surface and ground water into the state water system.

G. The Environmental Assessment Fails to Meet the Requirements of NEPA.

Even if an EIS were not clearly required here, the draft EA/FONSI prepared by the Bureau violates NEPA on its own. As discussed above, the draft EA does not provide the analysis necessary to meet NEPA’s requirements and to support its proposed finding of no significant impact. Further, as outlined above, the draft document fails to provide a full and accurate description of the proposed Project, its relationship to myriad other water transfer and groundwater extraction projects, its potentially significant adverse effects on salmon critical habitat in streams of interest tributary to the Sacramento River, and an assessment of the cumulative environmental impacts of the 2010-2011 Water Transfer Program when considered together with other existing and proposed water programs.

Additionally, the draft EA/FONSI fails to provide sufficient evidence to support its assertions that the 2010-2011 Water Transfer Program would have no significant impacts on the human or natural environments, neither decision makers nor the public are fully able to evaluate the significance of the 2010-2011 Water Transfer Program’s impacts. These informational failures complicate the Coalition’s efforts to provide meaningful comments on the full extent of the potential environmental impacts of the DWB and appropriate mitigation measures. Accordingly, many of the Coalition’s comments include requests for additional information.

1. The EA Fails to Consider a Reasonable Range of Alternatives.

NEPA's implementing regulations call for analysis of alternatives is "the heart of the environmental impact statement," 40 C.F.R. §1502.14, and they require an analysis of alternatives within an EA. *Id.* §1408.9. The statute itself specifically requires federal agencies to:

study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning available uses of resources.

42 U.S.C. §4332(2)(E). Here, because the Bureau's EA considers only the proposed Project and a "No Action" alternative, the EA violates NEPA.

The case law makes clear that an adequate analysis of alternatives is an essential element of an EA, and is designed to allow the decision maker and the public to compare the environmental consequences of the proposed action with the environmental effects of other options for accomplishing the agency's purpose. The Ninth Circuit has explained that "[i]nformed and meaningful consideration of alternatives ... is ... an integral part of the statutory scheme." *Bob Marshall Alliance v. Hodel*, 852 F.2d 1223, 1228 (9th Cir. 1988) (holding that EA was flawed where it failed adequately to consider alternatives). An EA must consider a reasonable range of alternatives, and courts have not hesitated to overturn EAs that omit consideration of a reasonable and feasible alternative. *See People ex rel. Van de Kamp v. Marsh*, 687 F.Supp. 495, 499 (N.D. Cal. 1988); *Sierra Club v. Watkins*, 808 F.Supp. 852, 870-75 (D.D.C. 1991).

Here, there are only two alternatives presented: the No Action and the Proposed Action. The lack of *any* alternative action proposal is unreasonable and is by itself a violation of NEPA's requirement to consider a reasonable range of alternatives.

Even more significantly, there are numerous other alternative ways to ensure water is allocated reliably when California experiences dry hydrologic years. We described several elements of reasonable alternatives above. These are the alternatives that should have been presented for the Bureau's draft EA/FONSI on the 2010-2011 Water Transfer Program to comply with NEPA. 42 U.S.C. § 4332(2)(E).

2. The EA Fails to Disclose and Analyze Adequately the Environmental Impacts of the Proposed Action

The discussion and analysis of environmental impacts contained in the EA is cursory and falls short of NEPA's requirements and stems from having an unclear and poorly described narrative for the proposed 2010-2011 Water Transfer Program. It obscures realistic chains of cause and effect, which in turn prevent accurate and comprehensive accounting of environmental baselines and measurement of the DWB's potential impacts. NEPA's implementing regulations require that an EA "provide sufficient evidence and analysis for determining whether to prepare an

[EIS].” 40 C.F.R. §1508.9(a). For the reasons discussed above, the EA fails to discuss and analyze the environmental effects of the water transfers, crop idling, and groundwater substitution proposed by the 2010-2011 Water Transfer Program. The Bureau must consider and address the myriad of environmental consequences that are likely to flow from this proposed agency action.

Along with our significant concerns about the adequacy of the proposed monitoring, the draft EA/FONSI also fails to explain what standards will be used to evaluate the monitoring data, and on what basis a decision to modify or terminate the pumping would be made. In light of the document’s silence on these crucial issues, the draft EA/FONSI’s conclusion that there will not be significant adverse impacts withers quickly under scrutiny.

3. The EA Fails to Analyze Cumulative Impacts Adequately.

The Ninth Circuit Court makes clear that NEPA mandates “a useful analysis of the cumulative impacts of past, present and future projects.” *Muckleshoot Indian Tribe v. U.S. Forest Service*, 177 F.3d 800, 810 (9th Cir. 1999). Indeed, “[d]etail is required in describing the cumulative effects of a proposed action with other proposed actions.” *Id.* The very cursory cumulative effects discussion contained in the EA plainly fails to meet this standard.

As discussed in Part I.C. above, the proposed DWB does not exist in a vacuum, and is in addition to a broader program to develop regional groundwater resources and a conjunctive use system. The 2010-2011 Water Transfer Program is also only one of several proposed and existing projects that affect the regional aquifers. The existence of these numerous related projects makes an adequate analysis of cumulative impacts especially important.

4. The Bureau Has Failed to Consider the Cumulative Impact of Other Groundwater Development and Surface Water Diversions Affecting the Region

In addition to the improper segmentation evident in the draft EA/FONSI, the assessment of environmental impacts is further deficient because the Bureau has failed to consider the cumulative impacts of the proposed groundwater extraction when taken in conjunction with other projects proposed for the development of groundwater and surface water.

The Bureau and its contractors are party to numerous current and reasonably foreseeable water programs that are related to the water transfers contemplated in the DWB including the following:

- Sacramento Valley Integrated Regional Water Management Plan (2006)
- Sacramento Valley Regional Water Management Plan (January 2006)
- Stony Creek Fan Conjunctive Water Management Program
- Sacramento Valley Water Management Agreement (Phase 8, October 2001)

- Draft Initial Study for 2008-2009 Glenn-Colusa Irrigation District Landowner Groundwater Well Program
- Regional Integration of the Lower Tuscan Groundwater Formation into the Sacramento Valley Surface Water System Through Conjunctive Water Management (June 2005)
- Stony Creek Fan Aquifer Performance Testing Plan for 2008-09
- Lower Tuscan Integrated Planning Program, a program funded by the Bureau that will “integrate the Lower Tuscan formation aquifer system into the management of regional water supplies.”
- Annual forbearance agreements (2008 had an estimated 160,00 acre feet proposed).

We briefly describe some of their key elements here.

Stony Creek Fan Conjunctive Water Management Program. The SCF Aquifer Plan is part of and in furtherance of the Stony Creek Fan Conjunctive Water Management Program (“SCF Program”). This program is being carried out by GCID, Orland-Artois and Orland Unit Water Association.

The long-term objective of the SCF Program is the development of a “regional conjunctive water management program consisting of a direct and in-lieu recharge component, a groundwater production component, and supporting elements...” (SVWMA: Project 8A Stony Creek Fan Conjunctive Water Management Program (“SVWMA Project 8A”), at 8A-1). The potential supply from such a program was estimated at 50,000 af per year to 100,000 af per year. *Id.*

The SCF Program has 3 Phases: (1) a feasibility study; (2) a demonstration project; and (3) project implementation. Phase I of the SCF Program has already been completed. The SCF Aquifer Plan described in a draft EA/FONSI is part of Phase II of the larger SCF Program. Phase III of the SCF Program will implement the program’s goal of integrating test and operational production wells into the water supply systems for GCID, Orland-Artois, and Orland Unit Water Association for long-term groundwater production in conjunction with surface water diversions.

The Bureau is well aware of the SCF Program, but declined to analyze the environmental effects of the program as a whole, and simply considered the effects of an isolated component of the larger program. Indeed, the Bureau recently awarded a grant to GCID to fund the SCF Program. The Bureau’s grant agreement states that the SCF Program “target[s] the Lower Tuscan Formation and possibly other deep aquifers in the west-central portion of the Sacramento Valley ... as the source for all or a portion of the additional groundwater production needed to meet [the SCF Partners’] respective integrated water management objectives.” BOR Assistance Agreement No. 06FG202103 at p. 2. The agreement further provides that provides that “[a]dditional test wells and production wells will be installed within the Project Area.” *Id.*

Moreover, the Bureau's own description of the reasons for not choosing the "No Action" alternative indicate the Bureau's recognition that the primary goal of the SCF Aquifer Plan is to realize the objectives of the SCF Program – "increas[ing] reliable water supplies through conjunctive management of groundwater and surface water" at a fast pace. *See* EA/FONSI at p. 5. The Bureau was obligated to assess the potentially significant environmental impacts associated with such conjunctive management of groundwater and surface water, and wholly failed to do so.

There are serious concerns raised by the proposal to engage in conjunctive management of groundwater and surface water that are not addressed in the EA. For example, in 1994, following seven years of low annual precipitation, Western Canal Water District and other irrigation districts in Butte, Glenn and Colusa counties exported 105,000 af of water extracted from the Tuscan aquifers to buyers outside of the area. This early experiment in the *conjunctive use* of the groundwater resources – conducted without the benefit of environmental review – caused a significant and immediate adverse impact on the environment (Msangi 2006). Until the time of the water transfers, groundwater levels had dropped but the aquifers had sustained the normal demands of domestic and agricultural users. The water districts' extractions, however, lowered groundwater levels throughout the Durham and Cherokee areas of eastern Butte County (Msangi 2006). The water level fell and the water quality deteriorated in the wells serving the City of Durham (Scalmanini 1995). Irrigation wells failed on several orchards in the Durham area. One farm never recovered from the loss of its crop and later entered into bankruptcy. Residential wells dried up in the upper-gradient areas of the aquifers as far north as Durham.

The SCF Program is a Component of the Sacramento Valley Water Management Program. The Sacramento Valley Water Management Program (Phase 8) ("SVWMP") also includes the SCF Program as one of its elements. (SVWMA Project 8A at pp. 8A-1 to 8A-13).

The SVWMP recognizes that the SCF Program "has the potential to improve operational flexibility on a regional basis resulting in measurable benefits locally in the form of predictable, sustainable supplies, *and improved reliability for water users' elsewhere in the state.*" *Id.* at p. 8A-2 (emphasis added). By piecemealing this program improperly and analyzing only the small component of the SCF Program, the Bureau has failed to assess the environmental impacts associated not just with the anticipated conjunctive use of the groundwater, but also the effect of the anticipated export of water to other regions of the state.

Additionally, approximately seven years ago, on August 5, 2003, the Bureau published a notice in the Federal Register announcing its intention to prepare a programmatic EIS to analyze the short-term phase of the SVWMP. 68 Fed. Reg. 46218, 46219 (Aug. 5, 2003). Like the SVWMP, this "Short-term Program" for which the Bureau stated its intent to conduct a programmatic EIS included implementation of the SCF Program. *Id.* at 46219, 46220.

The SCF Program is Also a Component of the Sacramento Valley Integrated Regional Water Management Program. The Bureau has been working with GCID and others to realize the

Sacramento Valley Integrated Regional Water Management Program (“SVIRWMP”). SVIRWMP is comprised of a number of sub-regional projects, including the SCF Program. *See* SVIRWMP, Appendix A at A-5; BOR Assistance Agreement No. 06FG202103. Here again, even though the SCF Aquifer Plan is clearly a necessary component of the SCF Program – which is in turn a component of the SVIRWMP – the draft EA/FONSI failed to even acknowledge, let alone assess, the cumulative impacts of these related projects.

Most obviously, the draft EA wholly fails to assess the impact of the Bureau’s *Sacramento Valley Regional Water Management Plan (2006)* (SVRWMP) and the forbearance water transfer program that the Bureau and DWR facilitate jointly. As noted above, the Programmatic EIS for the 2002 Sacramento Valley Water Management Agreement or Phase 8 Settlement was initiated, but never completed, so the SVRWMP was the next federal product moving the Phase 8 Settlement forward. The stated purpose of the Phase 8 Settlement and the SVRWMP are to improve water quality standards in the Bay-Delta and local, regional, and statewide water supply reliability. In the 2008 forbearance program, 160,000 af was proposed for transfer to points south of the Delta. To illustrate the ongoing significance of the demand on Sacramento Valley water, we understand that GCID alone entered into “forbearance agreements” to provide 65,000 af of water to the San Luis and Delta Mendota Water Association in 2008, 80,000 af to State Water Project contractors in 2005, and 60,000 af to the Metropolitan Water District of Southern California in 2003.

Less obvious, but certainly available to the Bureau, are the numerous implementation projects that Phase 8 signatories are pursuing, such as Glenn Colusa Irrigation District’s (GCID) 2008 proposal to divert groundwater pumped from private wells to agricultural interests in the District. *See* Attach. (GCID Proposed Negative Declaration, GCID Landowner Groundwater Well Program for 2008-09). Additionally, the draft EA does not consider the cumulative effect of the Lower Tuscan Integrated Planning Program, a program funded by the Bureau that will “integrate the Lower Tuscan formation aquifer system into the management of regional water supplies.” Grant Agreement at 4. This program, as described by the Bureau, will culminate in the presentation of a proposed water management program for the Lower Tuscan Formation for approval and implementation by the appropriate authorities. Clearly, the cumulative impact of this program and the 2010-2011 Water Transfer Program’s proposed groundwater extraction should have been assessed.

Finally, with the myriad projects and programs that are ignored in the EA and have never been analyzed cumulatively, the EA finally discloses that there could be a *devastating* impact to groundwater: “The reduction in recharge due to the decrease in precipitation and runoff in the past years in addition to the increase in groundwater transfers would lower groundwater levels. Multi-year groundwater acquisition under cumulative programs operating in similar areas of the Sacramento Valley could further reduce groundwater levels. Groundwater levels may not fully recover following a transfer and may experience a substantial net decline in groundwater levels over several years. This would be a substantial cumulative effect,” (EA p. 3-108). While the

honesty is refreshing, the lack of comprehensive monitoring, mitigation, and project cessation mechanisms is startling. This alone warrants the preparation of an EIS.

Here again, the current document does not discuss or analyze these potential impacts, their potential scope or severity, or potential mitigation efforts. Instead, it relies on the existence of local ordinances, plans, and oversight with the monitoring and mitigation efforts of individual “willing sellers” to cope with any adverse environmental effects. However, as we have shown above, for example, the Glenn County management plan is untested and does not provide adequate protection and monitoring of the region’s important groundwater resources. To further clarify the inadequacy of relying on local plans and ordinances, Butte County’s Basin Management Objectives have no enforcement mechanism and Butte County’s Chapter 33, while it requires CEQA review for transfers that include groundwater, has never been tested. As one can see, there is very limited local protection for groundwater and no authority to influence pumping that is occurring in a different county.

5. The 2010-2011 Water Transfer Program is likely to serve as precedent for future actions with significant environmental effects.

As set forth above, this Project is part of a broader effort by the Bureau and DWR to develop groundwater resources and to integrate GCID’s water into the state system. For these reasons, the 2010-2011 Water Transfer Program is likely to “establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration” (40 C.F.R. §1508.27(b)(6)), and should be analyzed in an EIS.

6. The 2010-2011 Water Transfer Program has potential adverse impacts for a threatened species.

As the Bureau of Reclamation is well aware, the purpose of the ESA is to conserve the ecosystems on which endangered and threatened species depend and to conserve and recover those species so that they no longer require the protections of the Act. 16 U.S.C. § 1531(b), ESA § 2(b); 16 U.S.C. § 1532(3), ESA §3(3) (defining “conservation” as “the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter are no longer necessary”). “[T]he ESA was enacted not merely to forestall the extinction of species (i.e., promote species survival), but to allow a species to recover to the point where it may be delisted.” *Gifford Pinchot Task Force v. U.S. Fish & Wildlife Service*, 378 F.3d 1059, 1069 (9th Cir. 2004). To ensure that the statutory purpose will be carried out, the ESA imposes both substantive and procedural requirements on all federal agencies to carry out programs for the conservation of listed species and to insure that their actions are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. 16 U.S.C. § 1536. See *NRDC v. Houston*, 146 F.3d 1118, 1127 (9th Cir. 1998) (action agencies have an “affirmative duty” to ensure that their actions do not jeopardize listed species and “independent obligations” to ensure that proposed actions are not likely to adversely affect listed species). To accomplish this goal, agencies must consult with the Fish and Wildlife Service whenever their actions “may affect” a listed species. 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14(a). Section 7 consultation is required for “any action [that] may affect listed species or critical habitat.” 50 C.F.R. § 402.14. Agency “action” is defined in the ESA’s implementing regulations to “mean all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States.” 50 C.F.R. § 402.02.

The giant garter snake (“GGS”) is an endemic species to Central Valley California wetlands. (Draft Recovery Plan for the Giant Garter Snake (“DRP”) 1). The giant garter snake, as its name suggests, is the largest of all garter snake species, not to mention one of North America’s largest native snakes, reaching a length of up to 64 inches. Female GGS tend to be larger than males. GGS vary in color, especially depending on the region, from brown to olive, with white, yellow, or orange stripes. The GGS can be distinguished from the common garter snake by its lack of red markings and its larger size. GGS feed primarily on aquatic fish and specialize in ambushing small fish underwater, making aquatic habitat essential to their survival. Females give birth to live young from late July to early September, and brood size can vary from 10 to up to 46 young. Some studies have suggested that the GGS is sensitive to habitat change in that it prefers areas that are familiar and will not typically travel far distances. The EA discloses that one GGS study in Colusa County revealed the “longest average movement distances of 0.62 miles, with the longest being 1.7 miles, for sixteen snakes in 2006, and an average of 0.32 miles, with the longest being 0.6 miles for eight snakes in 2007. However, in response to droughts and other changes in water availability, the GGS has been known to travel up to 5 miles in only a few days,

but the impacts on GGS survival and reproduction from such extreme conditions are unknown due to the deficiency in data and analysis.

Flooded rice fields, irrigation canals, and wetlands in the Sacramento Valley can be used by the giant garter snake for foraging, cover and dispersal purposes. The draft EA fails to comprehensively analyze the movements and habitat requirements for the federal and state-threatened giant garter snake and yet again defers responsibility to a future time. The 2009 Biological Assessment acknowledged the failure of Bureau and DWR to complete the Conservation Strategy that was a requirement of the 2004 Biological Opinion. (BA at p. 19-20) [The BA appears to have no page numbers] What possible excuse delayed this essential planning effort?

The 2010-2011 Water Transfer Program also proposes to delete or modify other mitigation measures previously adopted as a result of the EWA EIR process to substantially reduce significant impacts, but without showing they are infeasible. For example, the Bureau and DWR propose to delete the 160 acre maximum for “idled block sizes” for rice fields left fallow rather than flooded and to substitute for it a 320 acre maximum. (See 2003 Draft EWA EIS/EIR, p. 10-55; 2004 Final EWA EIS/EIR, Appendix B, p. 18, Conservation Measure # 4.) There is no evidence to support this change. In light of the agencies failure to complete the required Conservation Strategy mentioned above and the data gathered in the Colusa County study, how can the EA suggest that doubling the fallowing acreage is in any way biologically defensible? The agencies additionally propose to delete the mitigation measure excluding Yolo County east of Highway 113 from the areas where rice fields may be left fallow rather than flooded, except in three specific areas. (See 2004 Final EWA EIS/EIR, Appendix B, p. 18, Conservation Measure # 2.) What is the explanation for this change? What are the impacts from this change?

Deleting these mitigation measures required by the EWA approval would violate NEPA and CEQA’s requirements that govern whether, when, and how agencies may eliminate mitigation measures previously adopted under NEPA and CEQA. (See *Napa Citizens for Honest Government v. Napa County Board*.)

The 2010-2011 Water Transfer Program fails to include sufficient safeguards to protect the giant garter snake and its habitat. The EA concludes, “The frequency and magnitude of rice land idling would likely increase through implementation of water transfer programs in the future. Increased rice idling transfers could result in chronic adverse effects to giant garter snake and their habitats and may result in long-term degradation to snake populations in the lower Sacramento Valley. In order to avoid potentially significant adverse impacts for the snake, additional surveys should be conducted prior to any alteration in water regime or landscape,” (p. 3-110). To address this significant impact the Bureau proposes relying on the 2009 DWB Biological Opinion, which was a one-year BO. The expired BO highlights the Bureau and DWR’s avoidance of meeting federal and state laws stating, “This office has consulted with Reclamation, both informally and formally, approximately one-half dozen times over the past 8 years on various forbearance agreements and proposed water transfers for which water is made available for delivery south of

the delta by fallowing rice (and other crops) or substituting other crops for rice in the Sacramento Valley. Although transfers of this nature were anticipated in our biological opinion on the environmental Water Account, that program expired in 2007 and, to our knowledge, no water was ever made available to EWA from rice fallowing or rice substitution. The need to consult with such frequency on transfers involving water made available from rice fallowing or rice substitution suggests to us a need for programmatic environmental compliance documents, including a programmatic biological opinion that addresses the additive effects on giant garter snakes of repeated fallowing over time, and the long-term effects of potentially large fluctuations and reductions in the amount and distribution of rice habitat upon which giant garter snakes in the Sacramento Valley depend,” (p.1-2). The Coalition agrees with the U.S. Fish and Wildlife Service that programmatic environmental compliance is needed under the Endangered Species Act, NEPA, CEQA, and the California Endangered Species Act.

It is conspicuously noticeable that there isn't a claim of a less-than-significant impact for the Giant Garter Snake (*Thamnophis gigas*), in the EA/FONSI. There is really no conclusion reached due to the fundamental absence of science for the species. The Bureau should also prepare an EIS because the 2010-2011 Water Transfer Program will likely have significant environmental effects on the Giant Garter Snake, a listed threatened species under the federal Endangered Species Act and California Endangered Species Act. 40 C.F.R. §1508.27(b)(9).

II. Purpose and Need Issues of the 2010-2011 Water Transfer Program

A. The Purpose and Need Section of the EA/FONSI fails to specify the policy framework upon which the 2010-2011 Water Transfer Program is based.

Avoiding the requirements of the California Environmental Quality Act (CEQA) for the 2010-2011 Water Transfer Program does not reflect the actual environmental effects of the proposal—which are similar to the proposed 1994 Drought Water Banks and for which a final Program Environmental Impact Report was completed in November 1993. In 2000, the Governor's Advisory Drought Planning Panel report, *Critical Water Shortage Contingency Plan* promised a program EIR on a drought-response water transfer program, but was never undertaken. Twice in recent history, the state readily acknowledged that CEQA review for a major drought water banking program was appropriate. So, the 2009 DWB Notice of Exemption and complete avoidance of CEQA review for the 2010-2011 Water Transfer Program reflects an end-run around established water law through the use of water transfers, and is therefore vulnerable to legal challenge under the California Environmental Quality Act.

We question the merits of and need for the 2010-2011 Water Transfer Program itself. The existence of drought conditions at this point in time is highly questionable and reflects the state's abandonment of a sensible water policy framework given our state and national economic recession and tattered public budgets. Our organizations believe the agencies continue to go too far to help a few junior water right holders, and that at bottom the 2010-2011 Water Transfer Program is not needed. The Project intends to directly benefit the areas of California whose

water supplies are the least reliable by operation of state water law. Though their unreliable supplies have long been public knowledge, local, state, and federal agencies in these areas have failed to stop blatantly wasteful uses and diversions of water and to pursue aggressive planning for regional water self-sufficiency.

The EA/FONSI's statement of purpose and need on page 1-2 states specifically that, "The purpose of the Proposed Action is to help facilitate the transfer of water throughout the State from willing sellers of CVP water upstream of the Delta to buyers that are at risk of experiencing water shortages in 2010 and 2011." This paragraph and the section that it is in omit a coherent discussion of need. The purpose and need should also state that this transfer program would be subject to specific criteria and delineate priorities, but they are absent.

The EA/FONSI makes no attempt to place the 2010-2011 Water Transfer Program into the context of the 2005 California Water Plan that the state recently completed. It appears to us that this plan is largely on the shelf now, perhaps because of the state's dire fiscal problems. It does contain many good recommendations concerning increasing regional water self-sufficiency. However, our review of the 2005 California Water Plan reveals no mention of the 2000 Critical Water Shortage Reduction Marketing Program or any overarching drought response plan that the state could have planned for in 2005, but did not. We sadly conclude that the state of California has no meaningful adopted drought response policy, save for gubernatorial emergency declarations to suspend protective environmental regulations. This is not a sustainable water policy for California.

The purpose and need section of the EA/FONSI *and the 2009 Governor's drought emergency declaration* cry out for placing the 2010-2011 Water Transfer Program into a policy framework. What is the state doing otherwise to facilitate regional water self-sufficiency for these areas with the least reliable water rights? How does the 2010-2011 Water Transfer Program fit into the state and federal government's water and drought policy framework? Instead, the state and federal response to this third consecutive dry year falls back on simply the Drought Water Bank model that ran into environmental and water users' opposition in 1991 and 1992. Is anybody home at our water agencies?

B. The 2010-2011 Water Transfer Program is not needed because the state's current allocation system—in which the federal Bureau of Reclamation participates—wastes water profligately.

The incentive from the state's lax system of regulation of California's State Water Project and Central Valley projects is to deliver the water now, and worry about tomorrow later. Indeed, the State Water Resources Control Board (SWRCB) has been AWOL for decades. In response to inquiries from the Governor's Delta Vision Task Force last fall, the SWRCB acknowledged that while average runoff in the Delta watershed between 1921 and 2003 was 29 million acre-feet annually, the 6,300 active water right permits issued by the SWRCB is approximately 245 million acre-feet. In other words, **water rights on paper are 8.4 times greater than the real**

water in California streams diverted to supply those rights on an average annual basis. *And the SWRCB acknowledges that this “water bubble” does not even take account of the higher priority rights to divert held by pre-1914 appropriators and riparian water right holders, of which there are another 10,110 disclosed right holders. Many more remain undisclosed.*

Like federal financial regulators failing to regulate the shadow financial sector, subprime mortgages, Ponzi schemes, and toxic assets of our recent economic history, the state of California has been derelict in its management of scarce water resources here. This in no way justifies suspension of environmental and water quality regulations, for which the Governor’s drought emergency declaration calls. We supplement our comments on this matter of wasteful use and diversion of water by incorporating by reference the joint complaint to the State Water Resources Control Board of the California Water Impact Network and the California Sportfishing Protection Alliance on public trust, waste and unreasonable use and method of diversion as additional evidence of a systematic failure of governance by the State Water Resources Control Board, the Department of Water Resources and the U.S. Bureau of Reclamation, filed with the Board on March 18, 2008 (attached).

We question the Bureau and DWR’s contention of continued dry conditions, since the current storms have greatly increased reservoir levels throughout California. Non-state and non-federal reservoirs indicate conditions fast approaching normal for their facilities: Bullard’s Bar in Yuba County is at 99 percent of the 15-year average for this time of year, EBMUD’s Pardee Lake is at 97 percent of normal, San Francisco’s Hetch Hetchy Reservoir on the Tuolumne River is at 152 percent of normal, while Don Pedro Reservoir on the same river is at 106 percent. The CVP’s Millerton and Folsom reservoirs are below average for this time of year, but with the strong storms California is now getting through this week and into next, their storage figures are likely to improve dramatically when snowpack melts. These two reservoirs must provide water to the agricultural San Joaquin River Exchange Contractors first, and they have among the most senior rights on that river. Rice growers in the Sacramento Valley are generally expecting close to full deliveries from the CVP and their Yuba River water supplies. The CVP’s own New Melones Reservoir on the Stanislaus River, which contributes to Delta water quality as well as to meeting eastern San Joaquin Valley irrigation demands, is at 87 percent of normal for this time of year.

Moreover, the SWP’s terminal reservoirs at Pyramid (104 percent of average) and Castaic (99 percent of average) Lakes are right at about normal storage levels for this time of year, presumably because DWR has been releasing water from Oroville for delivery to these reservoirs.

The fact that reservoirs of the CVP with more senior responsibilities in the water rights hierarchy do well with storage for this time of year suggests that at worst this will be a year of below normal runoff in 2010—hardly a drought scenario. Low storage levels at Oroville, Shasta and San Luis may easily be attributed to redirected releases to terminal reservoirs or groundwater banks in the San Joaquin Valley and Tulare Lake Basin—these latter storage venues and their

current performance are not disclosed on DWR's Daily Reservoir Storage levels web site. Still, given what is known, from what these reservoir levels indicate many major cities and most Central Valley farmers are very likely to have enough water for this year.

The ones expecting to receive little water this year do so because of the low priority of their water service contracts within the Central Valley Project—their imported surface supplies are therefore less reliable in dry times. It is the normal and appropriate functioning of California's system of water rights law that makes it so. Among those with more junior water contractor allocations, the Metropolitan Water District and the Santa Clara Valley Water District are the wealthiest regions and the agencies most capable of undertaking aggressive regional water self-sufficiency actions. They should be further encouraged and assisted to do so through coherently formulated state and federal water policies and programs.

On the agricultural side, the Bureau and DWR's efforts appear to benefit mainly the few western San Joaquin Valley farmers whose contractual surface water rights have always been less reliable than most—and whose lands are the most problematic for irrigation. In excess of 1 million acres of irrigated land in the San Joaquin Valley and the Tulare Lake Basin are contaminated with salts and trace metals like selenium, boron, arsenic, and mercury. These lands should be retired from irrigation to stop wasteful use of precious fresh water resources. This water drains back—after leaching from these soils the salts and trace metals—into sloughs and wetlands and the San Joaquin River carrying along these pollutants. Retirement of these lands from irrigation usage would help stem further bioaccumulation of these toxins that have settled in the sediments of these water bodies.

The 2010-2011 Water Transfer Program would exacerbate pumping of fresh water from the Delta, which has already suffered from excessive pumping in earlier years of this decade. Pumped exports cause reverse flows to occur in Old and Middle Rivers and can result in entrainment of fish and other organisms in the pumps. Pumping can shrink the habitat for Delta smelt as well, since less water flows out past Chipps Island through Suisun Bay which Delta smelt often prefer. Our organizations share the widely held view that operation of the Delta export pumps is the major factor causing the Pelagic Organism Decline (POD) and in the deteriorating populations of fall-run Chinook salmon. The State Water Resources Control Board received word in early December that the Fall Midwater Trawl surveys for September and October showed the lowest abundance indices for Delta smelt, American shad, and striped bass in history. The index for longfin smelt is the third lowest in history. 2009 was the second consecutive year where no commercial fishing of fall-run Chinook fish will be allowed because of this species' population decline. While it is too early to know, 2010 could be the third straight year where no commercial fishing will be allowed, which would be unprecedented. Operation of the DWB at a time when others refrain from taking these fish and other organisms strikes us as a consummate unwillingness on the part of the State of California and the U.S. Bureau of Reclamation to share in the sacrifices needed to help aquatic ecosystems and anadromous fisheries of the Bay-Delta Estuary recover.

New capital facilities should be avoided to save on costly, unreliable, and destructive water supplies that new dams and canals represent. Moreover, these facilities would need new water rights; yet the most reliable rights in California are always the ones that already exist—and of those, they are the ones that predate the California State Water Project and the federal Central Valley Project. We should apply our current rights far more efficiently—and realistically—than we do now. California should instead pursue a “no-regrets” policy incorporating aggressive water conservation strategies, careful accounting of water use, research and technological innovation, and pro-active investments.⁵

III. Conclusion

The Bureau’s EA/FONSI states on page 3-16:

California Water Code Section 1810 and the CVPIA protect against injury to third parties as a result of water transfers. Three fundamental principles include (1) no injury to other legal users of water; (2) no unreasonable effects on fish, wildlife or other in-stream beneficial uses of water; and (3) no unreasonable effects on the overall economy or the environment in the counties from which the water is transferred.

We unreservedly state to you that the draft EA/FONSI on the proposed 2010-2011 Water Transfer Program appears to describe a project that would fail all three of these tests as currently described. The 2010-2011 Water Transfer Program clearly has the potential to affect the human and natural environments, both within the Sacramento Valley as well as in the areas of conveyance and delivery. It is entirely likely that injuries to other legal users of water, including those entirely dependent on groundwater in the Sacramento Valley, will occur if this project is approved. Groundwater, fishery and wildlife resources are likely also to suffer harm as instream users of water in the Sacramento Valley. And the economic effects of the proposed DWB are at best poorly understood through the EA/FONSI. To its credit, at least the Bureau studied the proposed project, while DWR has completely avoided CEQA, thereby enabling the agency to ignore these potential impacts.

Taken together, the Bureau and DWR treat these serious issues carelessly in the EA/FONSI, and in DWR’s specious avoidance of CEQA review. In so doing, they deprive decision makers and the public of their ability to evaluate the potential environmental effects of this Project, and violate the full-disclosure purposes and methods of both the National Environmental Policy Act and the California Environmental Quality Act.

⁵ See especially, Pacific Institute, *More with Less: Agricultural Water Conservation and Efficiency in California, A Special Focus on the Delta*, September 2008; Los Angeles Economic Development Corporation, *Where Will We Get the Water? Assessing Southern California’s Future Water Strategies*, August 2008, and Lisa Kresge and Katy Mamen, *California Water Stewards: Innovative On-farm Water Management Practices*, California Institute for Rural Studies, January 2009.

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None of the signatory organizations to this letter received notice from the Bureau that this EA/FONSI had been released on January 5, 2010. With the Coalition's 2009 DWB comments on the EA/FONSI, we had the following request: *Our organizations request advance notification of any meetings that address this proposed Project or any other BOR projects in Butte, Colusa, Glenn, or Tehama counties that require consideration of NEPA/CEQA as well as water rights applications that will be needed as the 2010-2011 Water Transfer Program moves forward. Please add C-WIN, CSPA, BEC, and the Center for Biological Diversity to your basic public notice list on this Project, and send us each any additional documents that pertain to this particular Project.* While we do find record of a news release about the EA/FONSI on the Bureau's Mid-Pacific Region web site, we believe the Bureau has not met its obligations under NEPA for providing adequate public outreach to solicit review and comment of its environmental review documents in this matter. We learned of the Water Transfer Program on January 14th more than halfway through the review period set by the Bureau. Bureau staff rejected our request for additional time to review the documents, much to our disappointment. Please add our names and email addresses to all future environmental review news releases.

Sincerely,



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