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BEFORE THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

HEARING IN THE MATTER OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION REQUEST FOR A CHANGE IN POINT OF DIVERSION FOR CALIFORNIA WATERFIX	**WRITTEN TESTIMONY OF FRASER SHILLING – ADAPTIVE MANAGEMENT (REVISED)** **(Part 2 Rebuttal)**

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I. INTRODUCTION

I am a research scientist at the University of California, Department of Environmental Science and Policy, though I am not representing the University or its views with this testimony. I received my Bachelors of Science in Biological Sciences from the University of Southern California (1986) and my Ph.D. in aquatic ecology, also from the University of Southern California (1991). During and since receiving my Ph.D., I have maintained an active research program across several disciplinary areas. For the last 20 years, I have concentrated on the ecological and human consequences of infrastructure development and land-use, primarily in California. During that time, I have been the principal investigator for close to 40 research projects with this focus, totaling over $5 million.

I have spent approximately half of my research effort on questions related to water quality and supply, including environmental justice, tribal rights, ways to measure sustainability, and web-informatics[1] for data sharing. The goal of these projects is typically to collect, interpret, and use environmental and human-related information to inform infrastructural and environmental management decision-making. In several cases, my research and analytical work was gathered and set forth in a single work product or compilation. For example, between 2003 and 2010, I supervised the development of the 2-volume California Watershed Assessment Manual for the Natural Resources Agency. Subsequent to that (2011–2013), I developed a Water Sustainability Indicators Framework for the California Water Plan, 2013 Update (DWR). I am currently completing a multi-metric California Water Indicators Portal for the US-EPA, which uses web-informatics to automatically evaluate and share information about water conditions throughout California. In these three examples and for other research projects, the concept and approach of adaptive management has informed or been a target for the research. Like many environmental scientists, my hypothesis-based research and data collection represents the monitoring and evaluation part of the adaptive management loop. My research hypotheses and questions are based around

[1] Web informatics is the display of data and information through a web system.

past or proposed management actions. The resulting evaluations are designed to inform future management in water, transportation, and shoreline adaptation to sea level rise. My Statement of Qualifications is included in LAND-136 and my power-point presentation for this testimony is in LAND-241.

OVERVIEW OF TESTIMONY

My Part 2 Rebuttal Testimony responds to the statements and positions set forth by Part 2 witnesses Christopher Earle (DWR-1014, pp. 4-8), Gwen Buchholz (DWR-1010, pp. 8-10, 12), and Marin Greenwood (DWR-1012, pp. 20-21, 24-25). (See also Hearing Transcripts, February 22, 2018, pp. 60-62, 146-147; March 5, 2018, pp. 110-114, 116-118, 120-128, 132-138, 142-145; March 9, 2018, pp. 96-100, 113-119 [cross examination regarding adaptive management].) Specifically, my testimony addresses the adequacy of the Adaptive Management Program for the California Water Fix and Current Biological Opinions on the Coordinated Operations of the Central Valley and State Water Projects ("AM plan") developed for Alternative 4A and presented SWRCB-107, Attachment 5, and in various forms in other Exhibits (see, e.g., SWRCB-102, SWRCB-104, Appendix 3.H, SWRCB-108, SWRCB-109, SWRCB-110, SWRCB-111, SWRCB-112) and during testimony from DWR's witnesses (DWR-1010, DWR-1012, DWR-1014). My testimony addresses the AM plan included with the Project, by comparing its basis and approaches to the theory and practice described in the technical and scientific literature. I frame the testimony around critical tests of adequacy of the AM plan.

My testimony centers on the narrow interpretation and use of adaptive management by Petitioners. The objectives of the AM plan proposed by the Petitioners are introduced as preliminary (SWRCB-107, Att. 5, Appendix 1), with final objectives "developed using collaborative processes and limited to those actions necessary to achieve applicable regulatory standards." (SWRCB-107, Att. 5, pp. 6-7.) They include targets for habitat restoration and species-specific survival and mortality limits, but it is not clear what happens if objectives are not met, beyond proposing modification of management. Overall, I address the Petitioners' inappropriate conflation of required mitigations for impacts to listed species with the idea or practice of adaptive management. This conflation makes it clear that either the

Petitioners do not understand the concept of adaptive management fully or do not intend to pursue this approach in a serious way, post-construction.

The following serious flaws in Petitioners' AM plan would make the AM plan unlikely to achieve its objectives, even when applied to just the operational phase of the project for which it was developed: (1) the Framework deals only with operations, not the extended 15-year construction phase; (2) the AM plan addresses only changes in operations within permitted ranges of water diversion; (3) there are no firm triggers resulting in changes in operations; only "long term outcomes" could conceivably trigger a change in management; (4) the focus of the Framework is limited to three listed aquatic species (smelt, salmon, and steelhead); (5) individual agencies may act alone in response to findings from monitoring and research if they do not agree with the other agencies; (6) major decision-making is through the Interagency Implementation Coordination Group ("IICG"), which is dominated by water agencies and includes no role for other affected stakeholders; (7) research and monitoring funding is decided by water agencies with a vested interest in the outcome of scientific results; and (8) there is no firm commitment to funding adequate to monitor, evaluate, and experiment with ecosystem and management conditions.

II. UNDERLYING ASSUMPTIONS IN THE AM-RELATED TESTIMONY CONSIDERED IN LIGHT OF CURRENT AM THEORY AND PRACTICE

In section (A), I describe the current theory and evaluation of AM as a practice. I survey the literature and describe primary concepts and critiques that describe how AM has been implemented and how to can be improved. In section (B), I also summarize the proposed AM framework from the Petitioners. This introductory material is used to inform the remaining evaluation of the potential issues with the AM framework as described, which is in section (C).

A. Theory & Best Management Practices for Successful AM

1. Structured and Comprehensive

The literature suggests that an AM program must be structured and comprehensive and federal wildlife agencies have stated, 'adaptive management should not be used in place of developing good up-front conservation measures or to postpone difficult issues' (FWS and

NOAA 2000). (LAND-243, Murphy and Weiland, p. 3.) AM is intended to be a "smart" management system where a range of management options are considered, conceptual models explored, experimental management actions tested and evaluated, monitoring of systems takes place before and after actions, management actions are evaluated, and new management actions are proposed as needed.

The U.S. Department of the Interior has developed AM guidance for its member entities. "An adaptive approach involves exploring alternate ways to meet management objectives, predicting the outcomes of alternatives based on the current state of knowledge, implementing one or more of these alternatives, monitoring to learn about the impacts of management actions, and then using the results to update knowledge and adjust management actions." (LAND-244, DOI, 2009.)

When management actions are initially constrained or their effectiveness unknown and subsequent management actions restricted, then true AM is not possible.

> Federal and state resource managers, who tacitly accept the notion that an initial management action will not produce the exact desired conservation outcome, presume that adapting or adjusting the same action might well provide the palliative. Not explicitly recognized with that attractive notion, however, is that a management action that is misinformed or misdirected is unlikely fit into an adaptive framework. Incremental adjustments to an ineffective management action will inevitably yield a management program that does not meet performance goals—a circumstance that can come with high societal costs and dubious ecological benefits. For example, if the limiting factor on the population growth of a salmon species is, say, the amount of available spawning habitat, then investment in and repeated adjustments to a predation-control management action well could yield no discernible benefits for the species.

(LAND-243, Murphy and Weiland, 2014, p. 2)

In its Part 2 Case in Chief, DWR's witnesses heavily cited AM as a solution for various ecological problems posed by the project, while failing to provide evidence of this particular plan's comprehensive coverage of the various well-known issues in the Delta. (See, e.g., DWR-1014, p. 8:19-27, DWR-1010, pp. 10:21-26 and 12:13-17, DWR-1012, pp. 21:1-3, 24:5-12, 25:19 to 26:2, 38:20-23, 40:5-10, and 47:1-11.)

The widespread failure to effectively implement AM has resulted in recognition in the scientific and legal communities that promises within AM plans where the critical details are vague or voluntary, do not lead to science-based and defensible implementation. (LAND-246, Gardner, 2013; LAND-243, Murphy and Weiland, 2014.) This failure to perform is typically ignored by agencies making subsequent decisions about developing and adopting AM plans, as if the history of failures in AM has no possible connection to future proposals to adaptively manage. As a result of the failure of AM plans, there is healthy skepticism about the functionality of AM in practice, especially in relation to protection of endangered species. (LAND-245, Biber, 2013.) State and federal agencies' failure or unwillingness to abide by their own AM standards and those of the scientific literature has led to widespread failure of AM in actual practice. As stated by DWR's own expert, AM actions are susceptible to failure for myriad reasons, such as poor designs, inadequate funding to realize the necessary work and unclear implementation processes. (Hearing Transcript, March 5, 2018, p. 117 [Earle discussing the various reasons adaptive management plans fail].)

2. Allows Modification of Management

Biber (2013) argues that management that is called "adaptive management" comes in different flavors—"active" management that follows scientific definitions and conducts experiments in management and outcome in order to inform better management; "passive adaptive management" where one model of management is developed based on historical conditions and subsequent monitoring is used to tweak the management approach; and "trial and error" where management actions are haphazardly carried out (possibly with other imperatives) and outcomes monitored. How seriously the principles and practices of AM are applied is critical to an assessment of potential effectiveness. (LAND-245.)

The most common type of agency-proposed AM plan is passive AM, presumably because it does not involve more complicated experimental manipulation of the natural and management systems. (LAND-254, Doremus, 2011.) Unfortunately, just because AM begins as one type does not mean it would not devolve into a less complex and effective form, such as trial and error. "Passive adaptive management relies on monitoring to facilitate learning that

then guides the adjustment of management actions. . . . Passive adaptive management is useful when there is high confidence in the anticipated ecosystem response, thus enabling managers to focus on refining management parameters or when regulatory or institutional constraints are strong. A potential problem with the use of passive adaptive management is that it often degenerates into mere 'trial-and-error' learning or ad hoc contingency planning, both of which fail to incorporate a structured procedure for learning." (LAND-246, Gardner, 2013, p. 236.)

Because of the size of the Delta, it is subject to the "Problems of Scale," which means that there can be no replication of processes or impacts, necessary for "active adaptive management." (LAND-245, Biber, p. 940.) This leaves passive AM as the most likely type to be adopted by agencies, which "might be feasible at large scales because it does not require replication. However, note that, as a result [of adopting passive AM], we may reduce the ability to learn from our management and regulatory choices—precisely the point of adaptive management in the first place." (LAND-245, Biber, pp. 940-941~~94~~.) In addition, it is not obvious that even passive adaptive management is proposed for the Delta with the proposed AM plan.

3. Not Subject to Bias and Political Pressure

There is often significant inertia in large political structures, or in contentious debates over natural systems. People with power over decision-making over water (for example) tend to want to maintain that power. (LAND-256, Sze et al., 2009.) "Structuring a learning-based adaptive organization can be handicapped by a pervasive belief that adaptive management does not constitute a significant departure from the past, and involves little more than occasionally changing management actions. . . . One consequence is that little attention is given to the institutional barriers to its implementation, and little effort is expended on redesigning organizational structures and processes to accommodate an adaptive style of management." (LAND-253, Williams et al., 2011, p. 1352.) AM frameworks and plans are often proposed without consideration for the political context that may determine success or failure of the plan.

There is significant overlap between the perception and reality of the political nature of AM implementation and other issues associated with successful AM implementation. For example, “Agencies . . . value flexibility and discretion in the development and implementation of adaptive management plans which enable them to continue to act when financial and human resources may not be adequate, and to better respond to changing political and social situations.” (LAND-246, Gardner 2013, p. 239.) The consequence is the common phenomenon of inadequately assessing impacts of management, maintaining management flexibility, and seeming to respond to social and political pressures that align with the agency’s mission. Although we may view this as typical and even acceptable, it is an approach that runs counter to the well-developed theories and recommendations for how objective, science-based AM should be implemented.

Because of the apparently inherent problem of politically controlled or biased agencies being responsible for theoretically objective, science-based AM, some have proposed that new governance structures are needed in the special case of AM. For example, “adaptive governance” is “an emergent framework for the management of complex environmental issues.” (LAND-258, p. 325.) The phrase was used “to describe the social and human context for the application of adaptive management” and some have described “this form of governance as necessary for the management of complex ecosystems, particularly when change is ‘abrupt, disorganizing, or turbulent.’ . . . Adaptive governance deals with the complex human interactions that have been obstacles to the implementation of adaptive management.” (LAND-258, Gunderson 2006, p. 325 [citations omitted].) There are several examples of this approach, which may not suit all applications of AM, but it is worth considering when dealing with complex systems.

One example of adaptive governance is in the Grand Canyon, where AM experiments and practices have been implemented over the last 20 years to deal with combined flow and sediment transport issues in a river that serves both energy and water demands. The Grand Canyon AM process is guided by a diverse set of leaders with overlapping leadership roles in “a stakeholder-based ‘Adaptive Management Work Group’ which uses planned management

actions and subsequent monitoring data to test hypotheses and build understanding of ecosystem dynamics. . . . The leaders in the Grand Canyon understand the uncertainties and complexities of the system, and believe that resolution of environmental issues can only be discovered, not achieved by predetermined policy . . . [T]hey have created 'space' for experimentation and learning [citation]. This has generated a great deal of trust among stakeholders and a more open and flexible institutional setting for dealing with multiple objectives, uncertainty, and the possibility of surprising outcomes." (LAND-258, Gunderson 2006, pp. 327-328.)

4. Monitoring and Research/Experimentation Is Continuously Funded, for the Length of the Project

A requirement of AM is effective, high-quality, and continuous monitoring. "Agencies with multiple objectives might be wary of pursuing monitoring when the resulting data might result in conflicts with other objectives. Even when a direct conflict does not exist, actual monitoring data might constrain an agency's freedom of maneuver and autonomy in the future in unpredictable ways. Finally, agency institutional culture might not be amenable to pursuing monitoring. For instance, scientists in agencies might have few professional incentives to conduct long-term monitoring projects." (LAND-245, Biber, p. 943.) Because there is usually no requirement for the amount, quality, or comprehensiveness of monitoring, there is thus no requirement for effective AM. The system essentially becomes voluntary.

The history of AM suggests that AM programs will not be science-based and will tend to be under-resourced: "While effectiveness monitoring might seem to be the foundational characteristic of an adaptive-management program, Walters (2007) [LAND-247] observed that from among more than 100 case study attempts to implement adaptive management, most failed to meet the criterion of an experimental management program, whereas others suffered from serious shortcomings in the design and implementation of their monitoring programs. Most recently, Westgate et al. (2013) reviewed 61 publications describing programmatic adaptive-management efforts, but just 13 were supported by published monitoring data accrued through the project." (LAND-243, Murphy and Weiland, p. 6.) In my experience,

managers and agencies tend to rationalize their situations by explaining that times are "different" now and that they will do AM effectiveness monitoring correctly this time. However, agencies monitoring impacts of their management and modifying future management actions tend to minimize the scale and scope of monitoring. (LAND-255, Nie and Schultz, 2012.) This will in turn tend to increase or maintain high uncertainty about conditions in the managed system and about the effects of management actions.

Finally, the literature is replete with descriptions of how monitoring associated with AM should be comprehensive, linked directly to changes in management, well-funded, independent from entities with vested interests in outcomes, and useful in testing hypotheses about the impact of management actions on vulnerable/affected systems. (See, e.g., LAND-253, Williams et al., 2011.) If monitoring is not comprehensive and done well, then the learning and adaptive part of adaptive management also fails. In other words, AM cannot exist without the monitoring, evaluation, and learning phase.

5. Firm Triggers and Guarantees

Biber (2013) argues that carrying out AM could be possible if agencies were constrained within inflexible limits that ensure performance. (LAND-245.) These requirements could come in the form of required levels of monitoring, required "triggers" where management actions must cease or take place if the target system changes beyond a certain point. Even with these limits and constraints, Biber argues that sophisticated AM proponents can game the system by highlighting the inherent uncertainty in ecosystem response as a reason to maintain management that benefits them. (LAND-245.)

Part of the balance that adaptive management is designed to reach is between "management", which usually involves extraction of a resource from or harm to a vulnerable system, and protection of species or habitats at risk of harm. Including triggers in adaptive management is key not only to the reduction of risk to vulnerable species and systems, but also the perception of risk and management among stakeholders: "courts, environmental groups and legislators often seek the inclusion of specific criteria or 'triggers' in adaptive

management plans that will provide certainty and satisfy the substantive legal standards of relevant environmental laws." (LAND-246, Gardner, p. 239.)

Key to the choice of range of triggers and guarantees is recognizing that there should be a corresponding range of alternative management actions that suits the possible range of system responses to management. "The management alternatives in an adaptive management project constitute a key element in its operating environment, in that the strategy choices in an adaptive management project are constrained by the set of available options. If these options fail to span a reasonable range of management activities or fail to produce recognizable and distinct patterns in system responses, adaptive management will be unable to produce effective and informative strategies." (LAND-253, Williams et al., 2011, p. 1348~~9~~.)

6. Uncertainty Not a Shroud for Indecision

Our understanding of large complex systems, like the natural, social and economic systems that are connected to Delta water exports, is rife with uncertainties, from understanding the state and changes in valued or legally-protected features, to having a clear picture of how management could affect these features. (LAND-254, Doremus, 2012.) One of the lures of AM is that it provides flexibility and potentially intelligent ways to manage complex systems. At the same time, the flexibility in allowing decisions under the guise of AM and the uncertainty that is often revealed by monitoring, especially when under-resourced, allows abuse by those with a desired outcome from management actions. "Powerful political actors that are opposed to major management changes can rely on this nearly inevitable, residual uncertainty to argue that the results of an adaptive management program do not, in fact, require changes in management." (LAND-245, p. 951.) Biber cites the example of Glen Canyon Dam, where experimental changes in operation led to scientific conclusions about how management should be changed. These changes were not instituted for 15 years "because of the decision-making structure for the Dam: power and water interests who would be hurt most by Dam reoperation have an effective veto over changes to Dam operation." (LAND-245, p. 952.)

Reducing uncertainty in our knowledge of natural systems requires experimentation and adequate monitoring (LAND-254, Doremus, 2012) and the most information comes from the most extreme experiments. However, these are also the most risky experiments and least likely to be supported by regulatory agencies, such as the State Water Board and U.S. Fish and Wildlife Service, or the public, especially when listed species are affected by the experimentation, or even by entities benefiting from resource extraction when the extraction is experimentally curtailed. This catch-22 means that active AM for listed species is virtually impossible, and even passive AM or trial and error is often constrained. I believe that, because of this limitation, it is not possible to effectively carry out AM as defined in the scientific literature where listed species are at risk or could be adversely affected in an area the size of the Delta.

One of the most difficult and uncertain areas to investigate and use in decision-making is the cumulative and synergistic effects of different stressors on valued systems. Most large natural systems have multiple pressures from "management actions," a code phrase for extraction and use. Disentangling the effects of a single management action, such as water diversion from the effects of other actions and natural drivers and variability is very difficult. (LAND-254, Doremus, 2012.) This provides one of the most certain shrouds for indecision by management entities faced with declines in valued attributes (e.g., fish populations) and uncertainty about the cause of the decline.

7. Include Stakeholders in Defining Management Outcomes

Pursuing AM while stakeholders disagree fundamentally on the underlying goals of the managed and management system may lead to the whole plan's failure. "[I]t is no surprise that a failure to resolve underlying controversy has been identified as a reason why adaptive management has failed. Stakeholders that are still in conflict over underlying goals for a regulatory or management program may continually point to residual uncertainty to support their differing positions and resist unfavorable regulatory or management action, even in the face of apparently successful experiments and monitoring programs." (LAND-245, Biber, p. 955.) This observation suggests that AM that includes competing interests and stakeholders in

the development, implementation, and interpretation of the scientific and procedural aspects is more likely to be successful. For example, writer and activist Marjory Stoneman Douglas brought attention to the declining ecological conditions Everglades in the late 1940s (e.g., 'Everglades, River of Grass' Douglas, 1947), which led to scientists and agencies studying the causes of eutrophication, flooding, and ecosystem decline and eventually to very large scale AM processes. Williams et al., 2011(LAND-253, p. 1348) states: "Of particular importance is the participation of stakeholders in assessing the resource problem and reaching agreement about its scope, objectives, and potential management actions (recognizing that differences of opinion about system responses may exist even with consensus on these issues)." At the same time, it is not enough to attempt to appease excluded stakeholders late in a well-established management process.

Besides placing monitoring, research, and management adjustment pressures on government agencies, stakeholders must also bear the burden of oversight and participation in AM processes that affect them directly. "In addition to using government resources, adaptive management may impose greater demands on stakeholders, who must monitor decisions and the decision making process not just at one point in time but continually. Because it implies that decisions are always tentative, it may also increase or extend controversy and conflict, despite claims to the contrary." (LAND-254, Doremus, 2012.) In situations where there is a large group of stakeholders who were not involved in original decisions, or who disagree with them, imposing AM may not actually resolve any differences and contention. Instead, the stress of continued involvement in a management process that is complex, filled with uncertainty and agency indecision, and not of stakeholders' making is likely to increase conflict rather than resolve or reduce it. This is particularly true for powerful interests that stakeholders may expect to be open and receptive to change: "There is a natural tension between the tendency of large, longstanding organizations to maintain a strong institutional framework for thinking and decision making, and the need in adaptive management for an open, flexible approach that recognizes alternative perspectives, embraces uncertainty, and utilizes participative decision making [citation]." (LAND-253, Williams et al., 2011, p. 1352.) Indeed the

"failure to engage stakeholders in the development of plans" (LAND-246, Gardner, 2013, p. 24137) has been recognized as a significant challenge to the success of AM.

B. How AM Was Developed for the Project

The construction of new state and federal water project intakes in the northern Delta has been contemplated for decades. As currently proposed, the Delta Tunnels are a water engineering project with desired water supply goals and ecological end-points. While the formerly proposed Bay Delta Conservation Plan ("BDCP")—abandoned in 2015—was alleged to have ecosystem benefits, no version of the Delta Tunnels plan has attempted to provide benefits to communities within the Delta. Rather, effects have been characterized as minimal, not "mitigatable" and overridden, and/or within the range of variability. (See SWRCB-110 [CEQA Findings].) However, the project was not conceived of, or designed as being beneficial to community needs and is instead intended to facilitate export of water, including "[r]estoring and protecting the ability of the SWP and CVP to deliver up to full contract amounts of CVP Project water." (See SWRCB-102, pp. 2-2 to 2-4 [project objectives].)

AM could have been applied at any or all of three phases of development and implementation of the Delta Tunnels: the decision to construct the intakes and tunnels, the estimated 15-year construction phase, and operation of the facilities once constructed. The decision to undertake the project was made outside of AM principles, and there is no evidence that any form of AM was used to address the over-arching questions of whether this major infrastructure change was justifiable, or whether constructing massive tunnels beneath the Delta was the best approach to ensure water reliability or even water conservation. This failure to consider AM principles at the outset affects all of the downstream decisions, including trying to use AM to compensate for the original decision: "Adaptive management cannot help when there is no way to correct an initial mistake, as for example when the decision in question is to allow irreversible alteration of the environment." (LAND-253, Doremus, 2012.)

Construction is not a short-term prospect and may take 15 years. During this time, many decisions would be made that potentially impact wildlife, fish, and communities. However, no AM has been proposed for the construction phase. The proposed monitoring of construction

impacts and potential mitigations (SWRCB-110) would not be considered AM under even the most liberal definition. For example, if noise impacts are measured in nearby communities, one eventual mitigation action would be to offer relocation to residents. (SRWCB-102, p. 23-30.) Once constructed, however, the project would be a fait accompli and not subject to AM.

Making decisions about possible ways to improve water supply reliability, protect freshwater diversion from sea level rise, and protect Delta ecosystems was a perfect area for AM, where the tunnels would have been one of a series of experimental actions. Similarly, experimenting with construction alternatives (e.g., intake location, pile-driving, habitat disturbance), monitoring effects, and potentially changing management decisions would have been an appropriate use of AM. Inclusion of these two stages in the development of Petitioners' project would have made this a serious AM approach and in line with similarly large (geography, communities, range of issues) AM processes in the Everglades and Grand Canyon. Absent the inclusion of decisions about project type and manner of construction, the plan is not an effective AM plan for this scale of problems and geography.

Since the Petitioners have revised the project to seeking a permit for a certain type of facility in a fixed location, facility operation is the remaining type of decision where AM could be applied. In order for this to be true, the full-range of operational uses must be available as part of the plan, not just operation to meet a minimum rate of extraction and corresponding mitigation. This would necessarily include not operating the intakes at all as a possible action. The next section includes evaluation of eight critical weaknesses in the AMP that, in my opinion, would impact its effectiveness relative to accepted standards for AM and meetings its own limited objectives.

C. Critical Limitations and Flaws in the Delta Tunnels AM Plan That Affect Its Potential for Success

There are two main ways to approach the potential for successful application of AM by Petitioners while implementing the adopted project: (1) Conduct AM in a way that learns from previous experiences by others with AM in large, complex systems, including learning from previous attempts to manage diversions while also protecting wildlife, fish, and community

interests in the Delta; and (2) For even the limited proposed scope of the AM plan, ensure that there are safeguards and triggers in the AM plan that ensure it is meeting obligations for including stakeholders in open governance, funding monitoring and research, management experimentation, and ceasing diversions if harm is or could be irreparable.

The proposed AM plan is modeled on the 2006 Comprehensive Everglades Restoration Plan, and consists of four phases: Plan, Assess, Integrate and Adapt. (SWRCB-107, Attachment 5, p. 13.) Five agencies, the Bureau of Reclamation, Department of Water Resources, U.S. Fish & Wildlife Service, National Marine Fisheries Service, and California Department of Fish & Wildlife, would implement the plan with the intent of maintaining the requirements of the Biological Opinions of the Central Valley Project, the State Water Project and the Delta Tunnels. (SWRCB-107, Attachment 5, p. 3.) While the plan purports to maintain these programs' consistency with the state and federal endangered species laws, along with the coequal goals of Delta Reform Act (SWRCB-107, Att. 5, p. 6), the plan only focuses on Delta Smelt, Longfin Smelt, Salmon and Sturgeon populations (SWRCB-107, Att. 5, p. 27-28). Specific triggers or objectives for these species are tied to the original BDCP and are framed as preliminary measures. (SWRCB-107, Att. 5, Appendix 1, p. 48.) The plan's ultimate goal is to allow for the most increases in water exports within the boundaries required for fish protection. (SWRCB-107, Att. 5, p. 11.)

The proposed AM plan suffers from several critical weaknesses, including: (1) the AM plan narrowly deals only with operations, not construction, and only changes within a narrow range of water diversion; (2) only a narrow range of management options is considered; (3) there would be significant pressure to deliver water through the Delta Tunnels, which would constrain AM actions; (4) there is no committed funding for monitoring, or evaluation of monitoring and research; (5) there are no meaningful triggers for changes in management across short or long-term timeframes; (6) operational rules are not sensitive to stress in the system; (7) water agencies with vested interests control the process; and (8) there is no accommodation of or role for affected communities. These key problems with the AM plan are described in more detail below:

1) Narrow scope of AM Plan. The management action was not chosen after considering all important conservation and management information. (LAND-243, Murphy and Weiland, 2014.) Instead, the management action was chosen and environmental and management consequences subsequently analyzed. Therefore, the initial and most important decision—choice of what to build and how to construct it, was not included in the AM process.

The AM Plan is limited in scope to monitoring impacts of new water withdrawals in the North Delta on certain listed fish species and proposing modifications to the twin tunnels operations. The AM plan was inappropriately narrowed by failing to include a process to determine whether the construction of the tunnels was an effective and appropriate approach to water diversion and failing to consider the 15-year construction phase as something that should be adaptively managed. Construction of the tunnels, in and of itself, would foreclose potential AM recommendations and decisions that require non-operation of the tunnels, as the more than $47 billion in financing obligations would create overwhelming pressure to continue operation of the tunnels. This is in contrast to guidance in the literature, which describes the need for wide ranges of management alternatives and advises strongly against making irreversible decisions that can preclude effective AM. (LAND-245, Biber, 2013; LAND-254; Doremus 2012; LAND-243, Murphy and Weiland.)

The narrowed range of the AM plan focuses only on the potential impacts on a few listed species from additional water diversion facilities for interests to the south. The AM plan excludes a long list of other interests and uses that could experience negative effects from project operation or implementation of AM management actions, including (but not limited to): local water users within the Delta, agriculture and communities within and adjacent to the Delta, discharges to the Sacramento and San Joaquin Rivers and the Delta, water quality, fish contamination, species that are not listed fish, invasive species, sediment movement and contribution to the Suisun Bay, San Pablo Bay, and San Francisco Bay marshes, and management of water sources for the Delta (e.g., Trinity River, Shasta Dam, the various regulated rivers in the Sierra Nevada foothills).

By focusing the AM Plan only on operation and not construction, there is another long list of interests and uses that could experience negative effects from the 15-year project construction, including (but not limited to): livability of adjacent communities (e.g., due to construction noise), road closures, safe traffic volumes and speeds, movement of first responders, water quality changes from accidents, and health of listed and non-listed aquatic organisms near intakes. Although mitigation is included for many of these impacts, there is no attempt described to monitor effectiveness of the mitigations, investigate alternative approaches, evaluate outcomes, and propose new mitigations, which would be a form of AM.

2) Narrow range of management options. The AM plan was constructed primarily as a mitigation monitoring plan for a limited range of species that require protection and for which there are conditions (SWRCB-105, SWRCB-106, SWRCB-107), and mitigation measures (SWRCB-111). This is fundamentally different from adaptively managing water quality and supply to achieve the co-equal goals described in the 2009 Delta Reform Act and elsewhere. Importantly, in addition to the goal of a more reliable water supply, the co-equal goals require the protection, restoration, and enhancement of the Delta ecosystem. (Wat. Code, § 85054.) The co-equal goals must be achieved in a manner that "protects and enhances the unique cultural, recreational, natural resource and agricultural values of the Delta …." (*Ibid*.) Petitioners recognize that application of ecological, social, and economic science to support achievement of the co-equal goals is critical to the success of the AM plan. (SWRCB-107, Attachment 5, p. 6.) Nevertheless, Petitioners' proposal is a very narrow interpretation of AM that is further narrowed by the small range of management options anticipated to be considered.

In many ways the AM plan ignores the wide range of management actions that should be available across timeframes, from short-term responsiveness to long-term changes in direction, and across ranges of actions, from experimentation to indefinite cessation of water deliveries. "This may be the consequence of a focus on the adaptive component of adaptive management, which places emphasis on the tail end of the cycle where learning and adaptation are expected to occur following evaluation of monitoring data. The Department of

the Interior notes, in its technical guidance on the subject, that many practitioners have the misconception that 'monitoring activities and occasionally changing them' constitutes adaptive management [citation]." (LAND-243, Murphy and Weiland, p. 3.)

The key basis for the Delta Tunnels AM plan is that investigation of the consequences of operations for listed species will be evaluated and operations changed within the boundaries of pre-conceived operational boundaries. "The decision regarding whether to adopt or reject a management adjustment proposal lies with the Five Agencies and occurs during **Phase 4: Adapt**. Dependent on whether the proposed modification is considered within the adaptive limits of operations, changes to the Operations and Science plans may require re-initiation of consultation or permit amendment." (SWRCB-107, Att. 5, p. 21.) Similarly, Greenwood's testimony (and Buchholz's) [DWR-1010, 1012] focuses almost exclusively on flow criteria and how meeting them under Alt 4A/H3+ would reasonably protect various listed species using the Delta for breeding or migration. The standard of performance cited is the minimal threshold in the ITP. In other words, project operation need only maintain the species at their current endangered level to be considered successful:

> The CWF ITP (Exhibit SWRCB-107, p. 172) requires that through-Delta survival must be equal to or greater than baseline, ensuring that the CWF H3+ must be operated to provide reasonable protection for juvenile listed salmonids…. it is anticipated that restoration of over 1,800 acres of tidal habitat (as required for Delta Smelt, described previously in my testimony), in addition to existing tidal habitat restoration commitments, will sufficiently address potential undesirable hydrodynamic effects of NDD operations.

(DWR-1012, p. 42 [Greenwood testimony].)

This approach speaks to the underlying principle of the operational plan as being related to reducing the negative impacts of project operations on listed aquatic species. However, as discussed later in my testimony, there are no definitive standards or triggers that could be used to address these impacts if they were detected through monitoring, or attributable directly to operations. This omission is reinforced in the success criteria for the AM approach:

> intent of this Adaptive Management Framework is to: …3. Identify the key uncertainties about how Central Valley water operations and other management actions to benefit the species can be implemented to avoid jeopardy and meet other regulatory standards applicable to state and federally-listed fishes, including future effects associated with the CWF.

(SWRCB-107, Att. 5, p. 6.) Indeed, the AM plan identifies pages of uncertainties. (SWRCB-107, Att. 5, pp. 51-59.) Despite all of these uncertainties, the proponents plunge forward with a "firm commitment" to meet the co-equal goals:

> it is the decision of the Five Agencies that the only practicable way forward is with a firm commitment and explicit plans to meet the co-equal Delta goals and to take management actions such that are not likely to jeopardize the continued existence of any endangered species or threatened species (or result in the destruction or adverse modification of critical habitat as provided under ESA section 7(a)(2)) and to ensure CESA authorization compliance as new scientific and operational information becomes available.

(SWRCB-107, Att. 5, p. 10.)

Despite Petitioners' "commitment" to meet the co-equal goals, which includes protection and enhancement of Delta resources, Petitioners' AM plan completely excludes consideration of any effects on Delta communities. Furthermore, within the narrow boundaries applicable to the fish species that are the focus of the AM plan, Petitioners fail to lay out triggers, or a process for arriving at triggers for the exceedingly low success criteria ("avoid jeopardy"). (See SWRCB-107, Attachment 1 [Appendix 1—Initial Objectives Derived From BDCP, Current Biops/CESA and CWF].) Given these deficits, it seems unlikely that the Petitioners would include enforceable triggers and corresponding ranges of management actions as part of implementation.

3) Committed water deliveries constrain AM. Deliveries of certain amounts of water are strongly associated with construction of the facility, further constraining operational flexibility, the only management option available. The AM plan does not anticipate nonoperation of the proposed new intakes in the event of threats to listed species, fish and wildlife habitats, and/or human communities both upstream (in source areas) and downstream of the project.

The Delta Tunnels project is funded by interests that expect a certain rate of water delivery as a return on their investment. (See, e.g., CDWA-315 [MWD PPT].) The history of Delta water exports indicates that this expectation would almost certainly be met by state and federal agencies who have agreed to the deliveries and are acting as brokers on behalf of the water interests. For example, LAND-260 shows that Delta exports have continued, with variation due to droughts, despite the dramatic declines in Delta smelt populations (See, e.g., SWRCB-102, p. 11A-3 to 11A-7). Pressures to increase deliveries would, as a practical matter, constrain the range of operational adjustments that can be made as the two primary operational flexibilities are timing and rate of diversion. This is in contrast to the literature evaluating AM success, which emphasizes the need to retain all practical management options. If monitoring and research finds that the operation of the project results in harm that cannot be mitigated to listed species and other fish/wildlife, ecosystem, and human processes and features of the impacted region, it is unlikely that the new water diversion intakes would be turned off. If there is no promised rate of delivery, then any permit should explicitly contain the option of turning off the intakes if unreasonable impacts to fish and wildlife or other impacts occur.

In my opinion, there is no reason to suspect that the interests that have pushed for the project, that are financing the project, and that expect to benefit from the project won't do everything in their power to maintain the water deliveries necessary to make the project work financially. It seems highly unlikely that the agencies in charge of funding monitoring and research, who must interpret findings and the urgency of changes, and the possible range of alternatives would act contrary to these interests. Even with the 2008/2009 Biological Opinions and continued decline in the Delta smelt and salmon populations, south Delta exports have continued, with only slight declines in dry years. (LAND-260.)

4) No committed and adequate resources for monitoring. Definite and adequate resources have not been committed to developing the continuing science-based understanding of the ecological processes and how they are impacted by the proposed management actions. (Hearing Transcript, March 5, 2018, pp. 119-120, March 8, 2018, pp. 66-67; cf. CALFED

(DWR-107) and Bay-Delta rates of funding.) The ITP does require the permittee to fund the AM plan (SWRCB-107, p. 175); the NMFS Biological Opinion also requires the Bureau of Reclamation and DWR to prepare and submit to DFW within one year of permit issuance an initial Adaptive Management Program funding strategy for review and approval; a funding strategy for review and concurrence and include within the strategy, responsible parties and levels of program funding is also required by the NMFS Biological Opinion (SWRCB-106, pp. 1192-1193). But submission of a "funding strategy" is not to a legally binding commitment to fund specific projects. Moreover, there are sure to be disputes about how much funding is needed and how to spread those costs among the various parties. Already we have heard cross examination on the issue of whether non-participating CVP contractors would need to pay for the AM plan and other monitoring. (Hearing Transcript, March 5, 2018, pp. 83-86.) The necessity for adequate and stable, non-politicized funding is a critical issue identified in the AM literature—including adequate funding for monitoring, experimental research, and evaluation of findings. (See, e.g., LAND-253, Williams et al., 2011.)

The draft AM plan for the Delta Tunnels includes very specific language describing the types of studies and information required to understand the needs of different life-stages of listed fish species. (SWRCB-107, Att. 5, pp. 27-35.) However, there is no link between the studies and operational or management responses. Similarly, the language describing the studies is replete with "should" but there is no certainty that all of the listed studies would be funded by the permit proponent or the various beneficiaries. All that is specified now is that: "Current and future funding requirements and schedules will be determined by the IICG." (SWRCB-107, Att. 5, p. 36.)

DWR's own witness concedes that AM plans often do not acquire "sufficient funding to do the necessary work." (Hearing Transcript, March 5, 2018, p. 117.) The high level of uncertainty surrounding funding for AM is a significant risk to the success of the Delta Tunnels AM program.

5) There are no meaningful triggers for abrupt, medium-term, or long-term changes in management. Objectives in the plan are described as "triggers" for management action (SWRCB-107, Att. 5, App. 1), however, there are no described/promised/hard-wired connections between the so-called triggers and management action. This lack of connection severs the traditional AM loop and leaves association of impacts/triggers and management action as a discretionary activity on the part of the water agencies. By leaving these decisions to the AM plan, rather than including specific permit terms, direct regulation by the permitting agencies and accessibility of information to the public are avoided.

The generally described triggers and responses in the AM plan are intended for long timeframe outcomes and the plan defines its objectives as "Triggers for Adaptive Management action", but these are limited to species-specific responses and no concomitant management actions (SWRCB-107, Att. 5, App. 1), leaving them potentially as "triggers of nothing". The draft AM plan for the Delta Tunnels acknowledges that:

> [O]bjective triggers are an essential component of this Adaptive Management Framework to signal when an alternative management action may be warranted. Triggers are defined, pre-set and measurable conditions that prompt evaluation of information collected to that point in the context of current conditions and considering whether potential alternative approaches are warranted. For the purposes of this Adaptive Management Framework, triggers will be focused on longer term outcomes. The current BiOps specify (and the CWF biological opinion is expected to) specify, the amount or extent of incidental take that will trigger re-initiation of consultation as described within their respective incidental take statements.

(SWRCB-107, Att. 5, p. 16.) What this means is that by the time negative outcomes are known or result in a trigger, it may be too late to change a situation that is in the process of degrading.

An example of a potentially meaningless objective/trigger contained in the AM plan is declines in Delta smelt, specifically "Limit entrainment mortality associated with operations of water facilities in the south Delta to ≤5% of the total Delta Smelt population . . ." (SWRCB-107, Att. 5, App. 1, p. 49.) A critical problem is that contemporary surveys for Delta smelt find very few adult or juvenile individuals (See SWRCB-102, p. 11A-3 to 11A-7) meaning that it would be very difficult to attribute a percent mortality to the intakes due to the difficulty of quantifying

the population. In addition, if the Delta smelt remain rare, then this trigger could be functionally abandoned from AM. This does not mean that impacts are not occurring, just that measuring them and applying the trigger may not be feasible. Finally, though this objective is defined as a trigger, there is no defined management response if a trigger is "pulled", meaning that essentially the trigger shoots blanks. The other objectives/triggers listed in Appendix 1 are similarly not paired with any responsive management actions.

Information from monitoring and research that indicates that negative impacts are occurring could result in proposals for changes in management made to the agency groups. For example, the AM plan explains, "[i]f the monitoring and research indicate that a management adjustment could improve the performance of the predator refugia, proposals to make said adjustment will be developed through the same scoping process." (SWRCB-107, Att. 5, p. 19.) This filtering mechanism, whereby proposed management adjustments are reviewed by multiple entities, means that there are not automatic triggers for changes in management when harm is detected or projected.

More generally, many of the species-specific triggers are vague to the point of being unenforceable. For example, the objective "[i]ncrease green sturgeon survival . . . and increase adult green sturgeon survival" provides no objective numeric targets. (SWRCB-107, Attachment 5, App. 1, p. 50.) It is not clear what measures would be used to meet this objective, or what the benchmark for success is. That these objectives lack specificity and are laden with problems is unacceptable, considering how long they have been in development. The objectives are characterized as "preliminary" but they are essentially lifted straight from the previous requirements developed during the BDCP process. (SWRCB-107, Att. 5, App. 1, p. 48.)

Further leading to ineffectiveness, "[t]he primary products envisioned for Phase 3 are written proposals for adjustment of management actions that will describe the anticipated effects of the recommended management change on listed species and water supply reliability and describe the actions necessary to implement said change." (SWRCB-107, Att. 5, p. 20.) Rather than require an immediate response to adverse effects, the approach taken in the AMP

is lengthy and uncertain, resulting only in "recommended" change with no firm requirement that recommendations be implemented, or timeframe for implementation. This lack of commitment to triggers and corresponding management action is contrary to recommendations in the literature for conducting adaptive management, as described in section A above.

6) Operational rules are not sensitive to stress/change in the system across the full-range of possibilities. While the ITP provides some minimal bypass flow criteria, certain minimal pulse flow protections (see DWR-515; SWRCB-107, pp. 83-84, 178-187), and spring outflow criteria, the AM plan leaves further details of operational rules to be decided later. And whatever rules are in effect, are subject to change under the AM plan and the IICG management structure. This closed door process provides no assurance to non-participating permitting agencies, stakeholders, the legislature, and the public that water users and the environment would be protected in the process of any such rule change.

Petitioners have acknowledged that implementation of the AM plan may lead to changes in initial operating criteria. For example, in DWR-1143, p. 6, fn. 39, Petitioners address the initial spring outflow requirements for Longfin Smelt in CWF H3+ and say that they could be changed under the AM plan. Presumably Petitioners, at the request of project proponents, would propose such a change in order to increase exports. Reduction in spring outflow, if it led to increased exports from the North Delta Diversion, would increase salinity in the Delta and thereby degrade the water supplies of local water users and adversely affect other salinity-sensitive ecosystem and community values. (See also DWR-1143, p. 3, fns. 29, 31 [adaptive management of South Delta operational criteria that may have water quality and other impacts on water users and public trust resources].) Without some role for stakeholders and oversight by an independent agency responsible for monitoring and approving such changes, there is significant potential for negative impacts to local landowners and Delta resources.

Though quick reactions well informed by science may be needed to avert negative consequences of the project, the draft AM plan for the Delta Tunnels purports to exclude real-time operational decisions: "The adaptive management and decision-making processes

described here do not apply to these real-time operations; where individual real-time operations decisions must be made on a daily, weekly or monthly time scale; because new research efforts cannot be developed and deployed in that same window of time." (SWRCB-107, Att. 5, p. 11.) This statement makes a false connection between timelines for developing research and monitoring with the immediacy of real-time operations. It is entirely possible to develop research that results in establishment of indicators and triggers that can be applied to real-time assessment of impacts and real-time operational changes. Even if the point of the AM plan is not to restrict responses to urgent problems in real-time, it is not clear what those responses would be, or why the AM would not be used to support urgent, real-time responses.

In addition, there is no direct connection to the AM plan and even less structure for real-time decision-making to prevent impacts other than those on listed fish. For instance, while the salinity Mitigation Measure WQ-11e provides no structure for decision-making that would affect other beneficial uses of water in the Delta. (See SWRCB-111, pp. 2-13 to 2-14.) Instead, Mitigation Measure WQ-11e explains that:

> Allowing sufficient flow in the Sacramento River at Emmaton, through real-time operations, would contribute to reduced EC levels at this location, relative to that modeled for the project alternative, and would reduce EC degradation at Emmaton in late August and September to less-than-significant levels.

(SWRCB-111, p. 2-14.)

Water quality effects of Microcystis, Impact WQ-32, are also expected to be avoided through real time operations, but no structure for this decision-making (or even a mitigation measure) is offered. (SWRCB-102, p. 8-982; see also SWRCB-110, p. 2-13.) While there is no mitigation provided, Mitigation Measure WQ-11e claims that it is "consistent with the adaptive management and real-time operations that would be utilized to minimize the project alternative's water quality effects to Microcystis in the summer months." (SWRCB-111, p. 2-14.) These vague references to adaptive management where there is no direct treatment of the impact in the AM plan obfuscate the lack of a plan to address these water quality impacts.

Noise impacts on land uses and structures are considered significant and unavoidable. (SWRCB-111, pp. 108; 103-107.) These impacts have led to testimony questioning the ability

of the community to remain in the project area during the lengthy and disruptive construction period. (See, e.g., LAND-205 errata.) Noise effects on humans and fish and wildlife would have been a possible subject for inclusion in the AM plan if it was designed to holistically address the full range of impacts of the project. Over a 15 year construction period there would be an opportunity to apply adaptive management principles to address these noise impacts. But no effort was made to use AM to address construction noise.

7) Water agencies with a vested interest in outcomes control the process. The water agencies (including state/federal providers and local/private contractors) stand at the helm for most critical decisions related to the AM plan, which is an inherent conflict of interest, from deciding which research to fund to data interpretation, to operational decisions. (See Figure 5-1, below.) The most minimal definition of science does not include directing or influencing certain outcomes from scientific investigations. Nor do most descriptions of adaptive management (see section A.3 above).

Under the AM plan for the Delta Tunnels, the IICG, co-led by Reclamation and DWR, includes a representative of Reclamation, USFWS, and NMFS, as well as one designated representative each from DWR, CDFW, a participating SWP contractor, and a participating CVP contractor. (SWRCB-107, Att. 5, pp. 10-11.) The IICG makes recommendations and DWR and the Bureau of Reclamation provide the "management hub" for the AM process. (SWRCB-107, Att. 5, p. 10.) The IICG would include seven representatives total and develop management plans and actions and disburse science funding. (SWRCB-107, Att. 5, pp. 10-11.)

While the AM plan proposes an advisory role for the Collaborative Science and Adaptive Management Program (CSAMP), the CSAMP is not an independent entity. "The CSAMP is structured as a four-tiered organization comprised of:

> 1. Policy Group consisting of agency directors and top-level executives from the entities that created CSAMP;
> 2. CAMT made up of managers and staff scientists that serve at the direction of the Policy Group;
> 3. Scoping Teams created on an as-needed basis to scope specific science studies; and

4. Investigators contracted to conduct studies."

(SWRCB-107, Att. 5, p. 38.)

The CSAMP program structurally separates the monitoring and scientific processes from the management/operations part of decision-making. (Figure 5-1 below, from SWRCB-107, Att. 5, p. 12.) However, within every level, or location of decisions of the CSAMP, water agencies control the process and outcomes. This gate-keeper role by water interests provides a high level of control over the process by water managers and contractors. (See Figure 5-1 below, from SWRCB-107, Att. 5, p. 12.) The literature is replete with cases of agencies with vested interests using the AM process to control outcomes. For example, Biber cites the example of Glen Canyon Dam, where experimental changes in operation led to scientific conclusions about how management should be changed. These changes were not instituted for 15 years "because of the decision-making structure for the Dam: power and water interests who would be hurt most by Dam reoperation have an effective veto over changes to Dam operation." (LAND-245, p. 952.)

The Bureau of Reclamation, one of the veto-holding powers in the case of the Glen Canyon Dam, and the California Department of Water Resources ("DWR") are both parties that could be hurt by changes in operation (e.g., cessation of withdrawals through the intakes), and yet, both hold sway over the CSAMP and ultimate veto power over IICG recommendations. There is no reason that these two agencies would not continue to point to uncertainty in ecosystem-management models and monitoring data as justification for maintaining continued use of the intakes and tunnels at the levels for which they have planned in their financing decisions.

While not a panacea for all of the problems identified with the influence of agencies always seeking to deliver more, not less, water, inclusion of more neutral agencies with no vested interest in certain deliveries would be helpful. For instance, as a permitting agency it is unclear why a role for the SWRCB is not included in the AM plan. If issued, this water rights permit would have important terms and conditions regarding operations and other matters and would reference the AM plan. The SWRCB, which has jurisdiction over all of the beneficial

uses of water, could provide a voice for protection of those beneficial uses and the public interest in the AM process.

8) No accommodation of or role for affected communities & water users.

The AM plan recognizes the vast scale of the project and its potential to change the Delta significantly: "Further, new water project facilities and changes to water operations in general and beyond CWF may have widespread effects that reverberate throughout the Delta and its tributaries." (SWRCB-107, Att. 5, p. 30.) The Statement of Overriding Considerations recognizes 43 significant and unavoidable impacts, and many other impacts, though labeled as mitigated to less than significant levels, are in dispute. (SWRCB-110.) Many of these impacts pertain to people and to wildlife, not just listed fish. Yet, the decision-making process, scientific investigation process, scope of allowable decisions, and scope of objectives considered are all closed to stakeholders in the Delta and other affected regions, and the broader public. (Hearing Transcript, March 5, 2018, pp. 136-138.)

The AM plan promises that in **Phase 3 Integrate** there would be "communicat[ion of] the results of implemented actions, research, and monitoring to policy makers, managers, stakeholders, the scientific community, and the public, so that they can understand and evaluate progress toward addressing uncertainties and respond as necessary." (SWRCB-107, p. 20.) Communication without any consideration of the full range of stakeholder concerns and no means to participate in an effective process to address those concerns is an empty and meaningless promise. This approach is also contrary to accepted theory and practice for AM plan formulation and implementation, as discussed in section A of my testimony.

A key component of effective AM of large and complex systems is that all stakeholders with an interest and the ability to affect management through political or legal means are included in formulation of the management framework and plan. (LAND-259, McLain and Lee, 1996.) This is not the case for the AM framework for the Delta Tunnels project. Instead, communities were not consulted and no plan for consulting them has been put forward, no representative of community interests has been proposed for an ombudsman or similar role in the science-interpretation and management decision phases of the AM process, and finally,

there is no community representative on the IICG, where most/all important decisions would be made.

The AM Plan describes “key uncertainties” related to impacts on a limited suite of biological systems and species. (SWRCB 107, Alt. 5, Appendix 1.) However, the AM Plan neglects to consider potential impacts to other natural systems, including terrestrial species, beneficial uses of local surface water and groundwater, recreation, and other natural and human uses of the Delta. DWR recognized 43 significant and unavoidable effects of the project, many of which impact local communities. (See SWRCB-110, pp. 106-109.) The failure to attempt to assess and mitigate impacts to the environment and local communities through AM is a major gap in the AM plan and ensures continued conflict and lack of progress on potentially shared water and resources management goals.

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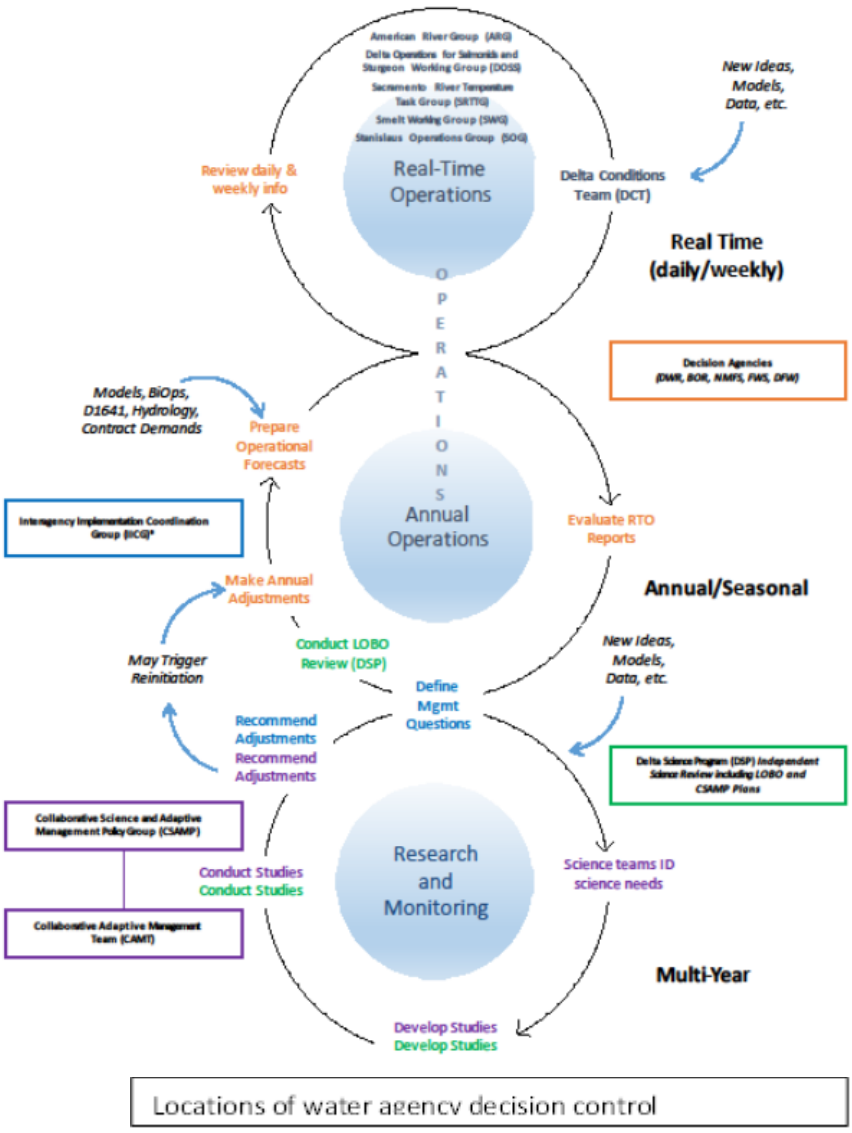


Figure 5-1. Describing the multiple time-scales of adaptive management for the California WaterFix and current USFWS and NMFS Biological Opinions on the coordinated operations of the Central Valley and State Water Projects

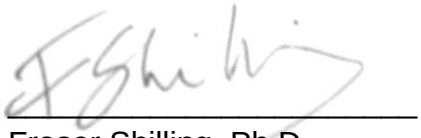
(SWRCB-107, Att. 5, p. 12.)

III. CONCLUSION

I have described here the various opinions and findings in the peer-reviewed scientific literature about the AM process and what can cause it to succeed or fail (section A). I also described the way AM was developed and limited within the Petitioners' proposed project to add water diversions north of the Delta (section B). In section C, I described the inconsistencies between Petitioners' AMP as currently described and the standards and findings in the literature. I evaluated the likelihood of success of the AMP based on

comparison with the literature and identified 8 critical weaknesses in the use of AM by the Petitioners, primarily in the AM plan. In my opinion, any one of these weaknesses could jeopardize success of the plan and collectively almost certainly doom the plan to failure. In this case, failure does not mean loss of water deliveries to the south, for which the proposed new facilities designed, but rather failure to result in: 1) protection of the target species; 2) protection of other aquatic organisms, processes, and valued features in the Delta; 3) persistence of healthy communities of people in the Delta; and 4) consistency with the Delta Reform Act's co-equal goals. If my observations and evaluations are accurate and these failures are likely to occur, then it would follow that the Petitioners must significantly revise the AM plan to ensure its effectiveness in meeting the Delta Reform Act requirements and avoiding unreasonable effects to the fish and wildlife, the public interest and Public Trust resources.

Executed on the 12th day of July, 2018, at Davis, California.



Fraser Shilling, Ph.D.