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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	TESTIMONY OF RICHARD A. DENTON, PH.D., P.E.

1. Declaration of Qualifications

I, Dr. Richard Denton, declare that I am a Water Resources Consultant and sole-proprietor of Richard Denton and Associates. I have 45 years of experience in the areas of hydraulics and water quality. I received my Bachelor of Engineering (Civil) with First Class Honours in 1972 from the University of Canterbury, Christchurch, New Zealand. I received a Doctor of Philosophy (Ph.D.) in Civil Engineering in 1978 from the University of Canterbury. I am a registered Civil Engineer in the State of California (C47212).

From 1989–2006, I was an employee of the Contra Costa Water District (CCWD), Concord, California, and served for much of that time as Water Resources Manager. From 1982–1989, I was an Assistant Professor in Civil Engineering (Hydraulic and Coastal Engineering) on the faculty of the University of California at Berkeley. During the mid-80s, while at U.C. Berkeley, I prepared four detailed reports on the currents and water quality in San Francisco Bay under a contract from the State Water Resources Control Board (SWRCB).

I have been involved in SWRCB Bay-Delta water right and water quality hearings since 1989. I have extensive experience analyzing Central Valley operations and flow and salinity regimes in the Sacramento-San Joaquin Delta ("Delta"). I provided key input to the environmental review and water rights permitting for CCWD's Los Vaqueros Project and the development of the 1994 Bay-Delta Accord. Since 1996, I participated in development and permitting of the Grassland Bypass Project which regulated agricultural runoff and resulted in significant decreases in selenium and salinity loads from the westside of the San Joaquin Valley. I also served as chair of the CALFED Operations and Fish Forum from 2001–2006.

In 1995, I received the first annual Hugo B. Fischer Award from the California Water and Environmental Modeling Forum in recognition of my development and innovative application of a salinity-outflow model for the Delta. In 2010, I received a Career Achievement Award from the California Water and Environmental Modeling Forum.

As a Water Resources Consultant, I assisted CCWD's completion of the environmental permitting of CCWD's Middle River Intake Project and Los Vaqueros Enlargement Project. I am currently assisting Contra Costa County and the Contra Costa County Water Agency, and Solano County on issues related to the California WaterFix Project and efforts to restore the Delta ecosystem and increase California's water supply reliability.

I am the author of 13 academic papers in peer-reviewed journals, 10 papers in conference proceedings and 6 research reports. A copy of my statement of qualifications has been submitted as Exhibit CCC-SC-2[1].

2. Summary of My Detailed Testimony

In my testimony, I explain how the proposed WaterFix project fails to contribute to meeting the co-equal goals of enhancing the Delta ecosystem and providing a more reliable water supply for California. (Cal. Wat. Code §85054.) There are other potentially viable alternatives for solving the current issues related to the Bay-Delta system. These alternatives incorporate additional surface water storage in the south-of-the-Delta export areas and screening of the inflow to Clifton Court Forebay, and would achieve State policy, by helping to achieving the coequal goals and the inherent objectives of improving water quality in the Delta and protecting the Delta as an evolving place. (Cal. Wat. Code § 85020.) The current proposal before the Board is, therefore, not in the public interest.

My testimony also discusses major flaws with the operations and water quality modeling performed by the Petitioners and the problems with the long-term averaging used to present those modeling data. The proposed WaterFix project will have adverse impacts that are masked when the flow and water quality data are only presented as long-term averages. The modeling data must be revised to accurately simulate the

[1] Exhibit CCC-SC-2 is a true and correct copy of the document.

existing and future operations of the Delta with and without the project, and the Petitioners must present the modeling data in a form that is useful and usable for decision makers, Bay-Delta stakeholders and the public. My testimony also suggests principles that could be used to develop permit terms for the amended permits.

3. Summary of Why the Proposed WaterFix Project is not in Public Interest

This testimony is submitted on behalf of Contra Costa County, Contra Costa County Water Agency, and Solano County (referred to collectively as the "Counties"). I agree with most of the parties to this hearing that the status quo for the Bay-Delta system is unacceptable. The abundance of key fish species has decreased significantly since the start of the 21st Century. (Exhibit CCC-SC-4[2], Cal. Dept. of Fish & Wildlife Fall Midwater Trawl (FMWT) Data.)

The proposed WaterFix project before the Board does not contribute to restoring and sustaining the Delta ecosystem. It threatens to further harm key fish species.

The Biological Opinion for the WaterFix Proposed Action (PA), issued on June 16, 2017 by the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), includes a detailed list of the contributions to incidental take expected to result from operations post-construction of the PA:

> "(1) Increased predation related to permanent structures built within the Delta due to PA activities (North Delta Diversions (NDDs) and Head of Old River (HOR) gate).
>
> (2) Avoidance and behavioral modifications related to increased turbidity and re-suspended sediment concentrations in the water column due to maintenance actions within the Delta.
>
> (3) Physiological and behavioral effects related to exposure to contaminants contained in re-suspended bottom sediments

[2] CCC-SC-4 is a true and correct copy of Cal. Dept. of Fish & Wildlife (CDFW) Fall Midwater Trawl data downloaded from the CDFW website on October 17, 2017.

due to maintenance actions within the Delta.

(4) Physical impacts related to maintenance dredging activities of the PA within the Delta.

(5) Impacts related to the operations of the NDDs related to mortality and injury of listed fish exposed to the intakes' fish screens.

(6) Operations of the CVP and SWP export facilities in the South Delta and their effect on salvage and loss of listed fish, hydrodynamics, and behavioral effects.

(7) Operations of the NDD and their effects on Delta hydrodynamics, behavioral effects and survival of listed fish in the Delta.

(8) Operations of the Delta Cross Channel (DCC) radial gates and their effects on the entrainment of listed fish into the open DCC junction."

(CCC-SC-5[3], NMFS WaterFix Final Biological Opinion, June 16, 2017, p. 1113.)

All of these listed factors regarding the proposed WaterFix project have the potential to harm the key fish species in the Bay-Delta system.

The operating criteria for the proposed WaterFix project may still be changed at some future date as part of subsequent consultation on operations of the new and existing Central Valley Project (CVP) and State Water Project (SWP) water facilities under dual conveyance. Both the U.S. Fish and Wildlife Service June 23, 2017 Biological Opinion and the NMFS Biological Opinion contain a mix of standard-level and programmatic-level project elements. All of the activities addressed programmatically will be subject to a subsequent consultation on future Federal actions in order to

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[3] CCC-SC-5 is a true and correct copy of pp. 1112-1113 of the NMFS WaterFix Final Biological Opinion, June 16, 2017.

proceed. Operations of new and existing CVP and SWP water facilities under dual conveyance, perhaps the most important project element, are only addressed programmatically.

The Biological Opinions also rely on the outcome of future, uncertain, adaptive management programs to reduce the adverse impacts of the proposed WaterFix project on threatened and endangered fish species. For example, the NMFS biological opinion states:

> "Taking into account the project impacts to each PBF, as well as the revised PA habitat improvements, the Sacramento River winter-run Chinook salmon critical habitat will likely be impacted to a moderate level by the PA. Commitments to adaptive management (as described in Appendix A2) will ensure impacts are minimized." (CCC-SC-6[4], NMFS WaterFix Final Biological Opinion, June 26, 2017, p. 880.)

In other words, the proposed WaterFix project is likely to impact the endangered Sacramento River winter-run Chinook salmon unless these impacts are addressed in the future by as yet unknown and unapproved adaptive management actions.

Of further concern regarding the potential adverse impacts of the proposed WaterFix project on key fish species is that the proposed operating criteria result in Delta outflows that are much lower than the SWRCB 2010 Delta Flow Criteria report determined to be necessary in the Delta ecosystem for fishery protection, under existing conditions. (SWRCB-25, Note to Readers). The SWRCB 2010 Delta Flow Criteria report further states that both the Category "A" and Category "B" flow criteria "are considered equally important for protection of public trust resources in the Delta

[4] CCC-SC-6 is a true and correct copy of pages 879 through 883 of the NMFS WaterFix Final Biological Opinion, June 26, 2017.

ecosystem, and are supported by scientific information on function-based species or ecosystem needs." (SWRCB-25, p. 129.)

The Petitioners did analyze a WaterFix operations scenario that corresponded to a SWRCB request to incorporate aspects of the 2010 Delta Flow Criteria report recommendations, the Alternative 4A, Boundary 2 scenario. However, the proposed WaterFix project is Alternative 4A, scenario H3+ which has lower Delta outflows than the SWRCB deemed necessary for fishery protection. The Petitioners have failed to present any information in Part 1 of this hearing showing Delta inflows and outflows as a function of unimpaired flow. Therefore, it is not possible for the Hearing Officers and Bay-Delta stakeholders to determine how the proposed WaterFix project compares to the SWRCB's 2010 recommendations in the Delta Flow Criteria report.

The salinity of water in the Delta has increased since the 1980s degrading water quality for fish and wildlife, drinking water use, agricultural use, and recreation. (Antioch-216[5].) In the report, Contra Costa Water District (CCWD) concluded that, prior to 1976, fall salinity in the Delta was high only in relatively dry years. Recently, fall salinity in the Delta is high almost every year. (Antioch-216, p 12.)

Salinities in October and November also show a significant increase in the fall after 1994, which coincided with adoption of the spring estuarine habitat objective (also known as February-June X2 or Spring X2). Exhibit CCC-SC-7[6] presents plots of monthly-averaged specific conductance (EC) at Jersey Point in October and November as a function of water year type, represented by the Sacramento Valley water year type 40-30-30 index. I prepared these graphs from DWR's Dayflow database (DWR-552) and DWR's Chronological Reconstructed Sacramento and San Joaquin Valley Water

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[5] Historical Fresh Water and Salinity Conditions in the Western Sacramento-San Joaquin Delta and Suisun Bay. A summary of historical reviews, reports, analyses and measurements. Water Resources Department, Contra Costa Water District, Concord, California, February 2010, Technical Memorandum WR10-001. (Antioch-216.)

[6] CCC-SC-7 is a true and correct copy.

Year Hydrologic Classification Indices (SWRCB-67). Figure 1 in exhibit CCC-SC-37[7] is a map of the Delta showing the flow and water quality monitoring locations discussed in this testimony.

The salinities during 1995-2008 increase significantly in below normal, above normal, and some less wet years. This may be due to the reductions in exports in the spring to meet Spring X2 being made up later in the year. This in turn results in reduced Delta outflows in the fall. However, since 2009 and the introduction of the Fall X2 requirements, this degradation appears to have reduced.

The WaterFix project reduces inflows to and through the Delta, worsening water quality for all uses, allowing for invasive species to thrive, and reducing the flushing of harmful contaminants out of the Delta. Reduced exports from the south Delta with the proposed WaterFix project will allow the buildup of salinity and other harmful water quality contaminants in the south and central Delta.

The water supply reliability for south-of-Delta export water contractors has also decreased in the past few decades. Total historical south-of-Delta SWP and CVP exports, when plotted as a function of the Sacramento 40-30-30 water year index, show a distinct decline about the time the 2008 USFWS and 2009 NMFS biological opinions were issued. (CCC-SC-8[8], Figure 1). The historical CVP water supply allocations show a decline starting in the early 1990s and even further decreases since 2008. (CCC-SC-8, Table 1.)

The WaterFix project would result in only a modest increase in export water supply relative to the No Action Alternative provided that the limited improvement in Delta flows that exceed Water Rights Decision 1641 requirements recommended by the Petitioners were to represent future operating conditions, *i.e.,* somewhere in the range between Alternative 4, Scenarios H3 and H4 compared to the No Action Alternative.

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[7] CCC-SC-37 is a true and correct copy.
[8] CCC-SC-8 is a true and correct copy.

(CCC-SC-9[9], Figure 10 excerpted from DWR-514.) The long-term average south-of-Delta deliveries for Scenarios H3 and H4 range from an increase of 13.4% to a reduction of 1.5% relative to the No Action Alternative. (CCC-SC-9.)

However, the SWRCB is considering requiring large increases in minimum Delta inflow and outflow requirements based on a percentage of unimpaired flow. This is part of Phases I and II of the Bay-Delta Water Quality Control Plan update. Once some version of the Phase I and II flow criteria are implemented by the SWRCB, it is anticipated the proposed WaterFix project would export less export water south of the Delta than the No Action Alternative. The long-term average south-of-Delta deliveries for Boundary 2 decrease by 32.8% relative to the No Action Alternative. (CCC-SC-9.)

With increased minimum Delta inflow and outflow requirements, it will not be possible for the project to consistently capture "new[10]" water during periods of high Delta outflow (wet months) without increased surface storage capacity in the south-of-Delta export area. As was the case during the very wet winter of 2017, San Luis Reservoir fills relatively quickly during wet periods and there is then nowhere to quickly store water. At this time there is also reduced demand for water south of the Delta because agricultural fields and urban lawns are already saturated. The diversion of water at the south Delta export pumps then drops well below capacity. (CCC-SC-10[11].) The computer modeling of WaterFix operations show similar reductions in exports once San Luis Reservoir is full, ending the opportunity to take a "Big Gulp." (CCC-SC-11[12].) The available aqueduct and canal capacity south of the Delta is also a factor limiting how much water can be exported during wet periods. This problem cannot be solved by only adding new conveyance through or under the Delta.

The proposed WaterFix project is not in the public interest because it fails to

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[9] CCC-SC-9 is a true and correct copy of Figure 10 from DWR-514.

[10] In this context, "new" water is considered to be water that otherwise would not have been exported or diverted to storage in upstream reservoirs, but would have flowed out into San Francisco Bay and the ocean.

[11] CCC-SC-10 is a true and correct copy.

[12] CCC-SC-11 is a true and correct copy.

contribute to restoring and sustaining the Delta ecosystem, fails to contribute to improving water quality in the Delta, and fails to increase water supply reliability for California.

There are alternatives that would restore and sustain the Delta ecosystem, restore water quality in the Delta, improve water supply for all Californians and protect the Delta as an evolving place. One component that should be considered in these alternatives is additional surface storage and groundwater storage in the south-of-Delta export areas.

California WaterFix, and its predecessor, BDCP, were premised on the "Big Gulp, Little Sip" concept. (CCC-SC-12[13].) Capturing more water during wet months (a true "Big Gulp") would reduce the pressure on the state and federal water projects to export as much water during dry months (a true "Little Sip") and facilitate increased Delta flows during dry periods when the Delta ecosystem is most vulnerable.

The proposed WaterFix project fails to consistently capture "new" water during wet periods (the opposite of a "Big Gulp"). As a result, the proposed WaterFix project has to rely on exporting more water from the Delta during dry periods than would occur under the No Action Alternative (the opposite of a "Little Sip").

The proposed WaterFix project is not in the public interest because it is a conveyance-only alternative that assumes the SWRCB will not implement increased Delta inflow and outflow requirements consistent with its 2010 Delta Flow Criteria Report. (SWRCB-25.)

Unfortunately, this water rights hearing began prior to completion of the current Bay-Delta Water Quality Control Plan update and implementation of Delta Flow Criteria necessary to restore and sustain key fish species. If the SWRCB significantly increases the minimum inflow and outflow requirements for the Delta, use of the new north Delta intakes and tunnels could be much more restricted and they could become a stranded

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[13] CCC-SC-12 is a true and correct copy of the BDCP Brochure, "An Overview and Update," dated March 2009.

asset. A Delta alternative that would be best suited to the increased minimum inflow and outflow requirements would likely include additional south-of-Delta storage and any new conveyance infrastructure may be different in size and location compared to the current WaterFix proposal.

To develop a successful and sustainable Delta solution, it is *first* necessary to determine how much flow must be left in the Central Valley and Bay-Delta systems to protect fish and other beneficial uses and *then* develop a joint storage-conveyance alternative that improves water quality, protects the Delta as an evolving place, and increases water supply reliability for California, as State law requires. (Cal. Wat. Code §§ 85020, 85054.)

The current proposed WaterFix project fails to contribute to meeting these co-equal goals enshrined in State policy, or the inherent objectives of improving water quality in the Delta and protecting the Delta as an evolving place.

4. The Proposed WaterFix Project and Corresponding Modeling Analyses Have Significant Flaws.

The proposed WaterFix project presented in Part 1 of this hearing, as well as the modeling studies used to analyze and partially disclose the adverse impacts of the proposed WaterFix project, have major flaws.

4.1 WaterFix Cannot Consistently Capture "New[14]" Water During Wet Periods.

One of the early Planning Principles adopted by the Steering Committee for the original Bay-Delta Conservation Plan was "*Divert more water in the wetter periods and less in the drier period*s." (CCC-SC-12, Bay Delta Conservation Plan (BDCP), March 2009 brochure ,"An Overview and Update," p. 6.) This has also been described by the

[14] In this context, "new" water is considered to be water that otherwise would not have been exported or diverted to storage in upstream reservoirs, but would have flowed out into San Francisco Bay and the ocean.

BDCP and WaterFix project proponents as the "Big Gulp, Little Sip" concept. (CCC-SC-13[15].)

The proposed WaterFix project is not in the public interest because it is not capable of consistently capturing "new" water during periods of high runoff. Conveyance limitations through the Delta and fish protection restrictions are factors, but this project flaw also results from the lack of sufficient south-of-Delta storage in the export areas.

For example, the winter of 2017 was one of the wettest on record and Delta outflows were very high beginning in January. (CCC-SC-10.) As a result, Delta exports increased to maximum capacity, or close to it from January 13 through February 15. The maximum combined SWP and CVP export pumping rate was 14,449 cubic feet per second (cfs) on February 2. However, starting on February 16, 2017, exports were reduced to only about 5,000–7,000 cfs because San Luis Reservoir was full. A lot of water was still available in the Delta to export but there was nowhere to rapidly store or use that water in the export areas. Agricultural and urban demands are reduced during wet periods because fields and lawns are saturated.

Figures 1 and 2 in exhibit CCC-SC-11 show the quantity of total south-of-Delta exports from the CALSIM II operations modeling for the version of the proposed WaterFix project used to develop the Biological Assessment during the period October 1, 1981 through September 30, 1984. These modeling data were made available to the public on February 3, 2016. (CCC-SC-30[16].) Water years 1982, 1983, and 1984 were all wet years. As shown in Figure 1 in exhibit CCC-SC-11, Delta outflows were very high in the winter months. However, as shown in Figure 2 in exhibit CCC-SC-11, once the simulated San Luis Reservoir storage reached capacity, the simulated total exports with WaterFix reduced well below maximum.

The Delta Stewardship Council has recently developed amendments to their

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[15] CCC-SC-13 is a true and correct copy.

[16] CCC-SC-30 is a true and correct copy of screen captures of Reclamation's February 3, 2015 announcement of availability of Draft Biological Assessment Modeling.

Delta Plan related to conveyance, storage and the operation of both in a coordinated way. However, the operation of conveyance and storage facilities that are widely separated both geographically and hydrologically will be difficult to coordinate in a way that increases water supply reliability for California. For example, operation of the WaterFix proposed tunnels and operation of a proposed future reservoir on the upper San Joaquin River at Temperance Flat will not really affect each other, or work together to improve water supply reliability. It is important to consider both new storage and conveyance improvements in a Delta-solution alternative. However, development of a viable solution to the problems of the Delta should be based on joint storage-conveyance facilities rather than either (1) treating conveyance and storage separately, or (2) not considering additional storage at all, as is the case for the proposed WaterFix project.

For these reasons, the proposed WaterFix project is not in the public interest because it only addresses conveyance, rather than a joint storage-conveyance solution to the problems with the Delta ecosystem, Delta water quality, and water supply reliability. Without additional south-of-the-Delta storage, the WaterFix north and south Delta export facilities will not be able to consistently capture “new” water during periods of high Delta flows.

If new south-of-the-Delta export-area storage is being considered by the Petitioners, it should be considered now as part of a Delta solution alternative so that the adverse impacts of any resulting future change in the timing and quantity of Delta operations can be fully understood and the joint storage-conveyance facilities can be sized and located to optimize the benefits. The current WaterFix conveyance-only proposed project will not necessarily be the most efficient or economical alternative if additional storage is added later.

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4.2 WaterFix Relies on Increasing Exports From the Delta During Dry Periods When the Delta Ecosystem is Most Vulnerable.

The Petitioners testified in Part 1 of this hearing that the WaterFix project presented at this hearing will not increase the export capacity of the State Water Project. (Transcript, Vol. 4, August 4, 2016, pp. 220:19-220:24.)

Subsequent cross-examination by other parties and Co-Hearing Officer Doduc attempted to determine whether the quantity of water exported by the State Water Project would increase if the SWRCB allowed a change to DWR's water right permits, even if the maximum permitted export capacity was not changed. (*See, e.g.,* Transcript, Vol. 4, August 4, 2016, pp. 222:1-223:20; pp. 224:20-227:4.)

The WaterFix modeling data for the WaterFix Biological Assessment (SWRCB-104), and earlier modeling performed for the BDCP and WaterFix environmental analyses (SWRCB-3; SWRCB-4), suggest that a change in DWR's water rights to incorporate the proposed WaterFix project will result in an increase in the quantity or amount of water the State Water Project is able to currently export south of the Delta. In fact, exports could even increase during dry periods when Delta outflow is very low and the Delta ecosystem is most vulnerable.

During March 16 through December 14, when inflow to SWP Clifton Court Forebay is currently limited by a U.S. Army Corps permit to 6,680 cfs, as a three-day average (CCC-SC-14[17], U.S. Army Corps public notice 5820A, amended October 13, 1981), the Petitioners plan to use the proposed new north Delta intakes, in combination with the existing south Delta intakes, to export at total quantity of State Water Project water equivalent to up to 10,300 cfs.

As shown in exhibit CCC-SC-15[18], which shows current and proposed diversion points and pump conveyance capacities, even though the combined capacity of the CVP Jones Pumping Plant (4,600 cfs), the SWP Banks Pumping Plant (6,680-10,300

[17] CCC-SC-14 is a true and correct copy of U.S. Army Corps public notice 5820A, amended October 13, 1981.

[18] CCC-SC-15 is a true and correct copy.

cfs), and the proposed new WaterFix twin tunnels (9,000 cfs) is 23,900 cfs, the maximum quantity of water that can be exported south of the Delta is limited to 14,900 cfs by the combined maximum capacity of Banks Pumping Plant and the California Aqueduct, and Jones Pumping Plant and the Delta Mendota Canal.

The Army Corps limits on inflow to Clifton Court Forebay allow inflows up to 10,300 cfs during the wetter time of year (December 15 through March 15). The inflow is increased by one-third of the inflow to the Delta at Vernalis, provided Vernalis inflow is equal to or greater than 1,000 cfs. (CCC-SC-14.) An additional 500 cfs can be exported from July 1 through September 30 (*i.e.,* up to 6,680 + 500 = 7,180 cfs) to replace water lost because of reduced pumping to benefit Delta fish species. (CCC-SC-16[19], CVP and SWP Operations Criteria and Plan Biological Assessment, footnote, p. 2-2.)

Importantly, the WaterFix operations modeling for the proposed project suggests that the Petitioners intend to take advantage of their future ability to export up to 10,300 cfs of SWP water when Delta outflow is very low and the Delta ecosystem is most vulnerable. During periods of low outflow, the inflow to the SWP Clifton Court Forebay from the south Delta is typically limited to 6,680 cfs, so this represents a 54% increase in SWP exports from the Delta. A detailed inspection of the WaterFix operations modeling using CALSIM II reveals that the proposed WaterFix project would increase SWP exports south of the Delta to 10,300 cfs when Delta outflows were as low as 4,000 cfs.

Figure 1 in exhibit CCC-SC-17[20] shows the total combined SWP and CVP exports with the proposed WaterFix project for the period January 1, 1941 through December 31, 1941. Also shown are the corresponding Delta outflows. These monthly-average operations data are from the WaterFix modeling of the Biological Assessment Proposed Action (PA). In the month of August 1941, Delta outflow is only

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[19] CCC-SC-16 is a true and correct copy of page 2-2 of the CVP and SWP Operations Criteria and Plan Biological Assessment.

[20] CCC-SC-17 is a true and correct copy.

4,000 cfs, but the WaterFix proposed project is exporting 14,439 cfs.

Figure 2 in exhibit CCC-SC-17 shows the total south-of-Delta exports for the Biological Assessment (BA) No Action Alternative (NAA) as a function of Delta outflow for two months: August 1941 and January 1983. These are the examples of the WaterFix project increasing exports during a dry period (discussed above), and the WaterFix project not exporting at maximum capacity during a wet period because San Luis Reservoir is full (CCC-SC-11.) These are the opposite of a "Little Sip" and "Big Gulp," respectively.

The advantage of this type of scatter plot over a simple time series plot, such as Figure 1 in CCC-SC-17, is that it illustrates how the proposed WaterFix project would change south-of-Delta export quantity over a range of Delta outflow conditions.

There are other examples of months when Delta outflows are low but total exports with the proposed WaterFix project are well in excess of the typical existing combined export limit of 11,280 cfs. Figure 3 in exhibit CCC-SC-17 shows the total exports for the Biological Assessment No Action Alternative (NAA) as a function of Delta outflow.

Figure 4 in exhibit CCC-SC-17 shows the simulated total exports for the WaterFix Biological Assessment Proposed Action (PA) as a function of Delta outflow. This scatter plot illustrates that even when Delta outflows are very low (5,000 cfs or less), the proposed WaterFix project would increase south-of-Delta exports up to a new maximum of about 14,900 cfs. Total CVP exports would still be limited to 4,600 cfs (unless the SWP pumps additional water for the CVP), but SWP exports could increase by up to 54% relative to existing conditions.

This significant increase in export quantity during drier periods – periods when Delta outflows are low and the Delta ecosystem is most vulnerable – could have significant adverse impacts on key threatened and endangered fish species. Relying on increasing exports from the Delta during dry periods is also contrary to the State Policy of reducing reliance on the Delta in meeting California's future water supply needs.

(*See* Cal. Wat. Code § 85021.)

Figure 5 in exhibit CCC-SC-17 shows the corresponding scatter plot of total exports as a function of Delta outflows for Alternative 4A, Boundary 2 scenario. This scenario was intended to represent increased flows along the lines recommended by the SWRCB in the 2010 Delta Flow Criteria report for protection of Delta fisheries. (*See* SWRCB-25.) Because this Boundary 2 scenario includes increased Delta minimum outflow requirements, south-of-Delta exports are significantly reduced relative to the Proposed Action scenario (CCC-SC-17, Figure 4), especially during low flow periods.

To ensure the proposed WaterFix project does not rely on exports from the Delta during dry periods, the SWRCB should consider limiting total exports based on Delta outflow. An example of this kind of limit is shown in Figure 5 in exhibit CCC-SC-17, limiting total CVP and SWP south-of-Delta exports to 1.5 times Delta outflow. This limiting condition would prevent exports greater than the typical existing maximum, unless Delta outflow was greater than 7,500 cfs. This suggested limit is roughly consistent with the effects of the enhanced Boundary 2 fish-protection outflow requirements.

4.3 The Proposed WaterFix Project Will Often Reduce Sacramento River Inflows to the Delta Above the Proposed North Delta Intakes.

The Petitioners have failed to fully disclose the reductions in inflow to the Delta from the Sacramento Valley that would occur as a result of the proposed WaterFix project. During Part 1 of this hearing, the Petitioners testified that the WaterFix project did not include any proposal to change the upstream operating criteria for the State Water Project or the Central Valley Project. (Transcript, Vol. 4, July 29, 2016, pp 41:19-42:3.) However, the proposed WaterFix project would still cause reductions in the inflow to the Delta from the Sacramento Valley.

It would be expected that exporting water from the North Delta via the proposed

twin tunnels would decrease flows below the new north Delta intakes. (CCC-SC-18[21], Figure 5E-9.) However, as discussed below, a more detailed inspection of the monthly-averaged flow data from the CALSIM operation studies also indicates that the WaterFix project would reduce Sacramento inflows to the Delta as measured above the new intakes.

Exhibit CCC-SC-19[22] shows the CALSIM II operations simulation data for the Sacramento inflow at Freeport for the Biological Assessment Proposed Action as a function of the corresponding No Action Alternative. The simulated Delta inflows at Freeport (upstream of the proposed north Delta intakes) often decrease because of the proposed WaterFix project. Some of these reductions in flow are greater than 30%. These reductions in inflow to the Delta, as measured at Freeport, could directly harm migrating salmon species and other key fish species in the Delta.

Figure 5E-8 in exhibit CCC-SC-18 is excerpted from the WaterFix Final EIR/EIS. It shows the simulated long-term averaged Freeport flows (water years 1922-2003) for each month with separate graphs for each water-year type. These graphs indicate that even the long-term averaged Freeport flows would sometimes be less than for the No Action Alternative, especially in July, August, and September.

For these reasons, before the SWRCB makes a decision on the Petitioners' petition, the Co-Hearing Officers should require the Petitioners analyze and disclose the reduction in inflows to the Delta at Freeport due to the WaterFix project and present this information at this hearing, so that the corresponding significant adverse environmental impacts of these flow reductions on the Bay-Delta ecosystem, and appropriate permit terms, can be fully assessed and considered.

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[21] CCC-SC-18 includes true and correct excerpts of Figures 5E-8 and 5E-9 from the WaterFix Final EIR/EIS (Volume 1, Appendix 5E, pp. 5E-18 and 5E-19).

[22] CCC-SC-19 is a true and correct copy.

4.4 Presentation of Monthly Operations Data and Daily Water Quality Data As Long-Term Averages Masks Significant Adverse Impacts in Individual Months.

By presenting the data as long-term averages, the Petitioners mask and fail to disclose significant adverse impacts that occur in individual months of individual years. The Petitioners' presentation of data in this manner prevents decision making on the petition and informed determination of appropriate permit terms.

The Delta Independent Science Board, in a September 30, 2015 comment letter to the Chair of the Delta Stewardship Council and Director of the California Department of Fish and Wildlife, describes the partially Recirculated Draft Environmental Impact Report/ Supplemental Draft Environmental Impact Statement for the Bay Delta Conservation Plan/California WaterFix as "sufficiently incomplete and opaque to deter its evaluation and use by decision makers, resource managers, scientists and the broader public." (CCC-SC-20, p. 1[23].) The presentation of WaterFix modeling data by the Petitioners in this hearing primarily as long-term averages similarly renders their testimony unsuitable for use by decision makers, resource managers, Bay-Delta stakeholders, and the general public.

As discussed earlier in section 4.2 of this testimony, the long-term averaging of Delta exports masks the fact that the WaterFix project has the potential to increase the quantity of exports from the Delta during dry periods (dry months) when the Delta ecosystem is most vulnerable. Similarly, long-term averaging makes it difficult to discern the fact that the proposed WaterFix project will often reduce the flow entering the Delta on the Sacramento River at Freeport relative to the No Action Alternative, as discussed in section 4.3 of this testimony.

At the Science Enterprise Workshop: Supporting and Implementing Collaborative Science at U.C. Davis on November 1-2, 2016, Dr. Alyssa Dausman, Science Director

[23] CCC-SC-20 is a true and correct copy of the Delta Independent Science Board's September 30, 2015 comment letter to the Chair of the Delta Stewardship Council and Director of the California Department of Fish and Wildlife.

for the Gulf Coast Ecosystem Restoration Council, noted that "it is helpful to stress the difference between *useful* science and *usable* science – it is important to have science that is usable for managers." (CCC-SC-21[24], p. 151.) Unless the Petitioners present their operations and water quality modeling in detail so that it is usable for decision-making and does not mask adverse impacts, the SWRCB will lack the basis to make an accurate or properly informed decision about the key hearing questions. As discussed in further detail below, the Petitioners have failed to present adequate, detailed water quality modeling that ensures informed decision making in this proceeding.

4.5 Artificially High Delta Outflows in October Result in Underestimation of Adverse Water Quality Impacts.

Contra Costa Water District's (CCWD) detailed comments on the WaterFix RDEIR/SDEIS pointed out that the CALSIM II simulations of Delta outflows in October with the WaterFix project were not realistic and were too high. (CCC-SC-22[25], WaterFix Final EIR/EIS, RECIRC 2597.) This means that in the WaterFix simulation of proposed project operations, the Delta is artificially fresh in October and subsequent months.

To simulate a 14-day shut down in south Delta exports during the October pulse flow on the San Joaquin River (modeled as October 16-31), the Petitioners assumed that Old and Middle River (OMR) flows would be limited to a minimum of -5,000 cfs during the whole month of October. (*See* DWR-515, p. 6, Table 3, footnote c.) A -5,000 cfs minimum OMR limit was also applied in November in the CALSIM II modeling study.

Note that the Petitioners are not recommending these minimum OMR limits in October and November as permit terms. They are merely modeling assumptions. These artificial modeling assumptions of a minimum OMR limit of -5,000 cfs in October

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[24] CCC-SC-21 is a true and correct copy of pages 1 through 7, page 110, and pages 151 through 159 of the Proceedings Report for The Science Enterprise Workshop: Supporting and Implementing Collaborative Science held on November 1-2, 2016.

[25] CCC-SC-22 is a true and correct copy of the Final EIR/EIS for the BDCP/Cal. WaterFix: Volume II, Responses to Comments, RECIRC 2597, pages 203 through 227.

and November did not apply to the No Action Alternative.

During the month of October, any releases from upstream reservoirs to meet D-1641 requirements for minimum flow in the Sacramento River at Rio Vista are unable to be captured at the south Delta export pumps, and therefore end up as additional Delta outflow for the whole month of October.

As discussed in CCWD's comments on the WaterFix RDEIR/SDEIS (CCC-SC-22), actual WaterFix operations in October would be able to capture the additional upstream reservoir releases during the 17 days in October when the south Delta export pumps are not shut down. The SWP and CVP could also use closure of the Delta Cross Channel during the 14-day export shutdown to meet the Rio Vista minimum flow requirements and avoid creating excess Delta outflow. That closure of the Delta Cross Channel would instead increase salinities in the south and central Delta, in stark contrast to the WaterFix modeling results where salinities artificially decrease in October.

CCWD stated that the "RDEIR/SDEIS fails to give adequate consideration to the changes to existing facilities operations that would necessarily occur due to implementation of the Preferred Alternative. This creates flaws in the analysis of water supply, water quality, and fisheries impacts." (CCC-SC-22, p. 207, comment 10.) The corresponding No-Action Alternative did not have the same problem with unrealistically high October outflow so the simulated change in water quality due to the proposed WaterFix project was significantly underestimated and the adverse impacts of the WaterFix project on Delta water quality are still not disclosed or mitigated.

Figure 1 in exhibit CCC-SC-23[26] shows a time series of the monthly-averaged Delta outflows for the month of October for water years 1922-2003 for the Biological Assessment Proposed Action and No Action Alternative. In most years, the October outflows for the No Action Alternative are the minimum allowed under D-1641, but the Proposed Action outflows are much higher. This is not a realistic simulation of the

[26] CCC-SC-23 is a true and correct copy.

operations of the WaterFix preferred alternative.

The effect of the unrealistic modeling of Delta operations in October on the estimates of water quality impacts in the Delta can be seen from the water quality changes in the western Delta for the months of August, September, and October. The DSM2 daily EC simulations for the Collinsville station on the Sacramento River near the confluence with the San Joaquin River and the entrance to Suisun Bay are used for this example. The WaterFix Final EIR/EIS acknowledges there will be months of substantial degradation at Emmaton in April and during July through September due to the WaterFix preferred alternative. (CCC-SC-24[27], excerpts from WaterFix FEIR/FEIS, Volume 1, Chapter 8, p. 8-938.)

Figure 2 in exhibit CCC-SC-23 shows the simulated daily-averaged Collinsville specific conductance (EC) data for the Biological Assessment Proposed Action plotted as a function of the Biological Assessment No Action Alternative for the month of September. Data above the 1:1 diagonal line represent months when salinity in the western Delta would increase relative to the No Action Alternative. The proposed WaterFix project would increase EC at Collinsville by 25% or more.

The corresponding simulated Collinsville daily-averaged EC data for the month of October, when there are often unrealistically high outflows in the with-project case, are shown in Figure 3. (Exhibit CCC-SC-23.) These unrealistically-high simulated outflows in October result in net reductions in salinity in the western Delta when compared to the No Action Alternative that had more realistic Delta outflows, *i.e.,* a minimum of 3,000 cfs in critical years and a minimum of 4,000 cfs in the other water year types. (SWRCB-21, SWRCB Water Rights Decision 1641, p. 184.)

The WaterFix Final EIR/EIS acknowledges that the "*level to which modeling output depicts degradation of water quality with respect to EC is primarily a function of the modeling not being able to fully capture how the system would be operated in real-*

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[27] CCC-SC-24 is a true and correct copy of pages 8-937 through -940 from the WaterFix Final EIR/EIS, Chapter 8.

time to minimize or avoid such degradation." (CCC-SC-24, excerpt from WaterFix Final EIR/EIS, Chapter 8, Water Quality, p. 8-938, line 21.) This was an attempt to minimize the significant adverse water quality impacts at Emmaton for April and July through September. The Final EIR/EIS further states: "*Discussions with SWP operators indicated that real-time operations would ensure that the Bay-Delta WQCP EC objectives at Emmaton, applicable from April 1 through August 15, would be met.*" (CCC-SC-24, excerpt from WaterFix Final EIR/EIS, Chapter 8, Water Quality, p. 8-938, line 24.) Real-time operations with the WaterFix preferred alternative will also result in lower Delta outflows in October closer to the D-1641 minimum outflows, and higher October and November salinities than disclosed in the Final EIR/EIS and hearing testimony. (DWR-513.)

The CALSIM II operations to meet Rio Vista flow requirements and to comply with a 14-day shutdown of the south Delta facilities in October need to be revised to more realistically capture how the Water Fix project would actually operate in October. The expected significant adverse water quality impacts of the proposed WaterFix project in October, and the corresponding reduction in south-of-Delta exports, must be fully disclosed and mitigated.

Unless the Petitioners complete new modeling runs that more realistically simulate operations in October and unless the modeling data are presented in sufficient detail to clearly disclose the expected significant adverse water quality impacts of the proposed WaterFix project in the Delta, the SWRCB will lack the basis to make an accurate or informed decision about the impact of the WaterFix project on the Delta environment and other key hearing questions. These corrected modeling runs should be submitted as testimony as part of this hearing with the parties given ample time to review and respond to the new simulations.

The artificially high outflows in October also underestimate potential adverse impacts of the proposed WaterFix project on key fish species because higher October outflows mean Fall X2 is also unrealistically low and not representative of what would

occur with WaterFix real time operations.

4.6 Excessive Exceedances of Water Quality Standards Render Water Quality Modeling Useless for Analyzing and Disclosing Water Quality Impacts of Proposed WaterFix Project.

The WaterFix water quality modeling shows frequent exceedances of the SWRCB D-1641 water quality standards, even in the No Action Alternative (NAA). The Petitioners have dismissed these impacts as modeling anomalies and discrepancies between the assumptions for the salinity-outflow relationship in the CALSIM II operations simulation model and the corresponding relationship between Delta salinity and outflow from the DSM2 water quality simulation model. (Transcript, Vol. 14, August 24, 2016, pp 37:5-39:2.) A few exceedances, in the form of distinct spikes in EC, are due to a mismatch between daily-averaged inflows to the Delta on the Sacramento River and monthly-averaged exports. (CCC-SC-25[28], WaterFix Final EIR/EIS, Chapter 8, Water Quality, p. 8-145:21, p. 8-146:30.)

Regardless of the reason for these exceedances, they render the water quality impact analysis useless for determining the significant adverse impacts of the WaterFix proposed project on Delta water quality. The exceedances mean that insufficient water was left in the Delta in the CALSIM II modeling to meet the D-1641 agricultural and municipal & industrial (M&I) water quality standards. That also means that too much water was exported in the month when the exceedance occurred. If the exceedance had been corrected through the use of a more accurate salinity-outflow computation in CALSIM II, then less water would be exported in that month, and additional water would likely be exported in subsequent months to meet annual demands. The impact on the Delta ecosystem and other beneficial uses of those exports in those subsequent months have not been disclosed. By failing to correct these exceedances of Water Rights

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[28] CCC-SC-25 is a true and correct copy of pages 8-140 through -154 of the WaterFix Final EIR/EIS, Chapter 8.

Decision 1641water quality standards in their modeling, the Petitioners are not fully disclosing the adverse impacts of the proposed WaterFix project on the Bay-Delta system.

The DSM2 water quality model is supposed to be calibrated and verified against historical data for the Bay-Delta system. (CCC-SC-25, p. 8-143, line 3 *et seq*.) Similarly, the salinity-outflow computation in the CALSIM II monthly operations model is supposed to be calibrated to emulate the DSM2 output. (CCC-SC-25, p. 8-141, line 25 *et seq*.) The fact that there are so many exceedances of water quality standards in the DSM2 modeling of WaterFix scenarios (*see*, e.g., DWR-66, p. 8, line 1 *et seq*., p. 10:25 *et seq*.) indicates that the salinity-outflow computation in CALSIM II is not accurate enough and must be replaced.

To fully disclose the impacts of the proposed WaterFix project on the Delta environment and other beneficial uses of water, the SWRCB's D-1641 water quality standards must be met in the WaterFix modeling, and the amount of Delta outflow and south-of-Delta exports must be accurately portrayed. It is not sufficient to simply state that "the models do not reflect the ability of the SWP/CVP operators to meet those water quality objectives." (DWR-66, p. 8:5.) These modeling flaws should be fixed, rather than merely dismissed.

The errors related to exceedances of the D-1641 water quality standards cannot be eliminated by doing a comparative analysis, for example by subtracting the results of a modeling study with WaterFix from the results without WaterFix (NAA). These exceedances are due to insufficient water being left in the Delta as Delta outflow to meet the D-1641 water quality standards. The impacts of any Bay-Delta water project on Delta water quality, and the Delta ecosystem, will tend to be greater when Delta outflows are lower (drier conditions) than when Delta outflows are higher (wetter conditions)[29]. Subtracting the with- and without-project results for a drier scenario will

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[29] For example, the relationship between salinity and Delta outflow is not linear. Reducing Delta outflow by, for example, 500 cfs when Delta outflow is only 4,500 cfs

not necessarily give the same comparative results as subtracting the with- and without-project results for a wetter scenario.

Unless the Petitioners present operations and water quality modeling analyses of the proposed WaterFix project that comply with D-1641, for example, no water quality exceedances exceeding the daily 250 mg/L chloride standard at the intake to the Contra Costa Canal off Rock Slough (*see, e.g.,* Figure C5 in DWR-513), the SWRCB will lack the basis to make an accurate or properly informed decision about the key hearing questions. Failure to meet the D-1641 standards also means that the Petitioners are overestimating how much water will be able to be exported with the proposed WaterFix project.

4.7 Operations and Water Quality Impact Analyses Are Not Representative of Future WaterFix Project Operations.

The modeling data presented by the Petitioners in this hearing (*see, e.g.,* DWR-513 and DWR-514) represent water project demands and climate change conditions in 2025-2030 which is as little as eight (8) years away. Resolving legal challenges to the proposed WaterFix project and constructing the new intakes, tunnels, Clifton Court Forebay facilities, and related infrastructure will likely take much longer than eight years. These short-term simulations of WaterFix operations are not representative of the future operations of the Delta with the WaterFix project and the potential future adverse impacts of the proposed project, because it is unlikely that the project will be operational within the next eight (8) years.

Unless the Petitioners have completed detailed modeling studies of the most recent version of the proposed WaterFix project under conditions most likely to occur at the time that the project is actually expected to be operating, the SWRCB will lack the basis to make an accurate or properly-informed decisions about the key hearing

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will cause a much greater increase in salinity than reducing outflow by 500 cfs when Delta outflow is 6,000 cfs.

questions for Part 2 of this hearing.

4.8 The 16-Year Period Chosen by the Petitioners for the Water Quality Modeling is not Representative of the Full 82-Year Period Used for the Operations Modeling.

The Petitioners submitted an exhibit in Part 1 of this hearing (DWR-511) that attempts to argue that the period 1975-1991 (16 years) is representative of the range of hydrology and operations that might be expected to occur when the WaterFix project is in operation. However, the operations modeling using CALSIM II was carried out for a longer period, 1922-2003 (82 years, more than 5 times longer), which represents a more diverse range of Central Valley hydrology and operating conditions.

As part of their modeling for the WaterFix Biological Assessment (SWRCB-104), the Petitioners carried out a full 82-year water quality simulation using DSM2. This water quality modeling was released to the public on February 3, 2016, prior to Petitioners' due date of March 30, 2016 for Part 1A written testimony and exhibits.

DWR-511 states that "DWR staff found that there is at times greater increases in chlorides in the 82-year simulation period than there are in the 16-year period when looking at the average monthly results." (DWR-511, p. 5A-D208.) This should have been a serious red flag to the Petitioners and suggests that they should have used the best available data – in this case, the full 82-year period – in their hearing testimony, rather than the 16-year period they selected. However, despite this finding, this DWR staff memo (DWR-511) determined that the conclusions based on the 82-year time period do not add any additional accuracy or value to the analysis.

4.8.1 Difference in distribution of water year type for the 82-year and 16-year periods

Table 1 of exhibit CCC-SC-26[30] gives the distribution of the five D-1641 water year types for the 82-year and 16-year periods. This table reproduces the data from the

[30] CCC-SC-26 is a true and correct copy.

table in exhibit DWR-511 (p. 5A-D212). It also includes a column showing the percentages that were used to develop the D-1641 water year type classifications. The short 16-year period is not statistically representative of the distribution of water year types and the range of different transitions from one water year type to the next year's water type. The short 16-year period has a much higher percentage of dry and critical years than the full 82 years.

Figure 1 of CCC-SC-27[31] shows cumulative probability distributions of the Sacramento Valley 40-30-30 water year indices for three different periods: (a) full available historical period 1906-2016 (111 years); (b) the 82-year period used for CALSIM II operations modeling (1922-2003); and, (c) the 16-year period used for most DSM2 water quality modeling (1976-1991). The D-1641 transitions between water year types are shown as horizontal black lines (SWRCB-21, p. 188). The water year indices were obtained from DWR's California Data Exchange Center Historical Water Supply Index website[32] (DWR-552). The cumulative probability for the 16-year period is much lower than for the longer periods suggesting again that the 16-year period is much drier than the 82-year period.

The DWR staff memo acknowledges that "*different year types following each other will impact the magnitude*" of water quality changes. (DWR-511, p. 5A-D215.) For example, a change from a critical year to a below normal year might be expected to result in some restoration of water quality in the Delta but the general increase in Delta flows will not be as large as for a change from a critical year to a wet year. In a wet year there is often enough flow to substantially freshen the Delta and the impacts of a new Bay-Delta project would be less significant in a wet year.

The impacts for a below normal year would likely be more significant. The 16-year period only contains one below normal year and that is preceded at early long term (2025) by a wet year. The 16-year period does not include any representations of this

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[31] CCC-SC-27 is a true and correct copy.
[32] Available at http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST

type of transition from a critical year to a below normal year.

The DWR staff memo incorrectly concludes that "*the 16-year DSM2 model is the best available model for the BDCP analysis. 82-year DSM2 results will not add additional value to this project.*" (DWR-511, p. 5A-D216.)

4.8.2 Difference in range of daily-averaged EC on Old River at Bacon Island for March for the 82-year and 16-year periods

I analyzed the full 82-year water quality data set for the WaterFix Biological Assessment Proposed Action (PA) and the corresponding No Action Alternative (NAA) and compared the results with a smaller 16-year subset (water years 1976-1991). The location I chose is Old River at Bacon Island which is representative of the water quality influencing the chloride concentrations at the SWRCB's D-1641 municipal and industrial compliance location at the intake to the Contra Costa Canal. Seawater intrusion into the Delta at this station also contributes to the water quality at Contra Costa Water District's other intakes on Old River at Highway 4 and Victoria Canal, and to the water quality at the SWP and CVP export facilities in the south Delta.

As shown in Figure 1 of exhibit CCC-SC-28[33], there is a large difference between the 82-year averages of specific conductance (EC) increase for each month of the year and the 16-year subset (1976-1991). This is especially noticeable in March when the WaterFix project would degrade water quality. The 82-year average increase in EC is 97 µS/cm, which is 3.5 times larger than the 16-year average (28 µS/cm). An EC of 97 µS/cm represents a chloride concentration increase of about 28 mg/L, which is significant. The conversion from EC to chloride concentration when seawater intrusion dominates is as given in exhibit DWR-509.

Similarly, in November, the average improvement in water quality for the full 82 years (-160 µS/cm) is appreciably less than the possible benefit of the WaterFix project when expressed as a 16-year average (-210 µS/cm). In other words, using a 16-year average underestimates the adverse impacts on water quality and exaggerates the

[33] CCC-SC-28 is a true and correct copy.

improvements.

However, the long-term averages used by the Petitioners to present the WaterFix modeling data mask potentially serious adverse impacts in individual months within the full 1922-2003 period. These long-term averages also hide the fact that the water quality modeling studies for the WaterFix project exceed the SWRCB's D-1641 water quality standards by a very large margin. (*See*, *e.g.,* DWR-513, Figure C-5). The long-term averaging also means there are only 12 data points for each alternative – one data point for each calendar-year month.

Figure 2 in exhibit CCC-SC-28 shows the 16-year and 82-year averages of Bacon EC data for March from the Biological Assessment modeling with the Proposed Action EC plotted as a function of the No Action Alternative EC (red square and blue diamond, respectively). As was shown in Figure 1 in exhibit CCC-SC-28, the averages for the PA and NAA for the two averaging periods are very different.

The EC equivalent of 150 mg/L chloride concentration is also shown. Old River at Bacon Island is very close to the D-1641 Contra Costa Canal intake municipal and industrial (M&I) compliance location which is set in terms of chloride concentration. One of the Contra Costa Canal intake standards requires meeting 150 mg/L chloride concentration for a given number of days per calendar year, depending on water year type (SWRCB-21).

This form of scatter plot (x-y plot) appears complicated at first glance but is useful for presenting the full data set at one time. Data above the 1:1 diagonal line represent adverse water quality impacts of the WaterFix project. Data points below the diagonal line represent improvements in water quality.

Figure 3 in exhibit CCC-SC-28 shows the 16-year subset of daily-averaged Bacon EC data for the month of March from the Biological Assessment modeling with the Proposed Action EC plotted as a function of the No Action Alternative EC (16 x 31 = 496 data points). Data above the 1:1 diagonal line represent adverse water quality impacts of the WaterFix project. Data points below the diagonal line represent

improvements in water quality.

Figure 3 in exhibit CCC-SC-28 also shows the corresponding 16-year and 82-year averages for March (red square and blue diamond, respectively). The daily-averaged data vary of a large of EC and show more detail than the two long-term average data points. The EC equivalents of 100 and 150 mg/L chloride concentration are also shown.

Figure 4 in exhibit CCC-SC-28 shows the full 82-year subset of daily-averaged Bacon EC data for the month of March from the Biological Assessment modeling with the Proposed Action EC plotted as a function of the No Action Alternative EC (82 x 31 = 2,542 data points). Data above the 1:1 diagonal line represent adverse water quality impacts of the proposed WaterFix project. Data points below the diagonal line represent improvements in water quality. Also shown are the corresponding 16-year and 82 year averages for March (red square and blue diamond).

The full 82-year data set shows a much larger range of water quality increases (Figure 4, CCC-SC-28) than the 16-year subset (Figure 3, CCC-SC-28). As shown in Figure 4 of exhibit CCC-SC-28, there are adverse water quality impacts (increases in salinity) due to the proposed WaterFix project of as much as 600 µS/cm, or about 170 mg/L chloride concentration. These significant water quality impacts were not disclosed by the 16-year data set utilized by the Petitioners for this proceeding. This finding from my analysis of the 82-year data set is consistent with the finding in DWR's draft memorandum that there are at times greater increases in chlorides in the 82-year simulation period than there are in the 16-year period when looking at the average monthly results. (DWR-511, p. 5A-D208.)

Unless the best available water quality data, in this case the full 82 years of data (1922-2003), is used for an analysis of the proposed WaterFix project's adverse environmental impacts, the SWRCB will lack the basis to make an accurate or fully informed decision about the key hearing questions for Part 2 of this hearing.

Note that the 16-year and 82-year averages for Old River at Bacon Island EC in

March shown in Figures 1, 2, 3 and 4 of exhibit CCC-SC-28 are within the range 300-400 µS/cm. They are not representative of the much larger range of water quality changes of the daily water quality data, including increases in chloride concentrations of as much as 170 mg/L. The effect of the long-term averaging masks significant adverse impacts on water quality in the Delta.

4.8.3 Difference in range of daily-averaged EC on Old River at Bacon Island for November for the 82-year and 16-year periods

Figure 5 of exhibit CCC-SC-28 shows the corresponding full 82-year subset of daily-averaged Bacon EC data from the Biological Assessment modeling for the month of November (instead of March). The Proposed Action daily EC is plotted as a function of the No Action Alternative EC (82 x 30 = 2,460 data points). Data above the 1:1 diagonal line represent adverse water quality impacts of the proposed WaterFix project. Data points below the diagonal line represent improvements in water quality. Also shown are the corresponding 16- year and 82 year averages for November (red square and blue diamond).

The full 82-year set of water quality data for November do suggest a net improvement in water quality at Old River on Bacon Island. However, as was discussed in section 4.5of this testimony, the proposed WaterFix project simulations of water quality impacts in October, November, and even December are suspect because of the artificially high Delta outflows in the CALSIM II operations studies in October. Actual outflows in October will likely be closer to the D-1641 minimum outflow requirements and seawater intrusion into the Delta will be larger. The artificially high October outflows did not occur in the No Action Alternative. This means that the absolute salinities with the WaterFix project were too low, and that the relative change in salinity was also underestimated.

Figure 5 in exhibit CCC-SC-28 also shows another major problem with the water quality modeling for the WaterFix project. The daily EC values are often well in excess of 1,053 µS/cm, which is the equivalent of 250 mg/L chloride concentration (according

to the conversion equations in DWR-509). The D-1641 compliance location in this area for both the 250 and 150 mg/L chloride standards is off Rock Slough at the intake to the Contra Costa Canal. However, the water quality at the compliance location is strongly influenced by the water quality at the Bacon Island station. The highest EC value for the No Action Alternative is 2,781 µS/cm, which is the equivalent of 743 mg/L chloride concentration.

The Petitioners attempt to dismiss the numerous and significant modeled water quality exceedances at Emmaton, Rock Slough and elsewhere, using CALSIM II and DSM2, as anomalies. (DWR-66, p. 3:7.) However, having chloride concentrations as high as 743 mg/L in an area where the maximum allowable daily value is 250 mg/L renders the water quality impact analysis invalid. As the Petitioners state, "*the models do not reflect the ability of the SWP/CVP operators to meet those water quality objectives*." (DWR-66, p. 8:2.)

In real time operations of the Delta by the SWP and CVP project operators, the 250 mg/L standard would be met, by among other things, increasing Delta outflow. To reduce chloride concentrations from 700 mg/L or more down to 250 mg/L would require a significant amount of additional outflow to reduce seawater intrusion into the Delta. This would in turn likely mean that less water would be able to be exported at that time. As part of real time operations, the SWP and CVP operators would typically attempt to make up for that loss of exports, and meet contract water demands, in subsequent months. This would then have the potential to reduce Delta flows and increase environmental impacts in those subsequent months. Those impacts on the Delta environment and other beneficial uses of water have not been disclosed by the Petitioners.

The Petitioners' modeling of the proposed WaterFix project is flawed because it relies on operations studies and water quality analyses that do not comply with the SWRCB's municipal and industrial and agricultural water quality standards, and that fail to accurately simulate actual flow and export operations and the corresponding impacts

on the Delta environment.

Unless the Petitioners provide new modeling simulations that fully comply with the D-1641 water quality standards and do not include artificial spikes in salinity due to a mismatch between daily-averaged Sacramento River inflows and monthly-averaged Delta exports, the SWRCB will lack the basis to make an accurate or fully informed decision about the water quality impacts of the WaterFix project and the key hearing questions for Part 2 of this hearing. The parties to this hearing should be given ample time to review these new data and respond.

4.9 The Proposed WaterFix Project Will Likely Harm Fish Because the Largest Diversion Point in the Delta, Clifton Court Forebay, Would Remain Unscreened.

The proposed WaterFix project does not include state-of-the-art fish screens for the intake to the Clifton Court Forebay, even though diversions there can be as high as 10,300 cfs as a daily average, and even higher when the intake gates are open for only half of the tidal cycle. There are feasible solutions for screening Clifton Court such as the proposed design in DWR's November 2009 Conceptual Engineering Report – Through-Delta Facility Conveyance Option. This detailed Conceptual Engineering Report recommends a new screened intake on Victoria Canal from which the water would then be conveyed via a siphon into Clifton Court Forebay. (CCC-SC-31[34], Figures 7-5 and 20-1-from the Conceptual Engineering Report.)

The proposed WaterFix project would still rely on diversions from the south Delta into Clifton Court for approximately half of the total WaterFix south-of-Delta exports. A proposed Delta project that fails to screen the largest diversion point in the Delta is not in the public interest.

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[34] CCC-SC-31 is a true and correct copy of Figures 7-5 and 20-1 from DWR's November 2009 Conceptual Engineering Report – Through-Delta Facility Conveyance Option.

4.10 The Version of the Proposed WaterFix Project in the Biological Assessment Does Not Lie Within the Range of Alternative 4A, Scenarios H3 and H4.

The Petitioners testified in Part 1 of this hearing that the proposed WaterFix project lies between Alternative 4A Scenarios H3 and H4 (Transcript, Vol. 4, July 29, 2016, pp. 39:9 – 40:2; Transcript, Vol. 4, July 29, 2016, pp. 70:10 - 71:12; Transcript, Vol. 4, July 29, 2016, pp. 129:21 – 130:22). This was also presented by the Petitioners in the form of a range diagram. (CCC-SC-32[35] (p. 10 from DWR-1 errata (corrected)).)

However, a more recent version of the proposed WaterFix project prepared for the WaterFix Biological Assessment – the Proposed Action, also called Scenario H3+ – has very different operations than for Scenarios H3 and H4. For example, the total south-of-Delta exports in April and May for the Proposed Action are much smaller than for either Scenarios H3 or H4. (CCC-SC-33[36].)

Scenarios H3 and H4 assumed that the 2009 NMFS Biological Opinion (SWRCB-84) requirements for the limits on the ratio of San Joaquin inflow to south Delta exports did not apply. (DWR-116.) The Proposed Action (Scenario H3+) for the WaterFix Biological Assessment (SWRCB-104) complies with those 2009 NMFS Biological Opinion requirements.

Table 1 in exhibit CCC-SC-33 clearly shows how the total south-of-Delta exports for April and May for Scenario H3+ are much less than for H3 or H4 and do not lie within that range. The data in Table 1 are derived from Tables 5E-75 and 5E-78 in Appendix 5E of the BDCP/WaterFix Final EIR/EIS (CCC-SC-34[37].) In the other months, the Proposed Action (H3+) exports are larger than either Scenario H3 or H4. This suggests that other key flow parameters may also lie outside the range of H3 to H4.

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[35] CCC-SC-32 is a true and correct copy of page 10 from exhibit DWR-1 errata (corrected).
[36] CCC-SC-33 is a true and correct copy.
[37] CCC-SC-34 is a true and correct copy of Tables 5E-75 and 5E-78 from the WaterFix Final EIR-EIS, Appendix 5E.

Unless the Petitioners present new detailed modeling results and analysis for the most recent version of the proposed WaterFix project, the SWRCB will lack the basis to make an accurate or fully informed decision about the key hearing questions for this hearing. As shown in exhibit CCC-SC-33, the most current version of the proposed WaterFix project is not represented by the range between Scenarios H3 and H4. The parties to this hearing should be given ample time to review these new data and respond.

4.11 Petitioners Must Disclose How the Ratios of Inflows and Outflows to Unimpaired Flow for the WaterFix Alternatives Compare with the SWRCB's 2010 Delta Flow Criteria.

The SWRCB is considering requiring new minimum inflow and outflow requirements for the Delta as part of Phase 1 and 2 of its current update of the Bay-Delta Water Quality Control Plan. These new minimum flow objectives will likely be set as a percentage of the corresponding unimpaired flow into the Delta consistent with the SWRCB's 2010 Delta Flow Criteria Report (SWRCB-25). The Petitioners have not presented any data so far in this hearing that discloses whether the flows with the proposed WaterFix project are close to, or well below, the percentages of unimpaired flow likely to be required by the SWRCB.

Figure 1 in exhibit CCC-SC-35[38] shows the simulated monthly-averaged Delta outflow as a percentage of unimpaired flow for the Biological Opinion Proposed Action for the period October 1993 through September 2003. The estimated historical unimpaired outflows are from DWR's March 2006 draft report[39], "Estimates of Natural and Unimpaired Flows for the Central Valley of California: Water Years 1922-2014."

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[38] CCC-SC-35 is a true and correct copy.

[39] DWR Draft Unimpaired Flow Report is available at https://msb.water.ca.gov/documents/86728/a702a57f-ae7a-41a3-8bff-722e144059d6

(CCC-SC-36[40].) Historical unimpaired flows were used because revised unimpaired flows for year 2025 have not been made available by DWR. While the outflow percentages for February and March, and sometimes January, meet or exceed the 75% January-June minimum proposed by the SWRCB in 2010 (SWRCB-25) the percentages for most of the data shown in exhibit CCC-SC-36 are much less than 75%. In some cases the percentages are less than 30%.

The change in timing and intensity of unimpaired flows with global climate change might be expected to change the outflow percentages in Figure 1 in exhibit CCC-SC-35, but many of the outflow/unimpaired flow percentages would still likely be less than 75%.

Figure 1in exhibit CCC-SC-35 is intended for illustrative purposes only. Unless the Petitioners provide evidence and testimony regarding the percentages of unimpaired flow that apply to different WaterFix alternatives, the SWRCB will lack the basis to make an accurate or fully informed decision about the whether the flows are sufficient to full protect fish species and about other key questions for this hearing.

5. Principles for Developing Water Right Permit Terms

In light of the significant problems with the proposed WaterFix conveyance-only project outlined in my testimony, the SWRCB should deny the water rights change petition.

However, if the SWRCB decides to grant a water rights petition change, I propose, on behalf of Contra Costa County, Solano County, and the Contra Costa County Water Agency, that the SWRCB consider the following principles in developing permit terms for the amended permits.

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[40] CCC-SC-36 is a true and correct copy of the cover and pages B-58 and B-59 of DWR's March 2006 draft report, "Estimates of Natural and Unimpaired Flows for the Central Valley of California: Water Years 1922-2014."

5.1 Set specific limits on the operation of the proposed WaterFix Project.

For example, any permit should set the maximum diversion rate at new north Delta intakes. Future changes to the CVP and SWP systems, such as the addition of new pumps at the downstream end of the tunnels or an increase in the amount of surface and groundwater storage in the south-of-Delta export area, could increase the quantity and timing of water exported south of the Delta without triggering a further hearing before the SWRCB. The SWRCB should also consider limiting the quantity of north Delta and total Delta diversions by water year type.

5.2 Ensure that the proposed WaterFix project exports less water in the drier periods.

A Bay-Delta project that relies on exporting more water during drier periods when the Delta ecosystem is more vulnerable is not in the public interest. As discussed in section 4.2, this limit on exports during drier periods when Delta outflows are lowest could take the form of total south-of-Delta exports less than or equal to 1.5 times Delta outflow. This could also be designed to be consistent with the State policy of reducing reliance on the Delta in meeting California's future water supply needs. (Cal. Wat. Code § 85021).

5.3 Limit use of the proposed new north Delta intakes and tunnels to times when Delta outflows are consistent with the SWRCB's 2010 Delta Flow Criteria.

The SWRCB's 2010 Delta Flow Criteria were selected as the flows needed in the Delta ecosystem for fishery protection under existing conditions. Until the SWRCB finalizes its revision of the Bay-Delta Water Quality Control Plan and implements new minimum flow requirements in the Bay-Delta water rights permits and licenses, the SWRCB should consider prohibiting use of the proposed WaterFix intakes and tunnels, if built, unless Delta outflows are high enough to be consistent with the SWRCB's 2010

Delta Flow Criteria. Such a limit could help ensure that fish and the Delta ecosystem are protected until the WQCP update process is completed.

5.4 Ensure that the proposed WaterFix Project does not reduce Sacramento inflows to the Delta.

The operations of the proposed WaterFix project will, at times, decrease the inflow to the Delta from the Sacramento Valley above the proposed new north Delta intakes. (CCC-SC-19.) The Petitioners have not clearly disclosed that the proposed project will often reduce Sacramento River inflows to the Delta at Freeport. Reducing Sacramento inflows to the Delta at Freeport has the potential to adversely impact key fish species, especially salmon species, migrating through the Delta.

5.5 Require new environmental analyses of Bay-Delta impacts if future changes to the SWP and CVP systems allow greater use of the proposed new WaterFix facilities, and require a new water rights hearing

The SWRCB should require a full CEQA/NEPA analysis and a new water rights hearing for any future projects that could increase the ability of the SWP and CVP to export water via the proposed new north Delta intakes and tunnels.

6. Conclusions

The operations and water quality modeling performed by the Petitioners for the proposed WaterFix project, when evaluated closely, indicate that the project is not in the public interest. The proposed WaterFix project fails to contribute to achieving the coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. (Cal. Wat. Code § 85054.)

The modeling of the water quality impacts of the proposed WaterFix project is fatally flawed because the Delta outflows in the month of October are artificially high

and not consistent with the probable real time operations. It is, therefore, not possible to draw any conclusions from the water quality data presented by the Petitioners regarding adverse water quality impacts in the Delta on ecosystem, urban, agricultural and recreational water uses. However, the proposed WaterFix project will reduce the flow of Sacramento River water through the Delta and will reduce the freshening effect of Sacramento flow into the south and central Delta. These factors would contribute to significant degradation of water quality in Delta water quality. This is contrary to the policy of the State of California which is to improve water quality to protect human health and the environment consistent with achieving water quality objectives in the Delta. (Cal. Wat. Code § 85020(e).)

Unless new modeling of the most current version of the proposed WaterFix project is completed to correct the numerous flaws in the modeling presented by the Petitioners, the SWRCB will lack the basis to make an accurate or properly informed decision about the key hearing questions. In particular, the new modeling should correct the unrealistically high Delta outflows in October. The data should also be presented in detail to make the modeling data usable by decision makers and the public. If the Petitioners present this or any other new modeling data, additional hearing days should be added to the current hearing to allow other parties to present direct testimony and to cross examine the Petitioners' modeling and operations witnesses regarding the new modeling information.

However, if the SWRCB decides to grant a water rights petition change, the SWRCB should consider the principles for developing permit terms for the amended permits proposed in this testimony.

Executed on this 29th day of November, 2017, in Oakland, California.

Richard A. Denton, Ph.D., P.E.