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BEFORE THE CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

In the matter of Hearing re CalWaterFix Petition for Change

SURREBUTTAL TESTIMONY OF SUSAN PAULSEN

I. QUALIFICATIONS

My name is Susan Paulsen and I am a Registered Professional Civil Engineer in the State of California (License # 66554). My educational background includes a Bachelor of Science in Civil Engineering with Honors from Stanford University (1991), a Master of Science in Civil Engineering from the California Institute of Technology ("Caltech") (1993), and a Doctor of Philosophy (Ph.D.) in Environmental Engineering Science, also from Caltech (1997). My education included coursework at both undergraduate and graduate levels on fluid mechanics, aquatic chemistry, surface and groundwater flows, and hydrology, and I served as a teaching assistant for courses in fluid mechanics and hydrologic transport processes.

I currently am a Principal and Director of the Environmental and Earth Sciences practice of Exponent, Inc. ("Exponent"). Prior to that, I was employed by Flow Science Incorporated, in Pasadena, California, where I worked for 20 years, first as a consultant (1994-1997), and then as an employee in various positions, including President (1997-2014). I have 25 years of experience with projects involving hydrology, hydrogeology, hydrodynamics, aquatic chemistry, and the environmental fate of a range of constituents.

My Ph.D. thesis was entitled, "A Study of the Mixing of Natural Flows Using ICP-MS and the Elemental Composition of Waters," and the major part of my Ph.D. research involved a study of the mixing of waters in the Sacramento-San Joaquin Bay-Delta (the Delta) using source water fingerprints. I also directed model studies to use chemical source fingerprinting to validate volumetric fingerprinting simulations using Delta models (including the Fischer Delta Model (FDM) and the Delta Simulation Model (DSM)). I have designed and directed numerous field studies within the Delta using both elemental and dye tracers, and I have designed and directed numerous surface water modeling studies within the Delta.

For my testimony in this matter, I incorporate my prior report and exhibits I submitted in support of Brentwood's case in chief into this sur-rebuttal testimony. A copy of my curriculum *vitae* is included as Exhibit Brentwood-101.

II. SUMMARY OF TESTIMONY

I was retained by the City of Brentwood to assist the City in its evaluation of the California WaterFix Project (WaterFix). I provided testimony to the State Water Resources Control Board (State Board) during Phase 1 of the WaterFix hearings as detailed in Exhibits Brentwood-100 through Brentwood-117, including Brentwood-102 Errata. I also provided testimony at the State Board proceedings on December 14, 2016. The testimony presented here is not intended to be duplicative of information previously provided to the State Board, but is intended to address three Sur-Rebuttal Opinions:

- Sur-Rebuttal Opinion 1: DSM2 shows exceedances of D-1641 standards, and we believe these exceedances are "real."
- Sur-Rebuttal Opinion 2: More effective methods exist to evaluate water quality objectives than those used by DWR.
- Sur-Rebuttal Opinion 3: The EC to chloride conversion used by Exponent is more conservative than the conversion used by DWR, and both chloride concentrations and project impacts calculated by Exponent are underestimated slightly.

III. TESTIMONY

A. Sur-Rebuttal Opinion 1: DSM2 shows exceedances of D-1641 standards, and we believe these exceedances are "real."

Dr. Nader-Tehrani has provided rebuttal testimony stating "the modeled exceedances in D-1641 agricultural, municipal, and industrial water quality objectives are not real, and occur mainly due to a difference in the assumptions in DSM2 and CalSim II, including a difference in the size of the time-step in the two models." (DWR-79, 45:18-21) Dr. Nader-Tehrani further explained in his testimony that "the modeled exceedances of all the scenarios presented during the hearing, including the NAA, are a result of: (1) limitations of the modeling process used in analyzing the CWF scenarios, or (2) a stressed CVP-SWP system under extreme operational conditions." (DWR-79, p.35:9-11)

In my analysis presented in Brentwood-121, I show that neither "extreme conditions" nor the three examples of "model limitations" presented by Dr. Nader-Tehrani can explain the long

periods of exceedance of the 250 mg/L chloride water quality objective at CCPP#1 for the Boundary 1 scenario (up to 85 continuous days). As detailed in Brentwood-121, the differences in simulated chloride concentrations at CCPP#1 between baseline model runs and the WaterFix scenarios are primarily a function of the differences in inflows, exports, and diversions—i.e., they are a direct function of the WaterFix project operations as compared to baseline (without WaterFix) conditions. To the best of my knowledge, DWR has not conducted an analysis to describe the operational adjustments that would be needed to avoid the long periods of exceedance that are shown in DWR's DSM2 simulation results. Further, Dr. Nader-Tehrani has not conducted, to the best of my knowledge, an analysis to characterize the "water cost" that would need to be imposed upon the SWP and CVP to avoid these exceedances. In summary, it is unclear how Dr. Nader-Tehrani reached his conclusions.

The ability of DSM2 to simulate Delta hydrodynamics is well-established, and DSM2 has been calibrated for salinity and can simulate salinity reasonably well at a number of Delta locations, including the western Delta. In my opinion the DSM2 model results provide a "real" indication of the likely rate of exceedance of D-1641 water quality objectives for different WaterFix scenarios.

B. <u>Sur-Rebuttal Opinion 2: More effective methods exist to evaluate water quality objectives than those used by DWR.</u>

DWR used both exceedance probability diagrams and long-term averages compiled from DSM2 results to assess potential impacts of WaterFix. For example, Dr. Nader-Tehrani used a probability exceedance diagram to assess D-1641 compliance with the 250 mg/L water quality objective at CCPP#1, and he testified that this was the "best way" he knew to analyze for water quality objective exceedances. (SWRCB California WaterFix Water Right Change Petition Hearing Transcript Volume 44, p. 2:23-24. May 12, 2017) In my opinion, there are more effective methods to evaluate compliance with water quality objectives.

Probability exceedance diagrams constructed from model output for the entire 16-year simulation period, such as those discussed by DWR in its rebuttal testimony, have the effect of obscuring important information; nonetheless, probability exceedance diagrams can be a valuable

tool and provide useful information. For example, probability exceedance diagrams constructed using DWR's Boundary 1 model results for dry and normal years, which occur approximately 55% of the time based on the historical record, indicate a substantial increase in the number of days per year predicted to exceed the D-1641 250 mg/L chloride objective relative to the 16-year simulation period as a whole.

In addition, daily average chloride data as shown in Brentwood-121 Figure 4 are important as they indicate when, for how long, and to what extent exceedances are simulated to occur. A time series of simulated daily salinity values is more useful than long-term cumulative probability diagrams to a water purveyor determining impacts upon their drinking water operations, and potentially more useful to the State Board seeking to determine the extent to which the WaterFix project will comply with water quality objectives.

C. Sur-Rebuttal Opinion 3: The EC to chloride conversion used by Exponent is more conservative than the conversion used by DWR, and as a result both chloride concentrations and project impacts calculated by Exponent are underestimated slightly.

Dr. Nader-Tehrani testified that "Dr. Paulsen explains in her testimony that she uses a different EC-to-chloride conversion in her analysis of WaterFix" (SWRCB California WaterFix Water Right Change Petition Hearing Transcript Volume 43 p.18:6-8. May 11, 2017). Dr. Nader-Tehrani stated that he was "just clearly making a point that the modeling that was done for California WaterFix uses a different conversion, and therefore, when you do that, you may not get the same numbers." (SWRCB California WaterFix Water Right Change Petition Hearing Transcript Volume 43 p.18:11-15. May 11, 2017) When asked if he disagreed with the conversion factor used by Exponent, he clearly stated, "I don't have an opinion." (SWRCB California WaterFix Water Right Change Petition Hearing Transcript Volume 43 p.18:19-20. May 11, 2017.) Dr. Nader-Tehrani later stated (on redirect) that "It is extremely important that the same conversion EC-to-chloride is used in both CalSim and DSM2." (SWRCB California WaterFix Water Right Change Petition Hearing Transcript Volume 43 p 56:17-23. May 11, 2017.) In response to this testimony, I evaluated the conversion factors used by Exponent and DWR, and the difference in analysis results and conclusions that result from those conversion

factors. I conclude that the differences in conversion equations used by Exponent and DWR do not affect the analyses or conclusions presented by Exponent. If Exponent had used the same conversion equation as DWR to evaluate exceedances of D-1641 objectives or to evaluate water quality impacts to the City of Brentwood, project impacts to water quality would have been slightly more substantial than those I originally presented.