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On behalf of Central Delta Water Agency,
South Delta Water Agency, Lafayette Ranch,
Heritage Lands, Mark Bachetti Farms
and Rudy Mussi Investments L.P.

STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD

Hearing in the Matter of California Department of Water Resources and United States Department of the Interior, Bureau of Reclamation Request for a Change in Point of Diversion for California Water Fix	**THOMAS K BURKE'S WRITTEN SUMMARY OF TESTIMONY IN SUPPORT OF THE SOUTH DELTA WATER AGENCY PARTIES' CASE-IN-CHIEF FOR PART 1B OF THE CALIFORNIA WATERFIX CHANGE PETITION**

1. I, Thomas Burke, submit this written testimony at the request of Protestants South Delta Agency, Central Delta Water Agency, Lafayette Ranch, Heritage Land Company, Mark Bachetti Farms and Rudy Mussi Investments L.P., the ("South Delta Parties/Protestants.") The matters contained herein are true and correct and based upon my personal knowledge. If called upon to testify to them, I would and could do so.

Background and Qualifications

2. I am a hydrologist and water resources engineer with over 35 years of experience in surface water and groundwater hydrologic modeling. Prior to starting Hydrologic Systems Inc., I held the position of Senior Associate with PWA, Western Regional Director of Water Resources for EA Engineering Science and Technology, and Hydraulic Engineer with the US Army Corps of Engineers. My experience ranges from development of two and three dimensional river and reservoir flow and circulation models to local and regional groundwater and transport models for basin-wide hydrologic analyses. My experience also includes the analysis of one and two-dimensional flow in river and wetland systems.

3. I hold a Master of Science in Civil Engineering from Colorado State University, Fort Collins (1992) and hold a Bachelor of Science in Civil Engineering from The University of Florida, Gainesville (1980). My Statement of Qualifications is marked as SDWA __.

4. I was retained in these matters by the South Delta Parties to analyze the potential impacts on the members of the South and Central Delta from the possible implementation of the Change Petition being requested by the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (BOR), (Petitioners) as part of the California Water Fix (CWF) project. More specifically, I was asked to: 1) , determine if there would be any change in salinity in the central and south Delta from the four potential operational scenarios that have been proposed by the Petitioners. 2) Determine if there would be any change to the water levels in the Delta that would result from implementing any of the four operational scenarios that have been proposed by the Petitioners. 3) Evaluate any change in residence time of waters in the central and south Delta from the four operational scenarios that have been proposed as part of the CWF project.

5. I have prepared a report summarizing my analysis, marked as Exhibit SDWA 47. I hereby incorporate that report as part of my written testimony.

Delta Hydrology and Hydrodynamics

6. Any analysis of water quality or availability in the Delta must begin with fundamental understanding of the hydrodynamics of the Delta. The Delta is connected to San Pablo Bay and San Francisco Bay through the Carquinez Straights. San Francisco Bay is connected to the Pacific Ocean. This connection allows the ocean tide to move water that is west of the Delta into the Delta during the incoming tide. As such, the Delta is tidally influenced which results in a constant resupply of water to the Delta. The tidal influence in the Delta extends through the central and south Delta. The water entering the Delta from the west mixes with the water that is entering the Delta from the San Joaquin River, Sacramento River, and other small tributaries along the east side of the Delta. The mixing of this tributary inflow with the diurnal tides entering from the west create a complex hydrodynamic system.

7. The tide moving into the Delta as measured at the City of Martinez, which lies along the Carquinez Straights, is approximately 6 feet from the mean higher tide to lower low tide. Consequently, the tide moving into the Delta essentially equates to a 6 foot slow moving wave of water entering the Delta each day. The area between high and low tide lines is called the tidal prism. The tidal prism defines the volume of water which is moved into the Delta with each tide cycle. The area below the tidal prism never dries out. In addition to the volume of water within the tidal prism, there is water in the channel below the tidal prism which is also flowing into the Delta with each tidal cycle. Over a typical cycle during the summer months approximately 170,000 acre feet of water moves into the Delta twice each day. There are two tidal cycles each day. Typically one cycle is higher than the other. As such, there are two high tides and two low tides.

8. The Delta channels, do not act like typical stream channels. Although it may appear counter-intuitive to some, water does not flow downhill. A basic law of physics is that water flows from a high head location to a low head location. In a typical stream the slope is the dominant factor that creates a high head location. But in a flat channel with little to no slope, the high head to low head condition can be created by the changing tides as well as pumping water into or out of the channel. If water is pumped from one location in the channel, the slight lowering of the water surface at that location can create a low head condition and water will flow in that direction. The effect of the relatively flat channels, numerous locations for pumping in the Delta, inflow from tributaries, exports , and the tidal influence at the outlet of the Delta create a very complex flow network of the interconnected channels that make up the Delta.

The California Water Fix Scenarios

9. The Petitioners have proposed four operational scenarios to define the range of exports that may be implemented in the CWF. These scenarios, labeled B1, H3, H4, and B2 consist of different sets of operational constraints that each scenario would conform to. The scenarios as listed go incrementally from a low export scenario, B1 to a high export scenario, B2.

Analysis of Effects on Salinity Levels from the CWF Scenarios

10. I performed an analysis to determine the effect that the CWF scenarios would have on the salinity in the Delta. To perform that analysis, I used the DSM2 models that were provided by the Petitioners. They were downloaded from the State Water Resources Control Board (SWRCB) FTP site. The site was created specifically for the hearing on the Petitioner's Water Rights Change Petition. There were five separate DSM2 models. Four of the models represented the four operational scenarios of the CWF project. The fifth model represented the No Action Alternative (NAA). The input to the DSM2 model was generated by the CALSIM II operations model for the Central Valley Project (CVP) and State Water Project (SWP).

11. The CALSIM II model was developed to run for an 82 year time period, Water Year (WY) 1922 to WY 2003. The DSM2 model was developed to run for a 16 year period WY 1976 to WY 1991. Given that the output from the CALSIM II model is used as input to the DSM2 model it is not understood why the DSM2 model was not run for the full period of the CALSIM II model. The shorter 16 year period is hydrologically different than the full 82 year period. This together with the short 16 year period, make high and low flow predictions from the results of the DSM2 model problematic and potentially unreliable.

12. To perform the salinity analysis, I identified 17 locations in the Delta that would provide information on water quality across the central and south Delta. I ran each of the five DSM2 models and evaluated the output from the models at each of those 17 locations. The 15-minute DSM2 output was used to create a daily average. The daily average salinity is provided in tables within Exhibit SDWA-51 and SDWA-53. The change in salinity was conducted by comparing the salinity from the output of each of the model that represented the CWF scenarios to the output from the model that represented the NAA. The DSM2 model analyzes flow through the Delta on a 15-minute time step. This allows for a very detailed comparison of the results from the different scenarios.

13. I plotted the DSM2 salinity model results from each of the different scenarios and the NAA alternative over the full time period that had been developed for the DSM2 models. Those plots are provided in Exhibit SDWA-49. The 15-minute data was averaged into a daily period for each scenario and the NAA. The difference between the salinity for each scenario and the NAA alternative were evaluated and plotted to see the change resulting from each CWF scenario. Those plots are provided in Exhibit SDWA-50. As can be seen in the plots, the CWF scenarios resulted in some very large increases in salinity as compared to the NAA. For the Old River at Tracy site, there were multiple instances where the difference in salinity was over 400µS/cm, and one period where the salinity was 650µS/cm greater than the NAA. These numbers represent a large increase in salinity. The Petitioners exhibits did not show a change this large due to the way that they averaged the results of the DSM2 model.

By developing a mean monthly average for salinity, they effectively averaged the 15-minute data into daily data then averaged the daily data into monthly data, then averaged the monthly data into mean monthly data which was averaged over the 16 year model period. The result of all that averaging is that the actual change in salinity from the CWF scenarios is masked. A further comparison of the model results revealed that the salinity for each of the CWF scenarios, is greater than the NAA roughly 50% of the time. Detailed plots for the time that the salinity for the CWF scenarios exceeded the NAA are provided in Exhibit SDWA-51.

Analysis of Effects on Stage from the CWF Scenarios

14. To evaluate the effect that the CWF scenarios may have on water level in the Delta channels, I ran the DSM2 models to evaluate the water level in the Delta downstream of the North Delta Diversion (NDD) No. 5. I then compared the stage results for all CFW scenarios and the NAA at a location immediately downstream of the NDD, 3 miles downstream of the NDD, and 9 miles downstream of the NDD.

15. The results from the above analysis showed that immediately downstream of the NDD, the maximum water level change was -4.1 ft. The maximum change 3 miles downstream of the NDD was -3.7 ft., and the maximum water level change 9 miles downstream of the NDD was -2.8 ft. Plots showing the timeseries of water level change for these three locations is provided in Exhibit SDWA47. A review of the plots shows that these maximum declines in water level do not occur very often, but there is a persistent reduction in water level that occurs for a major portion of each year.

Analysis of Effects on Stage from the CWF Scenarios

16. To evaluate the effect of the CWF scenarios on the residence time of water in the central and south Delta, I performed a volumetric flushing analysis on the Old and Middle Rivers. This analysis consisted of evaluating the change in the volume of water that is moved through the two rivers each year. The net positive volume of water that was conveyed through the river can be used as an index of the potential flushing of the system. An increase in the volume of water that is flushed through the river will lower the residence time, which can have beneficial impacts on temperature, nutrient concentration, and algal growth. A decrease in the volume of water that is flushed through the system can result in a buildup of nutrients, increased water temperatures, and an increase in algal growth.

17. The results from the above analysis were evaluated for a dry year. A dry year was selected because that is the year type when algal growth is most problematic. The analysis showed a decrease in positive flushing for all CWF scenarios in both rivers, except for scenario B1 for Middle River. The flushing volume decrease ranged from -1.5% to -9.5 % for Middle River. The flushing volume decrease ranged from +4.4% to -42% for Old River.

18. Details of all of the above analyses are provided in Exhibit SDWA47.

19. I declare under penalty of perjury under the laws of the state of California that the foregoing is true and correct.

Executed this 1 st day of September in Sacramento, California.

Thomas K. Burke

THOMAS K BURKE, P.E.