Appendix D-Attachment 3
CalSim-II X2 Analysis

Historically CalSim-II has always used an empirical equation developed by Kimmerer and Monismith (Kimmerer 1993) to estimate the monthly X2. However recent developments with the Artificial Neural Network (ANN) that CalSim-II uses for other salinity compliance has allowed for the use of the ANN to estimate the X2.

To show that the new implementation could replace the previously accepted Kimmerer and Monismith (KM) equation, two sets of comparisons were completed. One set looked at the ability of the Delta Simulation Model 2 (DSM2) and the KM equation to estimate historical calculated X2. The other set of comparisons looked at the ability of the ANN and the KM equation to estimate DSM2 in planning mode.

CalSim-II is a monthly model therefore the comparisons were on a monthly scale as well. For historical and DSM2 data X2 was determined by interpolating between four salinity monitoring stations to find that approximate location of 2.64 mmhos/cm. The four stations and respective distance from the Golden Gate are: Martinez at 56 km, Port Chicago (Roe Island) at 64 km, Chipps Island (Mallard Slough) at 74 km, and Collinsville at 81 km. The hourly electrical conductivity measurements for the historical data spanned 1997 to 2008 and were aggregated to monthly. DSM2 was run using historical inflows for a similar period and the 15 minute data were aggregated to monthly. The KM equation is based on a monthly time-step and so historical daily outflow data was aggregated to monthly and used in the equation.

Figure 1 shows the comparison between historical X2 and DSM2 as well as the KM equation based on historical outflow. The comparison between historical and DSM2 resulted in a slope of 1.16, an intercept of -12.0, and a R^2 of 0.95. The comparison between historical and the KM equation resulted in a slope of 0.92, an intercept of 4.5, and a R^2 of 0.83. From the comparison it is not easy to determine which relationship is more appropriate. We would like to see a slope of 1.0 and an intercept of 0 in order to have the best predictive model.

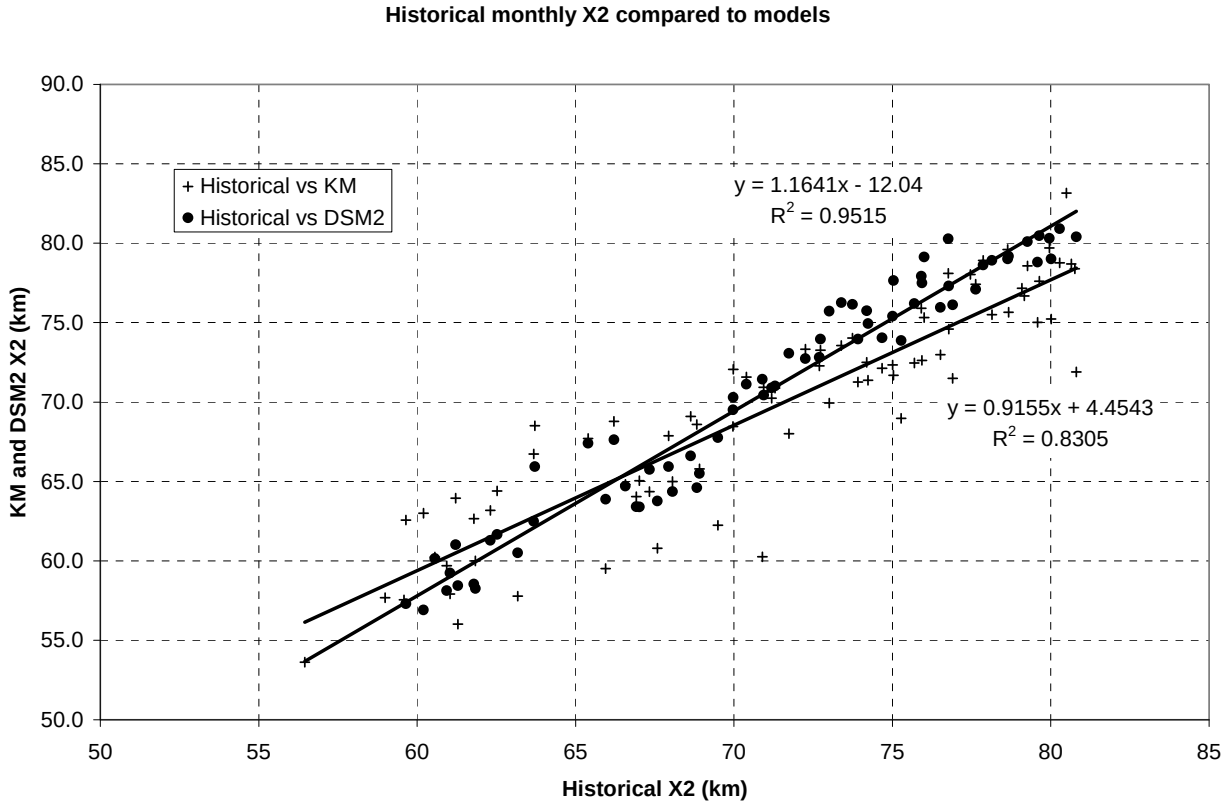

Figure 1 Historical comparison of X2.

The next set of comparisons compared DSM2 to the CalSim-II based ANN and KM equation. DSM2 was run using the same CalSim-II run from which the KM equation and ANN X2 results are being compared.

Figure 2 shows the comparison between DSM2 X2 and CalSim-II based KM and ANN X2. The comparison between DSM2 and the ANN resulted in a slope of nearly 1.0, an intercept of 1.5 and a R^2 of 0.98. The comparison between DSM2 and the KM equation resulted in a slope of 0.71, an intercept of 23.1, and a R^2 of 0.91

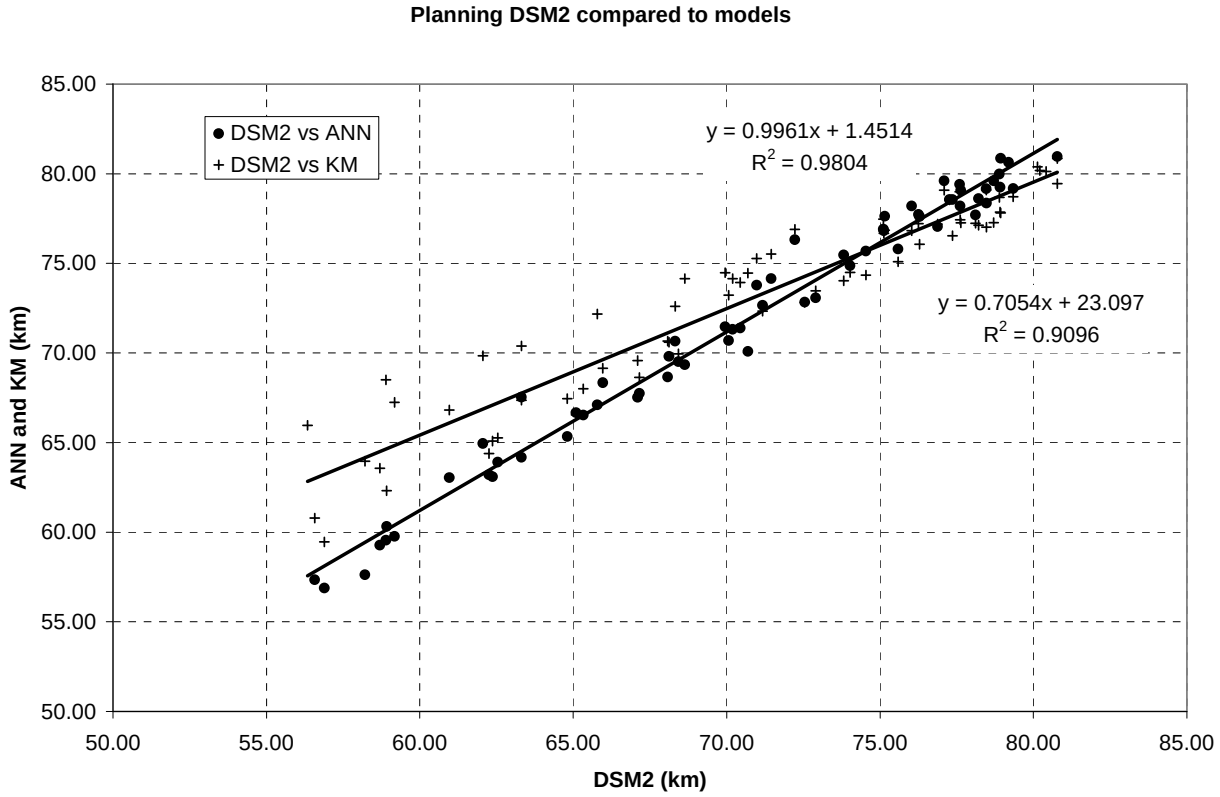

Figure 2 Planning comparison of X2

Assumptions:

- Historical and DSM2 estimates are made using a linear interpolation of the surface salinity to determine the approximate location of X2 (2.64 mmhos/cm surface salinity). A dispersion based interpolation may have been a better approximation, however due to time constraints a linear interpolation to find the location of X2 was used. This method of linear approximation may skew the resulting X2 towards a slightly higher value as compared to a dispersive interpolation which incorporates an exponential relationship. This may explain some of the differences seen in Figure 1.
- Planning DSM2 used a salinity boundary estimated using a modified G-Model approach (Ateljevich 2001). The G-Model estimates salinity and incorporates antecedent conditions into the estimate. The ANN was trained on this type of DSM2 and incorporates the following input parameters:
  - Northern flows: Sacramento River +Yolo Bypass + East streams + Calaveras - North Bay & Vallejo Exports

  - San Joaquin River Flow
  - Exports: Banks, Tracy, Contra Costa Exports
  - Delta Cross Channel Gate
  - Net Delta Consumptive Use
  - Tidal Energy (daily maximum – minimum from hourly astronomical tide)
  - 117 days antecedent conditions

- When using these methods (ANN and KM equation) to estimate X2 on a monthly time-step it becomes difficult to incorporate the salinity response, or antecedent conditions, due to actions occurring on a daily time-step. For example X2 maybe required for 5 days at Port Chicago (Roe Island) and 25 days at Chipps Island (Mallard Slough) the X2 estimate for Chipps Island should include the fresher conditions induced by the higher X2 requirement. Antecedent conditions have appropriately been incorporated to address this issue.

References:

Ateljevich, E. 2001. *Chapter 11: Improving salinity estimates at the Martinez boundary. In Methodology for flow and salinity estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. August. 22nd Annual Progress Report to the State Water Resources Control Board.* California Department of Water Resources. Sacramento, CA

Kimmerer, W. and Monismith, S. 1993. *An Estimate of the Historical Position of 2 PPT Salinity in the San Francisco Bay (August 1992).* San Francisco Estuary Project, U.S. Environmental Protection Agency, San Francisco.

SWRCB. 2000. *Revised Water Right Decision 1641.* State Water Resources Control Board, California Environmental Protection Agency, State of California.