DEPARTMENT OF WATER RESOURCES
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February 14, 2003

Mr. Thomas N. Clark
General Manager
Kern County Water Agency
Post Office Box 58
Bakersfield, California 93302-0058

Dear Mr. Clark:

Thank you for your comments of October 28, 2002, on the Draft State Water Project Delivery Reliability Report. We welcome the interest this draft report has generated and are pleased to provide a response to your questions and concerns.

Your comments request that the report should:

1. Include a statement that global warming is not expected to have a significant influence on SWP deliveries by 2021;
2. Explain why deliveries are estimated to increase over the next twenty years;
3. Provide more detail on the superiority of the “new method” for estimating Delta outflow requirements;
4. Extend the simulation to the year 2000 and
5. Include a fixed-demand 2001 study

Responses to these requests follow:

1. Climate Change: The potential effect of climate change over the next twenty years on the quantity and quality of SWP deliveries is unknown at this time. Information regarding the potential effects is being developed through the Water Plan Update 2003. This information will be incorporated into the next version of the Delivery Reliability report, expected in 2004.

2. Delivery amounts increase from 2001 to 2021: SWP modeled deliveries in many years are higher in the 2021 studies than in the 2001 study because the 2021 studies have higher SWP demands. The average SWP demand from the Delta is 3,712 thousand acre-feet in the 2001 study, 4,026 taf in the 2021A study and 4,133 taf in the 2021B study. Additional factors affecting deliveries include upstream depletion, precipitation-runoff and groundwater pumping. For the modeling of upstream depletion, the Sacramento Valley is divided into seven hydrologic units known as depletion study areas. The total 73-year average annual modeled depletion for the seven areas is 4,749 taf for the 2001 study and

4,875 taf for the 2021A study, an increase of 126 taf per year. This average annual increase in depletion is projected to be offset by an increase in precipitation-runoff of 145 taf per year primarily attributed to increased runoff from urbanization. In addition, average annual groundwater pumping is projected to increase by 77 taf in the 2021A study compared to 2001 study. The attached document provides additional information on upstream depletion (Attachment 1).

3. Improved method for calculating Delta outflow: The attached document explains why ANN is considered better than the G-model for calculating Delta outflow requirements (Attachment 2). This discussion will be contained in an appendix and referenced in the body of the report to direct readers to more detail on the subject.

4. Extending hydrologic input to year 2000: Hydrologic input is updated periodically but, due to delays in the availability of the field data and the amount of staff time required to develop the input, the simulated period lags present time by several years. We are currently updating the CALSIM II database to include the years 1995-1998.

5. Fixed-demand 2001 study: You requested that we provide another 2001 simulation with demand fixed at a level of roughly 3.6 maf. Except for Metropolitan Water District demand, the 2001 study contains the assumption that SWP demands are fairly close to full Table A amounts in most years. SWP agricultural demand for the 2001 study averages 98 percent of Table A and is assumed to be 100 percent of Table A in 60 of the 73 years. Agricultural demand is reduced to 80 percent of Table A in seven years and reduced to 96 percent of Table A in another six years based upon the Kern River flow. SWP M&I demand, other than MWD, is assumed to be at 98 percent of Table A for all years of the 73-year study period. MWD demand for the 2001 study was provided by MWD and averages 81 percent of Table A. Given the agricultural demand characteristics of the 2001 simulation, we believe the three studies contained in the report should provide sufficient information for planning purposes.

The Department of Water Resources plans to finalize the SWP Delivery Reliability Report in the near future. We recognize that this is an ongoing process and plan to revise the report at least every two years.

Your letter, as well as all others, commenting on the draft report and the corresponding responses will be included in an appendix to the final report. In addition, they will be posted on the State Water Project Delivery Reliability Report website (http://swpdelivery.water.ca.gov).

Thank you for your support and comments. If you wish to discuss this further, please call me at (916) 653-1099. For technical information, please contact Francis Chung, Chief of DWR's Bay-Delta Office Modeling Support Branch, at (916) 653-5924.

Sincerely,

Katherine F. Kelly

Katherine F. Kelly, Chief
Bay-Delta Office

Attachments

Upstream Depletion

Estimates of demands and water use are part of the hydrology development for CALSIM II. Areas upstream of the Sacramento-San Joaquin Delta are divided into hydrologic basins or units known as Depletion Study Areas. These depletion areas are categorized as valley floor areas and rim basin areas. Because valley floor areas are more complex, have large demands, and need to be integrated with the operation of the CVP/SWP they are represented in CALSIM II in much greater detail than rim basins. Flows from rim basins are determined prior to simulating CALSIM II and are input as a fixed time series. The attached map shows the delineation of the DSA boundaries.

The land use acreage used to develop water demands for each DSA is based on the desired Level of Development. Fixed levels of land use are used to determine water demands for the existing (normalized year 1995) and future (year 2020) LOD. The table below contains land use assumptions for each DSA in the Sacramento Basin. Levels of development between 1995 and 2020 are estimated by linear interpolation.

Sacramento Basin, Valley Floor Land Use (acres)

	1995		2020		Difference	
DSA	Urban	Agriculture	Urban	Agriculture	Urban	Agriculture
58	67,400	37,400	110,000	33,700	42,600	-3,700
10	21,800	188,000	33,300	199,600	11,500	11,600
12	7,900	370,100	12,800	386,000	4,900	15,900
15	3,400	279,200	4,800	279,800	1,400	600
69	49,900	392,400	81,000	384,800	31,100	-7,600
65	38,100	265,400	61,100	255,600	23,000	-9,800
70	180,500	126,800	284,600	108,100	104,100	-18,700
54	17,900	297,700	28,800	291,300	10,900	-6,400
55	24,900	135,300	35,700	126,400	10,800	-8,900
Total	411,800	2,092,300	652,100	2,065,300	240,300	-27,000

Source: DWR, Bay Delta Office, CU model input for use in CALSIM II, based on Bulletin 160-98 data.

Water consumption for different land use categories is calculated using DWR's Consumptive Use model. The CU model simulates monthly soil moisture conditions over the 73-year period of simulation for 12 different agricultural crop categories, urban irrigated landscape and native vegetation for each DSA. Based on minimum soil moisture requirements the CU model calculates the Consumptive Use of Applied Water for the irrigated land use categories. M&I demands are not fully addressed in the CU model. A large portion of M&I demands are non-consumptive and therefore not considered by the CU model. M&I diversions can have a large influence on reservoir operations and have, therefore, been included in CALSIM II for the American and Lower Sacramento rivers. M&I water diversion requirements are determined based on recent historic diversions for existing LOD and contract amounts for future LOD.

The CU model uses a very simple approach to estimate outdoor urban water demands. The urban land use classification combines residential, commercial and industrial sectors. The total urban acreage is subsequently proportioned between "lawns", "vacant lots" and "impervious surfaces". To calculate the consumptive use of these three land types, the following assumptions are made:

- Consumptive use of lawns is identical to irrigated pasture;
- Consumptive use of vacant lots is identical to native vegetation; and
- All precipitation on impervious surface results in runoff, i.e. zero consumptive use.

The CU model assumes 10-15% of CUAW is lost to the system as non-recoverable losses. The CU model is also used to adjust the historical rainfall runoff due to any land use change. The table below contains average annual irrigation demands by crop and DSA as calculated by the CU model. The total average annual depletion (CUAW and non-recoverable losses) for the Sacramento Valley floor at 2001 LOD is 4,749 taf/yr compared to 4,875 taf/yr at 2020 LOD.

Consumptive Use of Applied Water (ac-ft/ac)

DSA	Alfalfa	Citrus	Cotton	Field	Grain	Truck	Orchard	Pasture	Rice	Sugar Beets	Toma-toes	Vines	Urban
10	2.6	1.6		1.4	0.2	1.3	2.2	3.0	3.5	2.0	2.1	1.8	0.8
12	2.8		2.0	1.5	0.3	1.4	2.2	3.1	3.6	2.1	2.0	1.9	0.8
15	2.8		2.0	1.5	0.3	1.3	2.2	3.2	3.6	2.1	2.0		0.8
58	2.3	1.4		1.3	0.1	1.2	2.1	2.7				1.7	0.7
65	2.7			1.5	0.2	1.4	2.2	3.1	3.6	2.1	2.0	1.7	0.8
69	2.6		2.0	1.4	0.2	1.3	2.2	3.0	3.5	2.0	1.9		0.7
70	2.7			1.5	0.2	1.3	2.3	3.0	3.5	2.1	1.9	1.9	0.8
55 lowland	1.9			1.3	0.0	0.9	1.3	2.6	3.4	1.5	1.2	1.2	0.6
55 upland	2.9			1.6	0.3	1.7	2.4	3.0	3.6	2.3	1.9	1.9	0.8

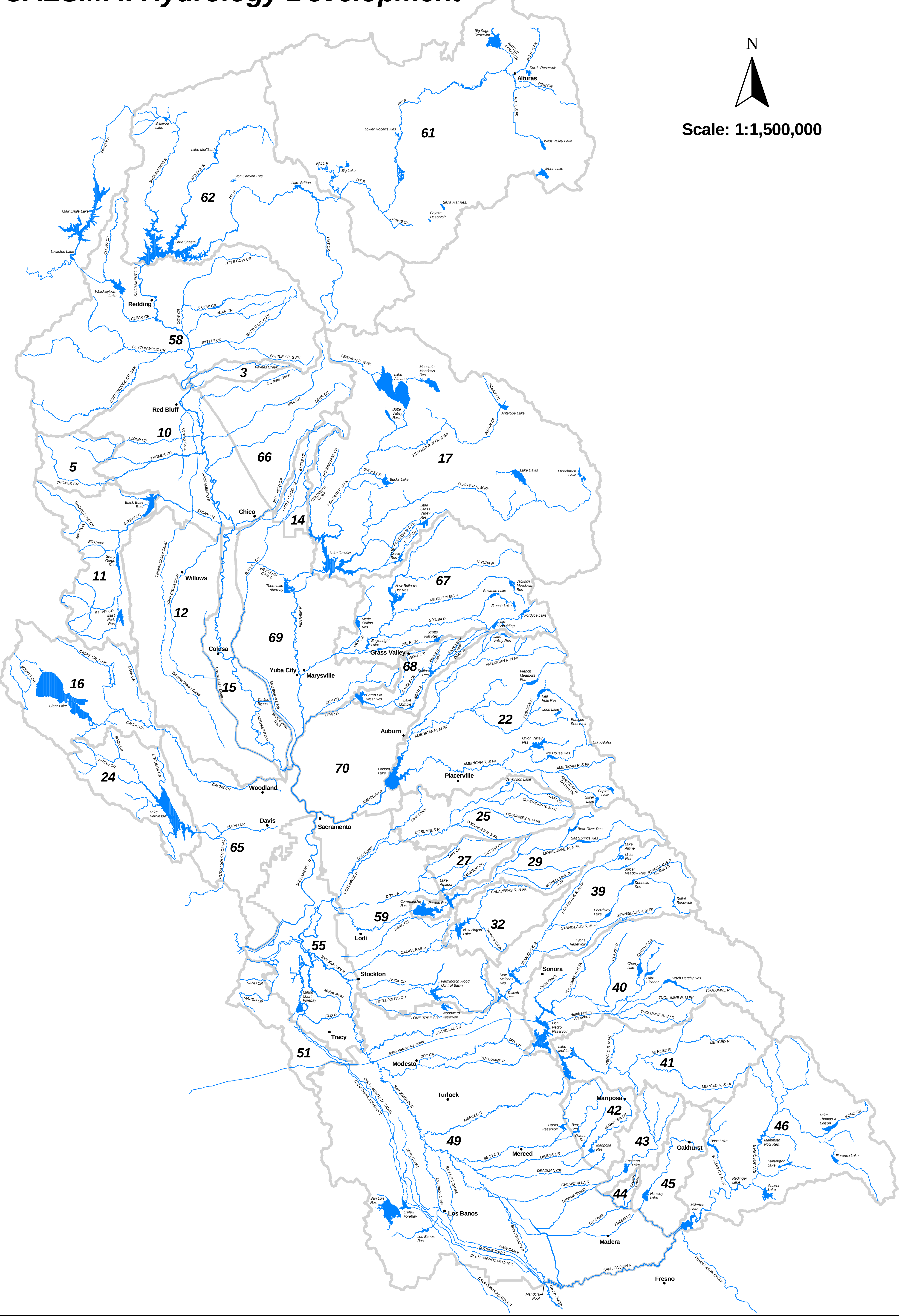
Notes: Blank values indicate that the crop is not grown in the region.
Reported urban CUAW is based on an assumed irrigated landscape area of 25%

The current figures in the SWP Delivery Reliability Report are based on Bulletin 160-98 land use estimates. The next revision of the report, planned in approximately two years, will be based on revised estimates in the California Water Plan Update 2003.

The calculation of irrigation demands for paddy rice differs from other crops. During the growing season rice fields are flooded to control weed growth. In the CU model water applied for flooding in April and subsequent months is treated as a consumptive use. The fields are assumed to be flooded to a depth of nine inches. The water recovered through draining the fields in September (1.5 to 2.0 inches) is added to the local water supply as an accretion. The quantity and timing of irrigation demands represent average planting and harvesting conditions in each DSA. Return flows from rice drainage are added to the time series of accretions for each basin. Return flows average approximately 70 taf/yr from a total of 485,000 acres of paddy rice at the 2001 LOD. Over the last few decades there have been substantial changes in the quantities of water diverted for rice production. Applied water demands have dropped as irrigation efficiencies have increased and farmers have switched to varieties with shorter growing periods. More recently fall flooding of rice fields for decomposition of rice straw has been adopted as an alternative to burning. Irrigation demands for rice are currently being reviewed and it is likely that model demands will be adjusted for the CALSIM II runs required to support the California Water Plan Update 2003.

Map attachment

Depletion Study Areas (DSAs) Used in CALSIM II Hydrology Development



Modeling Delta Salinity and Delta Outflow Requirement

Upstream reservoir operations, as modeled in CALSIM II, are often dependent on Delta salinity standards. The salinity in the Delta cannot be modeled accurately by the simple mass balance routing and coarse timestep used in CALSIM II. DWR's Delta Simulation Model (DSM2) is a one-dimensional hydrodynamic model capable of simulating flow, stage, and water quality throughout the Delta. However the upstream reservoirs and operational constraints cannot be modeled in the DSM2 model. An Artificial Neural Network (ANN) has been developed by DWR that attempts to faithfully mimic the flow-salinity relationships as modeled in DSM2, but provide a rapid transformation of this information into a form usable by the CALSIM II model. The ANN is implemented in CALSIM II to constrain the operations of the upstream reservoirs and the Delta export pumps in order to satisfy particular salinity requirements. Prior attempts to develop flow-salinity relationships for statewide planning models were based primarily upon operator experience or historical measurements. The first attempt to implement Delta outflow requirements for particular salinity targets was the Minimum Delta Outflow (MDO) curves that were primarily based upon operator experience. Curves were developed that specified required Delta outflow given a level of export, salinity target, and Delta Cross Channel gate position. The required Delta outflow increased in a nonlinear fashion as the export level increased. The MDO procedure was used in the previous statewide planning models developed by DWR.

Contra Costa Water District's G-model relates salinity at various locations in the Delta to the net Delta outflow, as well as the prior history of net Delta outflow. The use of antecedent outflow conditions was a significant step forward in the development of flow-salinity relationships. The G-model is based on historical observations of flow and salinity in the Delta and uses an equation similar in form to the advection-dispersion equation for salinity transport. The parameters required for the solution of this equation are determined by field measurements at the locations of interest. The equation may be solved for a required Delta outflow given a particular outflow history (G value) and desired salinity.

The MDO curves were developed to demonstrate that at different levels of pumping a nonlinear relationship of Delta outflow exists for the same salinity target. However, the curves did not account for antecedent conditions in the Delta. The G-model improved upon the prior model by including the antecedent outflow condition, but did not account for the flow patterns within the Delta. In reality, cross-channel gate operation, export levels, Sacramento and San Joaquin River inflows, and channel depletions all affect the salinity regime in a slightly different way. For example, for a Delta outflow of 20,000 cfs the export level could be 10,000 cfs with inflows of 30,000 cfs or exports of 5,000 cfs with inflows of 25,000 cfs. The resulting salinity is the same in both cases with the

G-model, since the dependent flow parameter (Delta outflow) remains the same. Similarly, a change in the cross-channel gate position would not affect the resulting salinity in the prior models since the Delta outflow is not affected.

The ANN developed by DWR attempts to statistically correlate the salinity results from a particular DSM2 model run to the various peripheral flows and gate operations. The ANN is “trained” on DSM2 results that may represent historical or future conditions. For example, a reconfiguration of the Delta channels to improve conveyance may significantly affect the hydrodynamics of the system. In such a case, the MDO curves and G-model may not represent the new flow-salinity relationships since they are based on historical measurements or experience. The ANN, however, would be able to represent this new configuration by being retrained on DSM2 model results that included the new configuration. Thus, by accounting for the major flow and operational parameters as independent parameters rather than aggregated Delta outflow, and the ability to better represent future modified conditions in the Delta, the ANN is a significant improvement over the existing models.

The current ANN predicts salinity at various locations in the Delta using the following parameters as input: Sacramento River inflow, San Joaquin River inflow, Delta cross channel gate position, and total exports and diversions. Sacramento River inflow includes Sacramento River flow, Yolo Bypass flow, and combined flow from the Mokelumne, Cosumnes, and Calaveras rivers (East Side Streams). Total exports and diversions include State Water Project (SWP) Banks Pumping Plant, Central Valley Project (CVP) Tracy Pumping Plant, North Bay aqueduct exports, Contra Costa Water District diversions, and net channel depletions. A total of 148 days of values of each of these parameters are included in the correlation, representing an estimate of the length of “memory” in the Delta.

In order for the ANN model to mimic DSM2 it must be calibrated and validated. This process, referred to as training, is based on a data set from a DSM2 simulation. The data used for this training process comes from a 16-year DSM2 simulation based on the Delta perimeter flows from a CALSIM II model run for a 2001 level of development under D1485 requirements. Ten years are used for calibrating, and the remaining six years are used for validation.

A full-circle analysis is performed after the training and implementation process to ensure the ANN is properly reproducing the flow-salinity relationship predicted by DSM2. The full-circle analysis compares the salinity predicted by ANN to those produced by DSM2 when the CALSIM II simulation’s Delta perimeter flows are used as inputs to the simulation. Ideally, these salinity comparisons would produce identical results, but due to the inherent nature of such statistical models they differ to some degree.