1 Introduction

Over the last eight years, the Delta Modeling Section has been developing and enhancing the Delta Simulation Model 2 (DSM2) and its support tools. The following are brief summaries of work that was conducted during the past year. The names of contributing authors are in parentheses.

Chapter 2 – DSM2 Calibration and Validation

Last year's annual progress report described the Section's participation in an Interagency Ecological Program project work team created for the recalibration of DSM2-HYDRO and QUAL with new geometry and flow data. Calibration and validation were completed and the Section began using the new calibrated version in January 2001. In general, the new version matches observed flow and water quality conditions much better than the 1997 version. Improvements in flow estimates around the Delta Cross Channel and Bacon Island are particularly noteworthy. The IEP project work team will undertake future calibration efforts as new data become available. These efforts will focus on issues that were not resolved in the most recent calibration work. *(Parviz Nader-Tehrani)*

Chapter 3 – Simulation of Historical DOC and UVA Conditions in the Delta

An *ad hoc* workgroup was assembled in late 1999 to assist CALFED's Drinking Water Constituents Workgroup in one of several tasks necessary to define baseline Delta water quality conditions. This *ad hoc* workgroup, which consisted of members of DWR's Delta Modeling Section and Municipal Water Quality Investigations Program, developed boundary conditions from available grab sample data to validate DSM2's capability to simulate organic constituents transport. For the validation period of March 1991 to December 1997, DSM2 does a satisfactory job simulating the distribution of dissolved organic carbon and ultraviolet absorbance and in representing observed seasonal peaks and trends. DSM2 is being used by the Section to evaluate DOC transport in support of the Integrated Storage Investigation (ISI) In-Delta Storage Project Feasibility Study. *(Ganesh Pandey)*

Chapter 4 – Validation of Dispersion Using the Particle Tracking Model in the Sacramento-San Joaquin Delta

This chapter is a condensed version of Ryan Wilbur's M.S. Thesis and covers the validation of dispersion using the DSM2 Particle Tracking Model (PTM). A complete copy of his thesis is on file with University of California, Davis. PTM results are compared with ADCP velocity profiles collected between 1997 and 1999 and tracer dye observations from a spring 1997 field study. This validation was done prior to the release of the latest DSM2 calibrated version described in Chapter 2. (*Ryan Wilbur*)

Chapter 5 – DSM2 San Joaquin River Boundary Extension

Last year's progress report described the Section's initial efforts to extend the DSM2 San Joaquin River (SJR) boundary upstream of Vernalis. This chapter summarizes work that was conducted over the past year to calibrate and validate the model extension. The simulation period of May 1997 to September 1999 was selected for initial calibration and validation in consideration of available stage, flow and salinity data. While DSM2 results generally showed good trending with field observations, it was clear that some significant sources of flow and salinity were not being modeled. To compensate for this apparent input data gap, constant base flows were added upstream of Patterson and Vernalis. These "add-water" flows were assigned a salinity signature with the temporal variability of an agriculture return and a magnitude reflecting a high-salinity groundwater and agriculture tail-water mixture. Historical data are being collected to conduct a longer-term simulation to test the robustness of the assumed "add-water" flows and salinity signature. The model extension will be used to evaluate Delta Mendota Canal re-circulation alternatives. CALFED funding has been secured to develop a "stand-alone" version of the upper SJR model in support of the San Joaquin River Total Maximum Daily Load (TMDL) stakeholder process. (*Thomas Pate*)

Chapter 6 – Dissolved Oxygen and Temperature Modeling Using DSM2

The Section has been reporting progress in dissolved oxygen and temperature modeling in its annual reports since 1994. This chapter summarizes a recent DSM2 dissolved oxygen and temperature calibration in the vicinity of Stockton on the San Joaquin River. The process of calibrating a numerical model to predict dissolved oxygen concentrations is highly data intensive. Based primarily on data availability, the periods of August to October 1998 and July to September 1999 were chosen for calibration and validation, respectively. DSM2 is now considered adequate for dissolved oxygen planning studies in the vicinity of Stockton, in view of significant data limitations. CALFED funding has been secured to conduct dissolved oxygen planning studies and to calibrate the DSM2 upper SJR extension for dissolved oxygen and temperature; these projects will be conducted in collaboration with an outside party in support of the San Joaquin River TMDL stakeholder process. (*Hari Rajbhandari*)

Chapter 7 – Integration of CALSIM and Artificial Neural Networks Models for Sacramento-San Joaquin Delta Flow-Salinity Relationships

Chapter 7 describes work conducted by the Office of State Water Project Planning Hydrology and Operations Section to integrate an Artificial Neural Network (ANN) representation of DSM2 into the statewide planning model CALSIM. The ANN will be used to model flow-salinity relationships within CALSIM II. Chapter 8 describes an application of the ANN to estimate Delta carriage water requirements. The Section has been reporting ANN development progress in its annual reports since 1995.
(*Ryan Wilbur and Armin Munevar*)

Chapter 8 – An Initial Assessment of Delta Carriage Water Requirements Using a New CALSIM Flow-Salinity Routine

This chapter presents a new approach to estimating carriage water requirements in the Delta; the approach utilizes the ANN implementation discussed in Chapter 7. Water supply impacts of the ANN routine are compared with the previous G-model Delta formulation utilized by DWRSIM and CALSIM I. This chapter, which is the first to quantify Delta carriage water costs over a long-term hydrologic sequence, supports DWR's typical carriage water assessments of 10 to 30%. Carriage water costs are shown to be sensitive to water year type, particularly costs associated with meeting salinity standards. Report findings have been shared with the Bay Delta Modeling Forum Carriage Water Review Team, in support of the State Water Resources Control Board's Phase 8 Water Rights Hearing. The review team intends to reach a settlement regarding the calculation of carriage water among interested parties. Carriage water estimates will be updated as new information and model enhancements become available. In particular, carriage water estimates will be updated to include input from the BDMF Carriage Water Review Team and to reflect progress in baseline modeling of CVPIA b(2) and EWA operations. (*Paul Hutton and Sanjaya Seneviratne*)

Chapter 9 – Use of Repeating Tides in Planning Runs

This chapter summarizes the development of a new repeating tide for DSM2 planning studies. DSM2 requires that tidal (i.e. stage) values be specified at its downstream Martinez boundary. DSM2 simulations that utilize this new "design-repeating tide" provide salinity results more representative of a non-repeating tide than simulations that utilize the higher energy "19-year mean tide." (*Parviz Nader-Tehrani*)

Chapter 10 – Planning Tide at the Martinez Boundary

DSM2 planning studies have traditionally relied on DWRSIM (and later CALSIM) monthly varying hydrology and operations as input boundary conditions. Repeating tides have been computationally advantageous when used by DSM2 in concert with monthly varying hydrology. However, CALSIM is presently being restructured to compute daily varying Delta hydrology and operations in support of the ISI In-Delta Storage Program Feasibility Study, and DSM2 is being restructured to accept these new boundary conditions. By moving from a monthly to a daily hydrology, repeating tides will lose their computational advantages over non-repeating tides. Chapter 10 summarizes the development of a non-repeating tide for DSM2 planning studies. This new planning tide, developed from data collected at Martinez and San Francisco between 1968 and 1999, has two components: (1) an astronomical tide that includes accurate harmonic components and spring-neap variation, and (2) a residual tide to estimate long-period fluctuations due to barometric changes and nonlinear interactions. (*Eli Ateljevich*)

Chapter 11 – Improving Estimates of Salinity at the Martinez Boundary

This chapter introduces an improved method of salinity estimation at Martinez, the downstream tidal boundary in DSM2. Development of a better boundary salinity estimator was motivated by the need for better absolute accuracy in the DSM2 real-time forecasting system (see Chapter 12) and by the re-structuring of DSM2 planning studies to include non-repeating tides (see Chapter 10). The method, designed to accommodate both real-time and planning applications, is based on the G-model with modifications to derive tidal (15-minute) salinity estimates. Model coefficients were calibrated for the period August 20, 1991 to September 5, 1992. The model provides a satisfactory validation of observed data over a period spanning the two calendar years 1993 and1994. (*Eli Ateljevich*)

Chapter 12 – DSM2 Real-Time Forecasting System

Chapter 12 summarizes work conducted by the Section, in collaboration with other DWR staff, to develop and use DSM2 as an operations decision support tool. This DSM2 Real-Time Forecasting System combines real-time field data with operational forecasts of the inflows, exports, and barrier configurations in the Delta through a series of pre-processing tools and scripts. These new real-time tools have reduced the time necessary to run DSM2-HYDRO, QUAL, and PTM. These tools also make it much easier to create alternative scenarios, thus encouraging DSM2 users to explore several "what if" questions while evaluating an operational forecast. The emphasis of this development effort has been to create easy-to-view model results in a timely fashion, while ensuring quality control. (*Michael Mierzwa*)