1 Introduction

Over the last nine 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 – Particle Tracking Model Verification and Calibration

Last year's annual progress report included a chapter on validation of dispersion using the DSM2 Particle Tracking Model (PTM). Chapter 2 summarizes the Section's work to re-calibrate and verify PTM dispersion in response to (1) a new formulation of the PTM mixing equations and (2) changes in DSM2. Last year's work, which was conducted by Ryan Wilbur, was completed prior to the release of the latest version of DSM2 which includes, among other things, re-calibrated model parameters and modified representations of channel bathymetry and open water areas. *(Aaron Miller)*

Chapter 3 – Analysis and Preparation of Observed Data for Input Files in Support of DSM2 Extended Validation (1975 – 1999)

Last year's annual progress report described the most recent DSM2 calibration and validation, which required the capability to simulate historical hydrodynamics and water quality transport for the period 1990-99. This chapter summarizes the Section's work to acquire, analyze and screen observed data collected prior to 1990, including stage, flow, and electrical conductivity. Work also included gathering information on unusual Delta events (such as levee breaks) and barrier installations prior to 1990. These data will be utilized to eventually extend the historical DSM2 simulation period back to 1975. *(Myint Thein)*

Chapter 4 – CALSIM versus DSM2 ANN and G-model Comparisons

For several years, the Section has been reporting updates on the development of a new flow-salinity model for the Department's statewide planning model. This year, the Section's Artificial Neural Network (ANN) flow-salinity model was implemented in CALSIM II. Through the CALSIM ANN Refinement Team (CART), the Section has been collaborating with staff from the Hydrology and Operations Section and the U.S. Bureau of Reclamation to make improvements to the ANN. Chapter 4 presents some work that was conducted in support of the CART effort, including (1) a robustness test assuming increased Banks Pumping Plant pumping capacity of 10,300 cfs and (2) a comparison with G-model performance. Water quality estimates are presented at three key water quality locations: Emmaton, Jersey Point, and Rock Slough. (*Michael Mierzwa*)

Chapter 5 – Relationships Between Delta Water Quality Constituents as Derived from Grab Samples

In 1986, the Department reported a Delta-wide evaluation of multiple water quality relationships derived from a sizeable grab sample data set. In this study, 34 Bay-Delta locations were independently examined and relationships between electrical conductivity, chloride and total dissolved solids were developed by water year type. This work has been referenced extensively by the Section. Chapter 5 presents the Section's current effort to expand upon this previous study by developing water quality relationships based on regional similarities for electrical conductivity, total dissolved solids and a suite of mineral constituents, including: bromide, chloride, sulfate, calcium, magnesium, potassium, and sodium. In addition to providing expanded ability to relate water quality constituents in the Delta, it is anticipated that this effort will provide insight into some characteristics of the mixing of Delta water and will provide another basis for validating DSM2-QUAL. Preliminary results illustrate regional relationships between chloride and calcium. (*Bob Suits*)

Chapter 6 – Calibrating DSM2-QUAL Dispersion Factors to Practical Salinity

This chapter discusses the background behind practical salinity and how it can be treated as an alternative water quality parameter for calibrating the dispersion factors in DSM2-QUAL. In the most recent calibration and validation of DSM2, EC was used to calibrate dispersion in QUAL. However, EC is not truly a conservative constituent, and at higher concentrations EC tends to underestimate true salinity. As is described in this chapter, use of practical salinity allows EC data to be used for validation, but accounts for the non-conservative behavior of EC at high salinity concentrations. (*Bob Suits*)

Chapter 7 – Generating Monthly Dissolved Organic Carbon and UVA at DSM2 Boundaries

DSM2 planning studies generally employ CALSIM II Delta hydrology and operations as flow boundaries to simulate the 16-year sequence of water years 1976-91. DSM2 planning studies also require specifications for water quality boundary conditions. Chapter 7 describes the Section's recent effort to develop dissolved organic carbon and ultraviolet absorbance boundary conditions for DSM2 planning studies. The resulting dissolved organic carbon boundary conditions, which are based on water quality grab samples collected by the Department's Municipal Water Quality Investigations (MWQI) Program, range between 1.5-5.5 mg/l and 2.4-11.4 mg/l in the Sacramento and San Joaquin Rivers, respectively. The boundary conditions attempt to capture the observed relationships between riverine organic loads and the seasonal "first flush" of watersheds. These boundary conditions were utilized by the Section in its most recent evaluation of the Integrated Storage Investigation (ISI) In-Delta Storage Project and will likely be used in subsequent evaluations of organics transport in the Delta. (*Bob Suits*)

Chapter 8 – CALSIM Water Quality Operating Rules to Meet Delta Wetlands Water Quality Management Plan

CALSIM II uses an Artificial Neural Network (ANN) to characterize Delta flow-salinity relationships under various planning scenarios. However, the ANN assumes an existing Delta configuration and has not been calibrated to predict water quality changes that might result from In-Delta Storage Project diversions and releases. To support the Department's Integrated Storage Investigations Program, the Section collaborated with the Hydrology and Operations Section and others to develop preliminary CALSIM II operating rules. These operating rules, as summarized in Chapter 8, are designed to account for interactions between In-Delta Storage Project operations and water quality at Delta urban diversions. (*Tara Smith*)

Chapter 9 – Implementation of DOC Growth in DSM2-QUAL

The Department's Municipal Water Quality Investigations (MWQI) Program conducted field experiments to determine potential changes in dissolved organic carbon concentrations resulting from peat soil contact. Based on the experimental findings, Marvin Jung proposed a set of logistic type equations to characterize the growth of DOC on flooded Delta islands. DOC growth is assumed to result from soil leaching and microbial decay. Chapter 9 summarizes the methodology used to implement the logistic equations in DSM2 and presents the results used to validate the implemented algorithm. The resulting module was utilized in a recent evaluation of the Integrated Storage Investigation (ISI) In-Delta Storage Project. (*Ganesh Pandey*)

Chapter 10 – Optimal Control of Delta Salinity

This chapter is a summary of Eli Ateljevich's Ph.D. dissertation on the optimal control of Delta salinity. After introducing the concept of optimal control, a simplified flow network was employed to compare two methods of incorporating "consistency" into an optimal control problem. Using one of these consistency methods to optimize a DSM2 simulation, a historical Delta salinity compliance problem (August-September 1994) was examined. Results suggest that salinity control through reservoir releases may be more efficient than was previously thought. Finally, the potential application of optimization methods to operational and planning models was discussed. (*Eli Ateljevich*)

Chapter 11 – 16-Year DSM2 Planning Studies with Adjusted Astronomical Tides and Daily Hydrology

This chapter describes the Section's new 16-year DSM2 planning study setup. In the new setup, the design repeating tide was replaced with an adjusted astronomical tide (described in last year's annual progress report) and the monthly hydrology was replaced with a daily hydrology. The new setup was motivated by a recent enhancement of CALSIM II to compute daily varying Delta hydrology and operations. (CALSIM II was modified in support of the ISI In-Delta Storage Program.) By simulating spring-neap tidal variation and daily varying Delta hydrology and operations, the new DSM2 planning study setup provides more detailed results than the previous DSM2 planning studies. (*Bijaya Shrestha*)

Chapter 12 – DSM2 Documentation

This chapter summarizes the Delta Modeling Section's strategy to improve documentation of the Delta Simulation Model 2 (DSM2). This chapter includes a summary of the documentation objectives, an overview of the planned documentation, an overview of the recently released DSM2 tutorial, and a review of the progress to date and future directions. (*Jamie Anderson*)

Chapter 13 – DSM2 Input Database and Data Management System

Chapter 13 summarizes the recent development of a new DSM2 input database and data management system. The new system, which is driven through a graphical user interface (GUI), will promote increased data standardization. DSM2 currently uses a text based input system, where the same task can be accomplished several different ways. The GUI will reduce potential ambiguities associated with text based input systems, and when coupled with a new data management system, will automate version controlling of the DSM2 input data. (*Eli Ateljevich and Tawnly Pranger*)

Chapter 14 – DSM2 Fingerprinting Methodology

This chapter outlines a DSM2 modeling approach used by the Section to estimate individual source concentrations of any conservative constituent at a given location in the Delta. This methodology, referred to as "fingerprinting", can answer questions such as "What percentage of the dissolved organic carbon at Banks Pumping Plant originated from agricultural drainage?" and "What percentage of the export volume at Tracy Pumping Plant originated from the San Joaquin River?" Use of fingerprinting techniques with DSM2 provides a powerful analysis tool for understanding both hydrodynamics and water quality dynamics in the Delta. (*Jamie Anderson*)

Chapter 15 – Short-Term Improvements to Artificial Neural Network Implementation in CALSIM

Through the CALSIM ANN Refinement Team (CART), the Section is collaborating with the Hydrology and Operations Section and the U.S. Bureau of Reclamation to review and improve the flow-salinity relationships used in CALSIM II. Chapter 15 summarizes the near-term objectives, current status and future considerations of CART. (*Sanjaya Senevirante*)