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The contribution of algal biomass to oxygen demand in the San Joaquin River Deep Water Channel, fall 2000

By

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October 31, 2001

Executive Summary

This report describes the results of research conducted in 2000 to determine the source of algal biomass and its relative contribution to oxygen demand in the San Joaquin River deep water channel downstream of Stockton during the fall. The research was funded by a CALFED Ecosystem Restoration Category III grant #99-B16 to the author and was conducted to obtain information needed by CALFED, the public, government agencies, and San Joaquin River stakeholders to characterize and determine the cause of oxygen depletion in the river.

The research was designed to address the following questions:

- Was the oxygen depletion in the DWC caused by physical stratification that prevented mixing?
- What is the relative contribution of algal biomass from in situ growth and upstream load to oxygen demand in the Stockton Deep Water Channel (DWC) ?
- What is the oxygen demand from algal biomass compared with other oxygen demanding substances?
- Are the load of oxygen demanding substances from Vernalis and Mossdale representative of the load that actually enters the DWC ?
- What mechanisms influence the impact of algal load and growth on oxygen demand?
- How well does the current semi-monthly DWR Channel Program characterize the oxygen conditions and algal biomass in the DWC compared with continuous monitoring?

Research demonstrated the importance of both upstream load and local growth to algal biomass in the DWC between Turner Cut and Navigation Light 48 where the net oxygen demand from algal biomass was 2 to 4 mg/L. The algal load from growth in the DWC was at least half of that from upstream and reached 100-300 kg/day as chlorophyll *a*. Algal biomass was primarily composed of a mixed assemblage of diatoms and was correlated with carbonaceous biochemical oxygen demand, but not total oxygen demand that increased seasonally.

The influence of algal growth on oxygen demand in the DWC was controlled by turbidity. Algal growth was light limited in the DWC where algae achieve about half of the light needed to achieve maximum growth rate. Light limitation was a function of low water transparency produced by high suspended sediment concentration and was strongly influenced by the high retention of both total suspended sediment and volatile suspended solids from upstream in the study reach. Unlike many aquatic environments, algal growth was not limited by macronutrients such as dissolved inorganic nitrogen and orthophosphate that were an order of magnitude higher than limiting levels.

Most of the biochemical oxygen demand in the DWC was produced by nitrogenous material. At Turner Cut, Rough and Ready Island and Channel Point nitrogenous BOD consistently comprised 50% to 80% of the oxygen demand. The discharge of ammonia

from the City of Stockton Regional Control Facility (RWCF) is a known source of nitrogenous oxygen demand in the deep water channel and increases between September and November. Ammonia from the Stockton RWCF probably drives the increase in nitrogenous BOD in September through November. This study also measured consistently high loads of non-ammonia Kjeldahl nitrogen from upstream that were often many times larger than the nitrogen load from ammonia. Nitrogenous material contributed about half of the oxygen demand upstream at Mossdale. Carbon to nitrogen ratios at Mossdale were too low to be produced by algae alone. Total BOD at Turner Cut and Rough and Ready Island in the DWC was significantly correlated with both nitrogenous BOD, total Kjeldahl nitrogen and ammonia concentration. Total BOD was not correlated with carbonaceous oxygen demand in the DWC, as would be expected if the primary source of oxygen demand was from algae.

The enhanced continuous water quality monitoring network developed in 2000 was far superior than discrete measurements at quantifying maxima and minima values and temporal variability of algal load and dissolved oxygen concentration. The continuous monitors measured somewhat lower dissolved oxygen at the bottom than the surface, even in this wet year. In addition, the continuous monitors demonstrated the consistent diel variation of dissolved oxygen of 4 mg/L to 7 mg/L that could affect compliance with the U. S. Environmental Protection Agency and CA Regional Water Quality Control Board standards and management alternatives. Upstream monitoring stations demonstrated the oxygen deficit in the DWC was primarily a function of processes in the channel and not imported from upstream.

Recommendations included: 1) separate the oxygen demand from algal respiration and nitrification of nitrogen by bacteria in growth studies, 2) conduct 2000 studies in a critically dry year when algal biomass, residence time, water temperature and oxygen demand are highest, 3) conduct more thorough studies to quantify the magnitude and identify the causes of decreased algal biomass, material load and biochemical oxygen demand between the upstream load at Vernalis and the deep water channel, 4) further evaluate the influence of both temperature an water transparency on algal growth and 5) gain a better understanding of the relative importance of nitrogenous and carbon load to the oxygen demand throughout the summer and fall.

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