

**San Joaquin River Low Dissolved Oxygen
Total Maximum Daily Load:
Interim Performance Goal and
Final Target Analysis Report**

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DISCUSSION DRAFT

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1 Introduction

1.1 Purpose

The purpose of this document is to propose a phased implementation approach and an interim numeric dissolved oxygen (DO) performance goal for the DO Total Maximum Daily Load (TMDL) to attain the Basin Plan dissolved oxygen water quality objectives in the Stockton Deep Water Ship Channel (DWSC).

Also (*under development*) is an analysis of data from existing DO monitoring programs that illustrate some of the temporal and spatial variability of DO experienced within the DWSC. This variability leads to a level of uncertainty that data collected at the Rough & Ready Island continuous DO meter is representative of conditions elsewhere in the DWSC. Based on findings from this analysis, suggestions are provided for further studies to better understand this variability and suggested improvements to the existing DO monitoring system for the purpose of assessing compliance with the proposed interim performance goals and final target. Improving our ability to characterize DO conditions throughout the DWSC will reduce the TMDL margins of safety that must be applied to oxygen demand reduction requirements for the selected implementation alternatives.

The approach described in this document is preliminary and is intended to facilitate discussion of the details within of the public Steering Committee process. The details of this approach will be modified and further developed after such discussions and as more studies and analysis are performed. The details of the approach will also be subjected to the California Environmental Quality Act (CEQA) functionally equivalent Basin Plan amendment process needed to adopt the TMDL implementation plan into the Basin Plan.

1.2 Phased Approach

A phased approach to this TMDL is being proposed because of its size and complexity and the possibility that re-evaluation of the existing Basin Plan DO water quality objective may be appropriate. A phased approach will allow implementation actions to proceed, based on our current understanding of the problem, while the following can take place:

- further develop source and linkage analysis to refine allocations of responsibility and source control measures;
- study the effectiveness of initially implemented alternatives in meeting the interim DO performance goal;
- design improvements to implemented initial phase alternatives and provide additional alternatives as necessary to meet final Basin Plan DO objectives; and
- examine the technical basis for the Basin Plan DO objective and, if appropriate, modify the objectives through the required State and Regional Board processes.

The number of phases and the specific actions to be performed in each phase will be developed as part of the TMDL implementation plan. The initial phase will be focused on implementing alternatives designed to meet a numeric interim DO performance goal. This performance goal is

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less stringent than the current Basin Plan DO objective, but will be a significant improvement over current conditions and will begin to provide a level of protection for beneficial uses. Compliance with the terms of the phased TMDL implementation plan will be assessed by whether responsible entities perform specific actions as outlined in the implementation schedule. If these actions are being performed on schedule and the interim DO performance goal is not being met in the DWSC, then implementation plan modifications addressing the non-attainment will need to be made in subsequent TMDL phases. The final phase will need to include all implementation actions required to meet the applicable Basin Plan DO objective. If the responsible entities do not meet completion milestones in the TMDL implementation plan, then the Regional Board will be forced to implement other strict discharge limitations and/or prohibitions of various types.

At some point during implementation of this phased TMDL, it is possible that the State and Regional Boards may modify the applicable DO objective. As discussed further below, there are two parts to the Basin Plan DO objective: one part is a Regional Board objective and may be modified by a Regional Board Basin Plan amendment; the other is a State Board objective that can only be modified by a State Board action. Therefore, modification of the entire Basin Plan DO objective will require both Regional and State Board action. The final TMDL phase must address attainment of the Basin Plan DO objective applicable at that time.

This phased approach is being proposed for a TMDL that is being developed in cooperation with the DO TMDL Steering Committee. According to the Bay Protection and Toxic Cleanup Plan (BPTCP), the Steering Committee has been given the opportunity to provide its own suggested allocation of responsibility and other technical input to the Regional Board by December 2002. The Regional Board will consider this and further input from the Steering Committee during development of its TMDL Report, which is due to the U.S. Environmental Protection Agency (U.S. EPA) by June of 2003, and during the subsequent Basin Plan amendment process for the TMDL and its implementation plan. Without acceptable input from the Steering Committee by December 2002, the Regional Board will begin development of its own TMDL and implementation plan based on discharge limitations and/or prohibitions of various types.

2 Current Objectives / Criteria

2.1 Beneficial Uses

The 303(d) listing for low DO in the DWSC is based on impairment to its fisheries-related beneficial uses. These beneficial uses are established in the Basin Plan as follows:

- warm freshwater species (striped bass, sturgeon, and shad) migration and spawning (WARM MIGR and WARM SPWN);
- cold freshwater species (salmon and steelhead) migration. (COLD MIGR); and
- warm and cold freshwater species habitat (not including anadromous species) (WARM and COLD);

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2.2 Basin Plan Dissolved Oxygen Water Quality Objective

There are two parts to the Basin Plan DO water quality objective that apply to the lower San Joaquin River (SJR):

Regional Board objective:

5.0 mg/l at all times on the SJR within the Delta (excluding SJR west of Antioch bridge)

A 5.0 mg/l objective first appeared for all waters of the Delta in the Interim Water Quality Control Plans for the Sacramento-San Joaquin Delta adopted in 1967 and again in 1971. It was then adopted into the 1st edition of the Basin Plan in 1975 (with the exclusion of SJR west of Antioch bridge) and has appeared unchanged (by intention) in all subsequent editions. The SJR west of Antioch Bridge is governed by the Basin Plan for the San Francisco Bay Regional Water Quality Control Board and is downstream beyond the impairment addressed by this TDML.

There are no specific references cited in any of the Basin Plans supporting the 5.0 mg/l concentration. However, the 1967 Interim Basin Plan did state: “migratory salmonids require at least 5.0 mg/l dissolved oxygen, as do the resident game fishes. Striped bass and other fishes also require at least 5.0 mg/l dissolved oxygen to successfully propagate.” Although not specifically referenced in the Basin Plan, much of the literature existing when the DO objective was first adopted supported this same conclusion. The 1968 U.S. EPA Water Quality Criteria (GreenBook), the 1972 U.S. EPA Water Quality Criteria (BlueBook) and the 1976 U.S. EPA Water Quality Criteria (RedBook) all suggested a 5.0 mg/l criterion. This criterion was typically interpreted as being applicable at all times and places except for low flow conditions worse than the lowest 7 day flow with a 10 year return frequency (7Q10). Likewise, a study by Hallock in 1970 provides data and findings that the adult salmon migration run upstream did not become steady until SJR DO concentrations were above 5 ppm (mg/l). The Hallock study did not discuss any time averaging or considerations of spatial variability.

State Board objective (adopted by Regional Board into Basin Plan objective):

6.0 mg/l minimum between Turner Cut and Stockton from September 1 through November 30

This objective was first adopted by the State Board in the 1991 *Water Quality Control Plan for Salinity, San Francisco Bay / Sacramento-San Joaquin Delta Estuary* (1991 Bay/Delta Plan) and was intended to provide protection for the spawning migration of the threatened fall run Chinook salmon in the SJR. This 6.0 mg/l objective was also carried forward into the 1995 *Water Quality Control Plan for the San Francisco Bay / Sacramento-San Joaquin Delta Estuary* (1995 Bay/Delta Plan), including an additional provision to grant dischargers a time extension for compliance. The Regional Board adopted this additional State Board objective for the first time into the 3rd edition of the Basin Plan in 1994. This is in addition to the 5.0 mg/l Basin Plan objective that was already part of the Basin Plan at that time (discussed above). The 5.0 mg/l objective is a Regional Board objective and was not part of the 1991 or the 1995 Bay/Delta Plans. The 5.0 mg/l Regional Board objective applies at all other times and locations not covered by the State Board 6.0 mg/l objective.

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According to the 1991 and 1995 Bay/Delta Plans, the technical basis for the 6.0 mg/l concentration was an agreement reached in 1969 between the California Department of Water Resources (DWR), California Department of Fish and Game, U.S. Bureau of Reclamation, and U.S. Fish and Wildlife Service to take specific actions “to maintain the dissolved oxygen content in the DWSC generally above 6 ppm (mg/l) when necessary.” It continues: “If DO levels drop to 6 ppm (mg/l), a temporary rock barrier is installed across the head of Old River to increase San Joaquin River flows past Stockton, thus improving DO levels.” No citations to scientific literature or other technical justification were provided in this inter-agency agreement. Another reference cited in the 1991 and 1995 Bay/Delta Plans was a study by Hallock in 1970. This study suggested that fall run Chinook salmon spawning migration was not blocked when DO concentrations were maintained above 5 ppm (mg/l). The Hallock study did not address the need for maintaining a 6.0 mg/l concentration. Also, in developing this part of the DO objective, the Bay/Delta Plans only addressed protection of fall run Chinook salmon spawning migration. They did not address protection of beneficial uses related to other runs of Chinook salmon or to other cold water or warm water species and life stages.

2.3 U.S. EPA Dissolved Oxygen Water Quality Criteria

The most recent U.S. EPA DO criteria appear in *Ambient Water Quality Criteria for Dissolved Oxygen* (EPA 440/5-86-003), April 1986. These are suggested criteria that States may use in developing their own objectives. Although not the basis for either part of the Basin Plan DO objective, it provides useful background for the development of an interim DO performance goal. The criteria presented in the 1986 document are significantly different from previous versions of the U.S. EPA criteria that consisted of a simple 5.0 mg/l (no averaging period), typically interpreted as a 7Q10.

The U.S. EPA criteria consist of four categories of DO criteria based on the types and life stages of fish species present. The numeric criteria and averaging periods are presented below along with the applicable Basin Plan beneficial use designation (discussed previously in Section 2.1).

1. Cold water -early life stages < 30days after hatching present
 - Not applicable: Not a beneficial use designated in the Basin Plan for the DWSC.
2. Cold water -other life stages present (COLD and COLD MIGR)
 - 6.5 mg/l – 30 day mean
 - 5.0 mg/l – 7 day mean of daily minimums
 - 3.0 mg/l – at all times
3. Warm water - early life states < 30days after hatching present (WARM SPWN)
 - 6.0 mg/l – 7 day mean
 - 5.0 mg/l – at all times
4. Warm water -other life stages present (WARM and WARM MIGR)
 - Not applicable: Superseded by more stringent coldwater criteria.

The first and last U.S. EPA criteria listed above are not applicable in the DWSC. The second criterion provides protection for the habitat and migration of cold water species, which are

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generally more sensitive than warm water species. The third criterion provides protection to early life stages of warm-water species that are present in the DWSC sporadically throughout the year. The following summarizes additional relevant considerations and conclusions presented in the 1986 U.S. EPA criteria document.

- For a number of technical reasons, U.S. EPA concluded that DO criteria stated as average and minimum concentrations were preferable to ones based on percent saturation.
- Invertebrate communities, although possibly altered, should be adequately protected by the criteria applicable to the fish species and life-stages that use them as a food source.
- Growth impacts were the most important consideration in developing the cold-water habitat criteria. Lower DO concentrations increased difficulty in respiration, which in turn reduced feeding activity and metabolism rates.
- For early life stages of warm-water species, low DO conditions lead to premature embryo hatching and increased stress on the feeding activities of larvae. The averaging period for these criteria is shorter (7-days) than the “other life stages” criteria (30-days) in order to better protect these short duration, sensitive life stages. Criteria for early life stages are intended to apply only where and when these stages occur.
- The aggravating effects of low DO concentrations with other stressors, such as increased susceptibility to disease and exposure to elevated toxicant concentrations are important considerations. For example, studies found that ammonia toxicity was enhanced by low DO more than for other toxicants, such as metals. High temperature stress further increases sensitivity of aquatic organisms to disease and toxic pollutants. Although the criteria are intended to be protective at high seasonal temperatures, there needs to be an emphasis on attaining DO criteria during periods when multiple stressors are present.
- The criteria represent values 0.5 mg/l above the “slight production impairment” values and represent values between “no production impairment” and “slight production impairment.” Each criterion may thus be viewed as an estimate of the concentration below which detrimental effects are expected.
- The criteria expressed as mean concentrations should be attained most of the time, but some deviation below these values will probably not cause significant harm.
- The U.S. EPA criteria include a daily minimum to protect against mortality due to hypoxia. If only a minimum or a mean can be given as a criterion, the minimum must be chosen.
- In considering daily or longer-term cyclical exposures to low DO, the literature indicates minimum concentrations may be more important in determining growth rates than the mean. Therefore, “other life stage” criteria contain a 7-day mean minimum value to protect against regularly recurring low DO exposures near the lethal threshold.
- For manipulatable discharges U.S. EPA suggests an additional limit on the frequency of excursion below the 7-day mean minimum on a site-specific basis. In such cases it is suggested to limit excursions below the 7-day mean minimum to 3 weeks per year or that the acceptable 1-day minimum be increased to 4.0 mg/l for cold-water species.

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- If daily cycles of dissolved oxygen are essentially sinusoidal, a reasonable daily average can be calculated from the highest and lowest values. A time-weighted average may be required if the cycle is not regular. The criteria have been established assuming that dissolved oxygen values used in calculating compliance with time-weighted average criteria will not exceed the air saturation value.
- If low DO is a seasonal condition, then the significance of reduced growth rates during that period must be considered. If growth is not important during the low DO season there is less urgency in attaining the criteria than if growth is important.

2.4 Summary

Although not specifically cited, the 5.0 mg/l portion of the Basin Plan DO objective, first adopted in the 1975 edition of the Basin Plan, is the same as that suggested by the 1970 Hallock study and the U.S. EPA DO criteria existing at that time. In 1986, the U.S. EPA significantly modified its criteria to include different sets of concentrations and averaging periods for four different categories of warm and cold water fish species and life stages. Regional Board staff will further evaluate whether and when to undertake the Basin Plan amendment process that would be needed to modify the 5.0 mg/l portion of the Basin Plan DO objective.

The references cited by the State Board in the 1991 and 1995 Bay/Delta Plans do not provide a clear technical basis for the 6.0 mg/l minimum concentration. It was beyond the scope of this document to evaluate the appropriateness of this objective (in the absence of cited justification) relative to the latest scientific literature and U.S. EPA criteria. Further evaluation of this part of the DO objective may be technically warranted. Since this part of the DO objective, however, was established by State Board policy, the administrative process for changing it will require State Board action. The Steering Committee would need to take the lead in initiating the State Board process to reconsider and possibly modify this part of the objective.

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3.1 Interim DO Performance Goal

The following is the proposed interim DO performance goal. The performance goal is applicable at all locations within the DWSC between Channel Point and Disappointment Slough. It is not applicable to the Turning Basin or local tributary canals, which are considered outside the scope of this TMDL.

Between June 1 and November 30 dissolved oxygen shall not be less than 5.0 mg/l measured as a 7-day mean of daily minimums, with no daily minimum below 3.0 mg/l. The Basin Plan objective of 5.0 mg/l will be applicable between December 1 and May 31.

Between June 1 and November 30 the interim DO performance goal is essentially the U.S. EPA criterion for the protection of coldwater species habitat. This performance goal is not a formal water quality objective, but rather a milestone on the way towards meeting the Basin Plan DO objective. Attainment of this performance goal would begin to provide a level of protection for

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beneficial uses and also represents a significant improvement in DO concentrations within the DWSC (see *pending* Section 4 for further discussion of low DO frequencies).

The interim DO performance goal will be the basis for selecting implementation alternatives designed to attain it. Compliance with the initial TMDL phase will be assessed by whether specific actions are performed by responsible entities as outlined in the implementation schedule. If the implementation plan is executed on schedule, but does not achieve the interim DO performance goal, then modifications to the implementation plan will be required in the final TMDL implementation phase. If the conditions of the initial TMDL phase are not met by the responsible entities, then the Regional Board will be forced to implement its own TMDL based on discharge limitations and/or prohibitions of various types.

3.2 Final DO Target

The final DO target is simply the Basin Plan DO objective that is applicable at the time the final TMDL phase is implemented. It is possible that the 5.0 mg/l portion of the existing Basin Plan DO objective may be modified by a Basin Plan amendment, however, the State Board 1995 Bay/Delta Plan mandates the 6.0 mg/l portion of the existing Basin Plan DO objective and would require State Board action to modify it. The final TMDL phase will need to include all implementation actions required to meet the final Basin Plan DO objective applicable at that time. If no modifications are made to the current Basin Plan DO objective, then the current objective will apply to the final TMDL phase.

3.3 Schedule of TMDL Phases

The Regional Board has committed to submitting a TMDL Report (often referred to as a Technical TMDL) by June of 2003. This document will present the problem statement, performance goal/target analysis, source and linkage analysis, allocation of responsibility and other related information to U.S. EPA for their information. It will not include the details of an implementation plan, nor will it need to be adopted formally by the Regional Board. The TMDL Report to U.S. EPA will have no regulatory authority. The TMDL and its implementation plan, however, will need to be adopted in a subsequent Basin Plan amendment. This Basin Plan amendment process will begin in the summer of 2003 with completion of an amendment for consideration by the Regional Board by June 2004. Once adopted by the Regional Board and approved by the State Water Resources Control Board and the Office of Administrative Law, the implementation of the initial phase of the TMDL shall begin.

Further discussion among the stakeholders and public, through the Steering Committee and Basin Plan amendment processes, will be needed to develop the detailed steps and schedule of the phased implementation plan. The following are a few considerations in developing the implementation plan and schedule commitments.

- The implementation of alternatives will likely need to undergo their own CEQA environmental impact analysis (and possibly NEPA, depending on the source of funds).
- Consideration must be given to the amount of time needed to collect and analyze performance data on the fully implemented initial phase alternatives before proceeding with subsequent and/or final phase modifications.

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- Depending on how extensive the required changes are to the subsequent and/or final phases of the TMDL, they may need to be adopted as a Basin Plan amendment.
- Including all necessary considerations, the implementation plan must commit to a date by which time the final TMDL phase will be fully implemented.

4 DO Measurement in the DWSC (pending)

This final section of the DO TMDL Interim Performance Goal and Final Target Analysis Report is still under development. It will provide an analysis of DO and other data that demonstrate some of the temporal and spatial DO variability in the DWSC. Understanding this variability is important when assessing how representative the Rough & Ready Island continuous DO meter is of conditions elsewhere in the DWSC, relative to the interim performance goals and final target. Based on findings from this analysis, suggestions will be provided for further studies to better understand this variability and for improvements to the existing DO monitoring system. Improving the ability to characterize DO conditions throughout the DWSC will reduce the TMDL margins of safety that must be applied to oxygen demand reduction requirements for the selected implementation alternatives.