

MEMORANDUM



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TO: Ed Brauner, Deputy City Manager
Miles Ferris, Utilities Director

RWQCB
REGION 1

OCT 10 2001

FROM: James Roth, Ph.D.
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SAW _____ CRJ _____ _____
 RLT _____ LGR _____ KAD _____
 FCR _____ RSG _____ _____

DATE: 5 October 2001

SUBJECT: Comments on Proposed 303(d) listing for Laguna de Santa Rosa

The 1990 303(d) listing of the Laguna for ammonia and dissolved oxygen led to a TMDL in 1995 which took the form of a wasteload reduction strategy (WRS) addressed at reduction of nitrogen loading from point and non-point sources. Ammonia-nitrogen interim concentration goals were attained, and the Laguna was removed from the 303(d) list in 1998. Dissolved oxygen (DO) goals continue to fall below the Basin Plan minimum objective of 7 mg/L, and this has prompted the RWQCB staff to propose listing the Laguna for dissolved oxygen and phosphorus. This memorandum provides a summary of a National Academy of Sciences report that recommends changes to the 303(d) listing process that should be followed by RWQCB, and an analysis of data that indicates that the proposed listing of the Laguna for DO and phosphorus is not appropriate.

SUMMARY OF COMMENTS

The National Academy of Sciences has provided recommendations for improving the 303(d) listing process. RWQCB's guidelines for listing were developed prior to the recommendations and have not been updated to reflect the recommendations. Following the recommendations lead to the conclusion that the proposed listing of the Laguna for DO and phosphorus is not appropriate. Examination of the RWQCB's TMDL Monitoring Data shows that DO at the four compliance monitoring stations in the Laguna was at a minimum during 1996 through 1998, and has been improving at all stations since 1998. A lag period between the reduction of nutrient inputs and the reversal of eutrophication is expected. Accordingly, including DO on the watch list rather than the 303(d) list is recommended. The 303(d) listing of the Laguna for phosphorus is not justified because the Board's recent TMDL Monitoring Data continue to support the conclusion that nitrogen, and not phosphorus, limits the growth of plants in Laguna waters.

NRC RECOMMENDATIONS

The National Research Council, the principal operating agency of the National Academy of Sciences, has recently completed a 109-page assessment of the 303d listing and TMDL

approach to water quality management (NRC 2001). Their report outlines recommended changes to the program. The NRC report recommends broad changes to the 303d listing and TMDL process, including the criteria for listing and delisting. One of the recommended changes is that RWQCB should emphasize attainment of designated uses rather than achievement of numerical water quality goals (p.5). Responding to testimony that "many waterbodies have been listed based on limited or completely absent data and poorly conceived analytical techniques for data evaluation," (p.20) the report "reviews the listing process and makes recommendations that will improve the reliability of the listing decision." RWQCB's 303(d) listing approach should be evaluated against the recommendations to identify areas of improvement.

One of the recommendations that has not been implemented by RWQCB is that "before a waterbody is placed on the action (303d) list it is suggested that states conduct a review of the appropriateness of the water quality standard" (p. 90) Recommended is a use attainability analysis (UAA), which "determines if impairment is caused by natural contaminants, nonremovable physical conditions, legacy pollutants, or natural conditions." (p. 92). The current Basin Plan minimum of 7 mg/L DO has not been subjected to such analysis. In fact, the City of Santa Rosa requested in writing on May 20, 1998, that RWQCB conduct just such an evaluation. RWQCB should conduct such an evaluation prior to listing of the Laguna for dissolved oxygen.

DATA ANALYSIS

Dissolved Oxygen

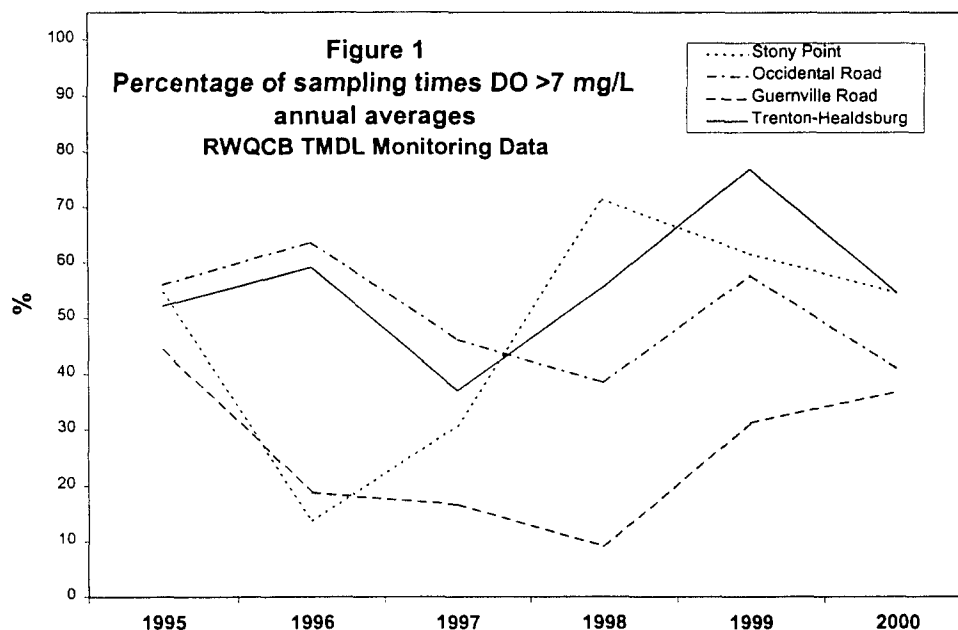
The RWQCB's rationale for recommending adding the Laguna to the 303(d) list for DO is that although nitrogen loading goals have been met since about 1998, Laguna DO objectives are not met. Reference is made to recent data collected in August/September 2001 which indicate that Laguna DO levels are less than the Basin Plan objective of 7 mg/L 90 percent of the time. The implication is given that DO levels in the Laguna have worsened in the most recent period. No reference is made to recent DO data from the RWQCB's own TMDL Monitoring program, although phosphorus data from that program are discussed.

- *Are Laguna DO levels worsening since nitrogen loading has been reduced?*

The RWQCB's Laguna de Santa Rosa TMDL monitoring program (Reference # 107 in 303(d) List Update Recommendations) began in January 1995, and continued until November 2000. Four compliance monitoring stations were each visited every two weeks throughout the year. One purpose of this program was to determine whether reduced nitrogen loading would result in improvements in Laguna DO levels. The 303(d) List Update Recommendations refer to data collected between 1995 and 1997 and conclude that DO compliance is not being

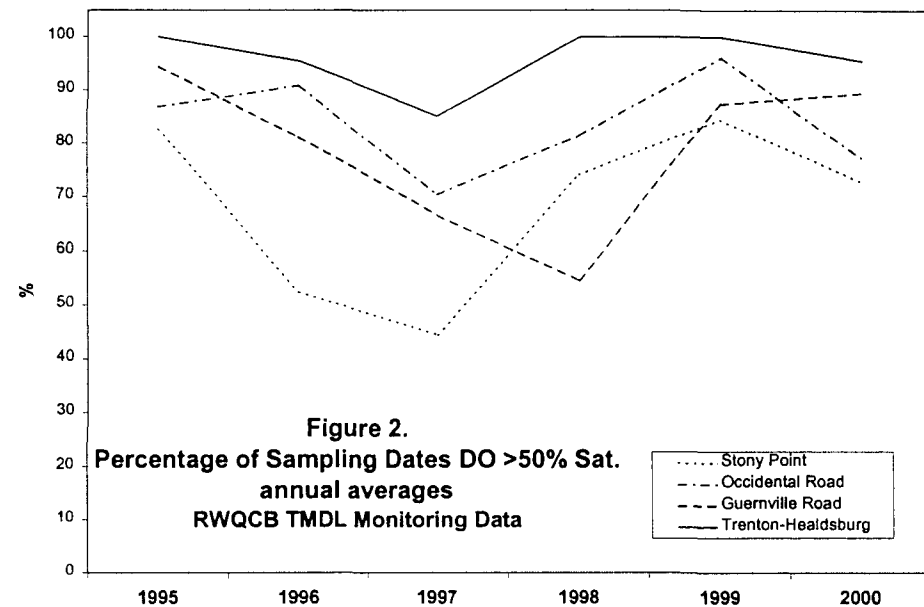
met. It is appropriate to compare DO data for the whole study period (1995-2000) in order to decide whether DO is worsening. Nitrate loading reductions achieved goals by 1998, but it is to be expected that reductions in Laguna eutrophication might not be immediate. A lag period, perhaps of several years might precede measurable DO improvements.

Based on the TMDL monitoring data, the percentage of times over the year that Laguna DO has attained the Basin Plan goal of 7 mg/L at each station (Figure 1) shows a distinct pattern during the last 6 years. In 1995 DO was above 7 mg/L on about half of the sample dates at all 4 stations. Attainment of the 7 mg/L goal declined at all stations in one or more of the next 3 years, in some cases strikingly (to 14 percent of dates at Stony Point Road in 1996, and to 9 percent of dates in 1998 at Guerneville Road). However, 3 of the 4 stations have increased in the



frequency of attainment since 1998. While none of the stations have achieved the goal of 100 percent attainment, it is encouraging that the Laguna DO is improving (percentages for 2000 are slightly underestimated because no samples were collected after mid-November, so averages did not include as many winter dates when compliance rate is high). There is thus no evidence from these data to support RWQCB staff's implication that Laguna DO is worsening.

Another perspective on recent Laguna DO, based on the same data set is the percentage of sample dates each year when the DO is over 50 percent saturation (Figure 2). Because oxygen is less soluble at higher temperature and the Laguna is a naturally warm waterway in summer, percent saturation provides is more relevant to the suitability of the Laguna as a habitat for native fish and



invertebrates than is the absolute concentration of dissolved oxygen. Percent saturation has also improved at all stations since 1998, and percent saturation at all stations was above 50% on at least 70 percent of the sample dates in 2000. (Again the 2000 percentages are probably underestimated due to fewer winter sampling dates.) A lag period between the reduction of nutrient inputs and the reversal of eutrophication is expected, and for this reason including the Laguna on the Watch List for DO, rather than the 303(d) list would be more appropriate than formally listing it.

Another important implication of the inverse relationship between temperature and oxygen solubility is that, due to natural conditions, temperature is sufficiently high that the 7 mg/L standard is frequently unattainable. When temperature is greater than 22 C, oxygen saturation is less than 7 mg/L (the Basin Plan standard). This fact should be considered by RWQCB in their evaluation of 303(d) listing of the Laguna for dissolved oxygen (and when evaluating if the standard of 7 mg/L is appropriate for the Laguna).

- *Do recent data collected in August/September 2001 demonstrate that Laguna DO is worsening?*

The Regional Water Board's DO data from August/September 2001 (Reference # 108 in 303(d) List Update Recommendations), monitoring conducted under contract by Sonoma County Water Agency) were collected with continuously recording instruments installed near the 4 attainment monitoring stations for periods 2 to 3 days on two occasions in August/September 2001. That 90 percent of the records were below 7 mg/L shows that low DO episodes at certain times and places may be sustained over extended periods. The 303(d) List Update Recommendations assert that this supports the need for 303(d) listing. However, there are several methodological and other differences between these data and data from previous monitoring. It is therefore impossible to determine whether the results represent recent changes in the Laguna DO regime. It is not unusual for DO concentrations in eutrophic streams to exhibit day-night fluctuations (diel DO sag), since photosynthetic inputs exceed DO consumption during daylight, whereas respiratory losses dominate at night.

The recording instruments were deployed on the stream bottom under water depths ranging from 0.5 to 1.0 meter. The sensors were thus located within a few centimeters of the sediments (Jeff Church, RWQCB, pers. com.) whereas the grab samples in the TMDL monitoring series were collected at the surface. Instruments were placed at concealed sites up to 100 yards of the bridge crossings where the bimonthly samples were collected. Individual records in a continuous series logged every 15 minutes are not statistically independent (consecutive observations are autocorrelated), so the number of records (1792) does not convey the statistical power implied by the expression "n=1792" as used in the Draft Update.

Phosphorus

The RWQCB's rationale for recommending adding the Laguna to the 303(d) list for phosphorus is that phosphorus levels in the Laguna exceed the US EPA criterion of 0.1 mg/L Total P, and since DO levels appear to be worsening despite nitrogen loading reductions, that phosphorus, not nitrogen, must be limiting algal growth in the Laguna.

- *Do Laguna phosphorus concentrations exceed any federal or State water quality standards?*

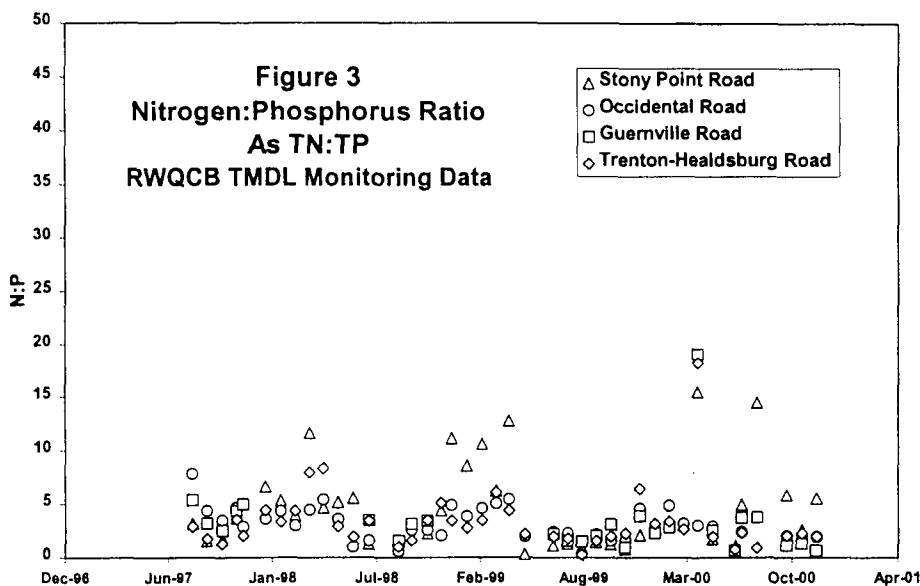
The Basin Plan issued by the RWQCB does not contain any numerical phosphorus standards. The US EPA has not promulgated any numerical phosphorus standards that address the prevention of eutrophication as described in EPA (2000):

EPA is publishing technical guidance which presents EPA's method for setting nutrient water quality criteria for lakes and reservoirs. The EPA has not previously issued guidance for developing ecoregional nutrient criteria. In addition, current criteria for nutrients do not specifically address the prevention of eutrophication. In 1976, in EPA's publication entitled *Quality Criteria for Water* (also known as the Red Book), EPA presented ambient water quality criteria for nitrates, nitrites and phosphorus. The criterion for nitrate nitrogen was 10 mg/L for the protection of domestic water supplies. The phosphorus criterion was 0.10 ug/L elemental phosphorus for the protection of marine and estuarine waters. This criterion was based on a conservative estimate to protect against the toxic effects of the bioconcentration of elemental phosphorus to estuarine and marine organisms, and not on the potential to cause eutrophication.

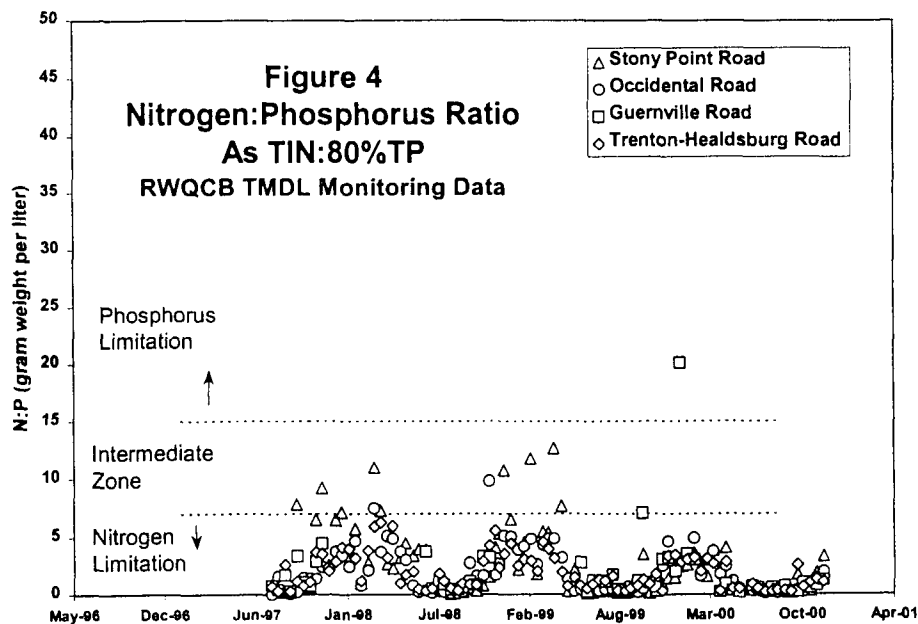
- *Do recent data support the conclusion that algal growth in Laguna waters is phosphorus-limited?*

The 1995 TMDL (RWQCB 1995) identified ammonia and total nitrogen as limiting nutrients in the Laguna. This conclusion was based on a variety of data, including Algal Growth Potential (AGP) tests and analysis of nutrient ratios, collected over several years by several investigators. Nitrogen-to-phosphorus ratios based on recent Laguna measurements continue to indicate that nitrogen is the macronutrient controlling plant growth in the Laguna.

The simple ratio of total nitrogen to total phosphorus (Figure 3) suggests that Laguna waters are nitrogen-limited, but this ratio may not accurately predict the relative importance of each nutrient, because several forms of each element may not be available to plants for growth. Lee et al. (1980) found that for a wide variety of aquatic habitats, a good estimate of the bioavailable phosphorus is given by the sum of the dissolved orthophosphate and 0.2 x the particulate phosphorus in a water sample. The recent phosphorus data collected in the RWQCB's TMDL monitoring series evaluated total phosphorus only, which includes both particulate and dissolved forms. However, both dissolved and total P were measured at Laguna stations by the City of Santa Rosa in their Laguna Monitoring program. Two of their stations (Occidental Road and Stony Point Road) correspond to stations also sampled in the 1995-2000 RWQCB TMDL series. The dissolved orthophosphate averaged 76% of total P in 82 pairs of



determinations made on water from the two stations at all seasons during the years 1993-1999. Using this estimate, the sum of dissolved P and 0.2 x particulate P is estimated by $0.808 \times \text{Total P}$ (i.e., $0.76 + (0.2 \times 0.24)$). Accordingly, the N-to-P ratio, calculated as Total Inorganic Nitrogen (TIN) divided by $0.8 \times \text{Total P}$ (Figure 4), should realistically represent the bioavailable forms of both elements. This figure clearly shows that nitrogen continues to be the macronutrient controlling algal growth in the Laguna. The degree of N-limitation appears to be increasing, not surprising since N inputs have decreased.



REFERENCES CITED

- Lee, G.F., Jones, R.A., and W. Rast. 1980. Availability of phosphorus to phytoplankton and its implications for phosphorus management strategies. P. 259-308, *In*: "Phosphorus Management Strategies for Lakes," Ann Arbor Science Publishers, Inc.
- National Research Council. 2001. Assessing the TMDL approach to water quality management. National Academy Press. 109 p.
- RWQCB, North Coast Region. 1995. Waste Reduction Strategy for the Laguna de Santa Rosa. March 1, 1995.
- US EPA. 2000. Nutrient Criteria Technical Guidance Manual for Lakes and Reservoirs. EPA-822-F-00-002. April 2000.