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Subject: Nutrient-Caused Delta Domestic Water Supply Water Quality Problems
X-Mailer: AOL 3.0 for Windows 95 sub 62

January 26, 1998

Dear Judy,

With reference to the CALFED Water Quality Program PAT Discussions of Delta domestic water supply nutrient-related problems, presented below is a summary of my experience devoted to a discussion of these problems. If you or other members of CALFED management have questions or comments on this matter, please contact me.

Fred

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January 26, 1998

Dr. Mark D. Beuhler
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Dear Mark:

I am following up on a couple of situations that have recently occurred that relate to your Watershed and Reservoir Management Committee activities, as well as MWD's interest in source water quality protection. I have been an active participant on a voluntary basis (unsupported) in the CALFED Water Quality Technical Group and the Sacramento River Watershed Program. My participation has focused on providing comments on technical issues that CALFED management should consider to develop a technically valid, cost-effective definition of real water quality problems in the Delta and its tributaries that are important to the beneficial uses of the Delta. One of the areas that has been of concern to me for which until recently I have been unable to obtain interest by anyone is the excessive fertilization problem that occurs within the Delta. In 1989, when I first moved back to California, one of my first consulting jobs was with Delta Wetlands, where I was asked to examine the expected water quality in the storage reservoirs that were proposed for development

on several of the Delta islands. My work in this area was based on my then previous 30 years of work on lake and reservoir water quality that I have conducted throughout the US and in other countries. It included having served for a period of four years as chairman of the AWWA national Water Quality in Reservoirs Committee. During my tenure as chairman in the late 1970s - early 1980s, I tried to get the AWWA management to incorporate review of watershed activities as they may impact a water supply's raw water quality.

The Quality Control and Reservoirs Committee under my direction developed guidance manuals on how this could be done, focusing on the use of the OECD eutrophication study results for determining nitrogen and phosphorus sources as they may impact the excessive fertility of a waterbody. The AWWA management did not support at that time my efforts to broaden reservoir water quality management to include review of watershed activities. In fact, they prevented the release of the Committee report because it would lead to pointing fingers at sources of constituents that are impairing a water supply's raw water quality. As you know, the water utility field and AWWA have changed drastically since then so that now they are finally waking up to the fact that a reservoir's watershed activities are key areas to controlling raw water quality.

My primary purpose in contacting you arises out of recent discussions held at the CALFED Water Quality Technical Group Parameter Assessment Team meeting where there was discussion about the importance of nutrients as a cause of water quality deterioration, both within the Delta and in downstream water supply reservoirs. Those responsible for developing the CALFED domestic water supply water quality concerns about Delta water quality have focused their efforts on trihalomethane precursors, such as TOC (DOC) and bromide. For some reason, they chose not to include the well-known Delta water quality problems for domestic water supplies which are caused by nutrients which cause excessive algal growth which leads to significant taste and odor problems and, in some instances, increased trihalomethane precursors.

In 1989 when I returned to California, I became involved in the excessive growth of algae as it may impact domestic water supply use of Delta waters. I developed a report, "Regulating Drinking Water Quality at the Source," for a University of California, Davis Water Resources Center symposium specifically addressing this issue. Further, as a follow-up a couple of years later on behalf of the CA/NV AWWA Source Water Quality Committee, I developed a report, "Impact of the Current California Drought on Source Water Supply Water Quality," which discussed the impact of the California seven-year drought on domestic water supply water quality focusing on the Delta and downstream reservoir algal growth issues that lead to taste and odors, shortened filter runs, and increased trihalomethane precursors. Copies of these reports are available upon request. They provide a discussion of the excessive fertilization - eutrophication problems that exist in the Delta as they may impact the use of Delta waters for domestic water supply purposes. It was clear from my reviews of the nutrient planktonic algal chlorophyll and domestic water supply water quality problems related to excessive growth of algae that nutrient input to the Delta was a significant cause of water quality deterioration in downstream reservoirs.

I became concerned when I learned about the Contra Costa Water District developing a water supply reservoir for storage of Delta water. I tried to get the Contra Costa Water District management interested in this issue, with limited success. I concluded that the management was simply interested in having water, independent of its quality, and would face the quality issues after the reservoir was built. There was little doubt then that based on the experience of the Santa Clara Water District that the Contra Costa Water District water supply reservoir would experience severe algal problems as a result of the excessive nutrients in the water supply reservoir which derives its water from the Delta.

With respect to algae serving as a source of TOC which is a THM precursor, as

discussed in my earlier reports, it became clear to me that the Contra Costa Water District needed to explore whether the TOC in its raw water supply was derived to any significant extent from algal growth within the Delta. As indicated, from my work in the late 1980s, it became clear that algae can serve as a source of THM precursors when there is a short coupling time between the death of the algae and when chlorination occurs. Depending on temperature, if a period of a week to two weeks occurs between death of the algae and chlorination, the algal-derived total organic carbon appears to be mineralized sufficiently so that it contributes little to the background TOC in a waterbody.

Typically, excessive algal growth in water supply reservoirs is controlled through the use of copper sulfate. However, with some waterbodies, like San Francisco Bay, experiencing excessive copper concentrations compared to the US EPA water quality criterion, the use of copper sulfate for algae control is threatened. In the early 1990s I tried to get the AWWA interested in the potential significance of having to curtail the use of copper for algae control because of the increased attention to copper as a cause of water quality problems in the receiving waters for wastewater discharges that arise at least, in part, from raw water supplies that are treated with copper for algae control. I offered to present a paper on these issues at the AWWA national meeting that was held in the Los Angeles area several years ago, however those in charge of developing the program were not interested.

In the early 1990s, I explored the possibility of working with MWD staff on investigating in more detail the relative significance of nitrogen and phosphorus as a cause of down-Delta domestic water supply water quality problems. I obtained from MWD staff the available monitoring data for the various reservoirs. Unfortunately, there were insufficient data available then to develop the kinds of information needed to assess the relative significance of nitrogen vs. phosphorus as a limiting nutrient in the down-Delta reservoirs.

My work at that time indicated that it may be possible to limit the phosphorus input to the Delta sufficiently so that even though nitrogen is the limiting element potentially controlling algal growth for most of the time, it may be possible to convert the Delta into phosphorus limitation because of the significant excess nitrate. Further, it is unlikely that significant control of nitrate inputs to the Delta can be achieved. While it is possible to remove on the order of 90% of the phosphorus from domestic wastewater sources at a cost of about 3 cents/person/day for the population contributing the wastewaters to the Delta system, much higher costs are involved for the control of nitrogen .

At the December CALFED Water Quality Program meeting, both Larry McCollum and Lynda Smith indicated that nitrogen and phosphorus should be included as Parameters of Concern in the CALFED Water Quality Program for the Delta because of their impact on domestic water supply water quality. I strongly supported their suggestions on this matter. I understand that they will be making a presentation on this issue at the January 28, 1998 CALFED Water Quality Program Parameter Assessment Team meeting.

Because of my long-standing interest in this matter, I would like to know whether MWD has conducted the appropriate studies to determine whether nitrogen or phosphorus are, in fact, limiting algal growth in the water supply reservoirs that use Delta waters as a source of raw water. Further, has MWD explored whether reducing the nitrogen and/or phosphorus inputs to the Delta and its tributaries could lead to an improved raw water quality in these reservoirs through limiting algal growth? To my knowledge, this type of examination has not been done. It is certainly appropriate in light of CALFED's mission and direction to consider doing these types of studies. If these studies have not been done or have been done inadequately - unreliably, then they should be done in the near future.

I have followed the various consultants' reports on source water quality issues associated with the Delta and found them significantly deficient in addressing key issues pertinent to this and related topic areas. To my knowledge, work on this

topic has not yet been properly done. It is important that those doing the studies have a good understanding of nutrient dynamics, the relative significance of nitrogen vs. phosphorus and how to properly determine whether either or both of these constituents are, in fact, limiting algal biomass as it impacts domestic water supply water quality. There are few individuals in the field who understand these issues. The approach of simply taking Redfield total N and total P numbers as an indication of nutrient limitation can readily lead to erroneous conclusions.

As part of the work that Dr. Anne Jones and I did with the AWWA Quality Control in Reservoirs Committee in the early 1980s, we developed guidance, "Determination of Nutrient Limiting Maximum Algal Biomass in Waterbodies," on how to determine limiting nutrients in water supply reservoirs. A copy of that write-up is available upon request. We also developed guidance, "Study Program for Development of Information for Use of OECD Eutrophication Modeling in Water Quality Management," on the minimum monitoring program necessary to develop the database that can be used to determine limiting nutrients and the potential benefits of controlling one or more nutrient inputs on the eutrophication-related water quality. A copy of that report is also available upon request. Both of these reports have relevance to your ISWA Watershed Reservoir and Management Committee. While they were developed almost 20 years ago, they are still applicable to managing excessive fertilization of waterbodies from a domestic water supply water quality protection perspective. They also are applicable to CALFED's, MWD's and other water utilities' interests in Delta water supply water quality issues.

If there is interest, I would be happy to review any work that has been done on determining limiting nutrients and the potential benefits of controlling nitrogen and/or phosphorus on the eutrophication-related raw water quality for down-Delta reservoirs and within Delta water supply sources. I could work with MWD staff in providing guidance on how to properly evaluate the nutrient limitation issues and the potential benefits of controlling nutrients inputted to the Delta on domestic water supply raw water quality. I could undertake this work as a consultant to MWD or through a CALFED-funded project. Also, if I can help with your IWSA Watershed and Reservoir Management Committee activities, please contact me.

If you, members of your staff, Lynda Smith or Larry McCollum have questions or wish further information, please contact me. Thank you for taking the time to review these matters.

Sincerely yours,

G. Fred Lee

G. Fred Lee, PhD, DEE
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