Comments on the CVRWQCB Draft Charter Document – Process to Develop a Delta Nutrient Management Strategy Dated December 22, 2014

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On January 9, 2015, the Central Valley Regional Water Quality Control Board (CVRWQCB) held a Delta Nutrient Stakeholder & Technical Advisory Group Meeting[1] as part of its charge *"to prepare and begin implementing a study plan to develop nutrient objectives for the* [San Joaquin] *Delta."* Part of that meeting was devoted to review of the staff's "Draft Charter Document – Process to Develop a Delta Nutrient Management Strategy," dated December 22, 2014
[http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/public_involvement_stag_meetings/2014_1222_straw_propsl_chrtr_rev_draft.pdf].

That document was developed to begin to meet recommendations made in the 2013 Delta Plan (as quoted in the Draft Charter Document):

> *"The State Water Resources Control Board and the San Francisco Bay and Central Valley Regional Water Quality Control Boards should prepare and begin implementation of a study plan for the development of objectives for nutrients in the Delta … by January 1, 2014. Studies needed for development of … nutrient objectives should be completed by January 1, 2016. The Water Boards should adopt and begin implementation of nutrient objectives, either narrative or numeric, where appropriate… by January 1, 2018."*

Delta Stewardship Council Review of Delta Nutrient Problems

We strongly support the need to develop a Delta nutrient control strategy for nutrient (nitrogen and phosphorus) sources in the Delta watershed and within the Delta. We followed closely the Delta Stewardship Council (DSC) efforts to develop reliable information on nutrient caused water quality problems within the Delta and downstream of the Delta that use Delta water. We found that the DSC technical staff in developing information on the Delta nutrient water quality problems repeatedly failed to present reliable technical information on the issues that need to be addressed in developing a nutrient management strategy to begin to control the excessive fertilization issues in the Delta. As discussed in our comments submitted to the DSC,

> Lee, G. F., and Jones-Lee, A., "Comments on the Delta Stewardship Council's Third Staff Draft Delta Plan – Chapter 6 Improve Water Quality to Protect Human Health and the

[1] [meeting agenda available at http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/public_involvement_stag_meetings/2015_0109_stagmtg_ag.pdf]

Environment – Released April 22, 2011," Submitted to Delta Stewardship Council, Sacramento, CA, Report of G. Fred Lee & Associates, El Macero, CA, Updated May 1 (2011). http://www.gfredlee.com/SJR-Delta/DSCThrdStaffDraft-Com.pdf

Lee, G. F., and Jones-Lee, A., "Comments on Delta Stewardship Council Staff May 14, 2012 Draft of the Delta Plan," Comments to Delta Stewardship Council by G. Fred Lee & Associates, El Macero, CA, June 13 (2012). http://www.gfredlee.com/SJR-Delta/DSC-Comments-May2012-StaffDraft.pdf

Lee, G. F., and Jones-Lee, A., "Comments on Revised Delta Plan Staff Draft Chapter 6 'Improve Water Quality to Protect Human Health and the Environment' as Presented in the Fourth Staff Draft of the Delta Plan," Comments Submitted to Delta Stewardship Council, Sacramento, CA, by G. Fred Lee & Associates, El Macero, CA, June 14 (2011). http://www.gfredlee.com/SJR-Delta/DeltaPlan4DraftCh6Comm.pdf

Lee, G. F., and Jones-Lee, A., "Comments on the DSC Staff Fifth Draft of Chapter 6 Devoted to Delta Water Quality Issues in the Delta Plan," Comments Submitted to Delta Stewardship Council, Sacramento, CA, by G. Fred Lee & Associates, El Macero, CA, August 21 (2011). http://www.gfredlee.com/SJR-Delta/DeltaPlan5DraftCh6Comm.pdf

Lee, G. F., and Jones-Lee, A., "Comments on the Adequacy of C. Dahm's Discussion of Delta Eutrophication Issues & Delta N/P Rations as a Cause of Adverse Impact on Delta Fish," Comments to Delta Stewardship Council, Report of G. Fred Lee &Associates, El Macero, CA, November 17 (2011). http://www.gfredlee.com/SJR-Delta/DSC-Comments-Dahm-Eutroph.pdf

As we discussed in our previous comments on the DSC staff draft discussion of Delta nutrient water quality issues, the DSC staff continues to omit reference to several of the most important technical papers/reports on Delta nutrient issues even though those references, with a discussion, were provided to the DSC staff in our comments. These omissions deprived the readers of the staff draft plan key information that should be considered in understanding the Delta nutrient water quality problems and that should be used to formulate a Delta nutrient management strategy.

Presented below is a section of our November 17, 2011 comments to the DSC [available at: http://www.gfredlee.com/SJR-Delta/DSC-Comments-Dahm-Eutroph.pdf] that identify and discuss significant technical omissions from the staff draft:

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"At today's Delta Stewardship Council public meeting, there was considerable discussion of Delta eutrophication water quality/resource issues and the impact of N/P ratios in the Delta as presented in Glibert et al.'s recent paper:
Glibert, P. M., D. Fullerton, J. M. Burkholder, J. C. Cornwell and T. M. Kana. 2011. Ecological stoichiometry, biogeochemical cycling, invasive species, and aquatic food webs: San Francisco Estuary and comparative systems. Reviews in Fisheries Science 19:4, 358-417.

The current DSC staff draft versions of the Plan and C. Dahms's presentation today continue to fall significantly short of reliably and adequately informing the DSC on the professional literature on these issues.

In our comments on the third draft of the DSC Plan,

> Lee, G. F., and Jones-Lee, A., "Comments on the Delta Stewardship Council's Third Staff Draft Delta Plan – Chapter 6 Improve Water Quality to Protect Human Health and the Environment – Released April 22, 2011," Submitted to Delta Stewardship Council, Sacramento, CA, Report of G. Fred Lee & Associates, El Macero, CA, Updated May 1 (2011). http://www.gfredlee.com/SJR-Delta/DSCThrdStaffDraft-Com.pdf

we reported the following:

"Impact of N/P Ratios on Delta Aquatic Life Resources The DSC third staff draft Chapter 6 devotes considerable attention to the writings that discuss N/P ratios in the Delta as a cause of ecosystem changes, the pelagic organism decline (POD), and of other resource problems in the Delta. The third staff draft Chapter 6 fails to mention a number of technical issues related to that concern that are discussed in the literature. For example, in his presentation cited below, Cloern discussed the lack of technical validity in the Glibert's claim that changes in N/P ratio are a cause of changes in the Delta ecosystem that has occurred in recent years.

> *Cloern, James "Historical Perspective on Human Disturbance in the Sacramento-San Joaquin Delta Ecosystem", Senior Research Scientist, U.S. Geological Survey Menlo Park, CA presented at National Academies of Science (NAS) National Research Council (NRC) meeting, "Sustainable Water and Environmental Management in the California Bay-Delta" held on July 13-15, 2010 in Sacramento, Ca, PowerPoint slides obtained from the NRC Public Access Records Office at www.nrc.gov/reading-rm/foia/foia-privacy.html.*

In his CWEMF nutrient workshop presentation entitled, "Impact of Sacramento River Input of Phosphorus to the Delta on Algal Growth in the Delta," Dr. Erwin Van Nieuwenhuyse summarized his recent paper describing the response of average summer chlorophyll concentration in the Delta to an abrupt and sustained reduction in phosphorus discharge from the Sacramento County Regional Sanitation District wastewater treatment facility. His presentation provides important information on the impact of Sac Regional phosphorus discharge on Delta planktonic algae in the Delta, and is available at, http://www.cwemf.org/workshops/DeltaNutrientsWrkshp/VanNieuwenhuyse.pdf."

In our comments on the fifth draft DSC staff Plan,

> *Lee, G. F., and Jones-Lee, A., "Comments on the DSC Staff Fifth Draft of Chapter 6 Devoted to Delta Water Quality Issues in the Delta Plan," Comments Submitted to Delta Stewardship Council, Sacramento, CA, by G. Fred Lee & Associates, El Macero, CA, August 21 (2011). http://www.gfredlee.com/SJR-Delta/DeltaPlan5DraftCh6Comm.pdf*

on Page 142 line 27 and following: In our comments on technical deficiencies in the third staff draft Chapter 6 (cited above) we stated,

"The California Water Environmental Modeling Forum (CWEMF) develops peer reviews of modeling approaches and develops workshops on water modeling issues; Dr. Lee was asked to serve as a member of the CWEMF steering committee. With Dr. Jones-Lee he developed for the CWEMF a workshop entitled, "Overview of Delta Nutrient Water Quality Problems: Nutrient Load - Water Quality Impact Modeling," which was presented to an audience of about 100 in March 2008. Information on that workshop is available on the CWEMF website [http://www.cwemf.org] at: http://www.cwemf.org/workshops/NutrientLoadWrkshp.pdf. Additional information on the workshop is

available at:

Lee, G. F., and Jones-Lee, A., "Delta Nutrient-Related Water Quality Problems," PowerPoint Slides Presented at CALFED Science Conference, Sacramento, CA, October 24 (2008). http://www.gfredlee.com/SJR-Delta/CALFED_SciConf10-08.pdf

Lee, G. F., and Jones-Lee, A., "Synopsis of CWEMF Delta Nutrient Water Quality Modeling Workshop – March 25, 2008, Sacramento, CA," Report of G. Fred Lee & Associates, El Macero, CA, May 15 (2008). http://www.gfredlee.com/SJRDelta/ CWEMF_WS_synopsis.pdf

"Overview of Delta Nutrient Water Quality Problems: Nutrient Load – Water Quality Impact Modeling," Agenda for Technical Workshop sponsored by California Water and Environmental Modeling Forum (CWEMF), Scheduled for March 25, 2008 in Sacramento, CA (2008). http://www.gfredlee.com/SJR-Delta/CWEMF_Workshop_Agenda.pdf

As noted in our review of DSC third draft Chapter 6 the work of Dr. Van Nieuwenhuyse should be mentioned at this location in Chapter 6. We stated in our comments on the third staff draft of Chapter 6: "In his CWEMF nutrient workshop presentation entitled, "Impact of Sacramento River Input of Phosphorus to the Delta on Algal Growth in the Delta," Dr. Erwin Van Nieuwenhuyse summarized his recent paper describing the response of average summer chlorophyll concentration in the Delta to an abrupt and sustained reduction in phosphorus discharge from the Sacramento County Regional Sanitation District wastewater treatment facility. His presentation provides important information on the impact of Sac Regional phosphorus discharge on Delta planktonic algae in the Delta, and is available at, http://www.cwemf.org/workshops/DeltaNutrientsWrkshp/VanNieuwenhuyse.pdf.

"As discussed in the van Nieuwenhuyse workshop presentation and published paper,

vanNieuwenhuyse, E., "Response of Summer Chlorophyll Concentration to Reduced Total Phosphorus Concentration in the Rhine River (Netherlands) and the Sacramento– San Joaquin Delta (California, USA)," Can. J. Fish. Aquatic, Sci. 64(11):1529-1542 (2007). [http://www.ingentaconnect.com/content/nrc/cjfas/2007/00000064/00000011/art00006]

and the Lee and Jones-Lee workshop presentation, backup information, and papers referenced in their presentations, it is well-established that reducing the phosphorus loads and in-waterbody concentrations effects reductions in the phytoplankton biomass in Delta waters. This occur even in situations in which the available phosphorus concentrations in the waterbody remain surplus compared to growth-rate-limiting concentrations. The decrease in planktonic algae in the Delta associated with decreased phosphorus loads to the Delta is important information that must be discussed in a creditable discussion of the impact of nutrients on Delta water quality.

The changes in the Delta ecosystem that occurred associated with Sac Regional decreased phosphorus discharges rather than the change in N/P ratios as discussed in the DSC staff third draft are a more likely cause of changes in the fish production than the change in the N/P ratios discussed by the staff in the third draft."

In our comments on the fourth draft of Chapter 6

Lee, G. F., and Jones-Lee, A., "Comments on Revised Delta Plan Staff Draft Chapter 6 'Improve Water Quality to Protect Human Health and the Environment' as Presented in the Fourth Staff Draft of the Delta Plan," Comments Submitted to Delta Stewardship Council, Sacramento, CA, by G. Fred Lee & Associates, El Macero, CA, June 14 (2011).

http://www.gfredlee.com/SJR-Delta/DeltaPlan4DraftCh6Comm.pdf
we stated,
"Impact of N/P ratios
We discussed the inadequate coverage of the issue of the impact of N/P ratios on Delta aquatic life resources (beginning on page 21 of our comments on the third staff draft). The fourth staff draft discussion has been expanded to include the reference to the report by Cloern on this issue that we noted in our comments. However the revised Chapter 6 fails to mention a very important reference to the work of Dr. Erwin Van Nieuwenhuyse on phosphorus reduction issues, also noted in our previous comments."

"The importance of nutrients as a cause of water quality problems in the Delta is discussed in the revised third staff draft, now the fourth staff draft of Chapter 6. While considerable information on these problems is provided in the revised chapter, the draft fails to discuss and provide adequate reference to the most comprehensive review of the nutrient issues, i.e., the 2008 CWEMF Delta Nutrient workshop. Nutrient issues were discussed in our comments on the third staff draft, from page19 through part of page 21. The 2006 reference provided in the fourth staff draft to an outdated DWR report on nutrient issues is not adequate for providing the reader with current information on Delta nutrient water quality issues that need to be addressed. Of particular concern is the impact of nutrients on drinking water quality and the potential for controlling nutrients and their impacts. The fourth staff draft Chapter 6 continues to provide recommendations to the CVRWQCB on when it should develop nutrient criteria. We discussed the unreliability of recommendations pertaining to nutrients in our comments on the third staff draft."

In the fourth, and now the fifth, draft of Chapter 6, the draft Delta Plan still fails to mention or provide reference to the work of Dr. van Nieuwenhuyse on the potential role of phosphorus in impacting phytoplankton populations in the Delta and the failure to mention the CWEMF Delta nutrient workshop represents a fundamental flaw in how the DSC staff have reviewed and incorporated information provided by DSC draft plan reviewers in revisions of the Plan.

The bottom line is that there was considerable information provided in the Workshop presentations by experts on Delta nutrient water quality issues (available on the CWEMF website) that has not been properly incorporated into the Plan or discussions of the issues before the DSC. Furthermore, the unreliability of the Glibert, et al. N/P ratio approach for assessing the impacts of nutrients on Delta fish populations has been addressed by internationally recognized experts on the Delta ecosystem, including in the following paper (a preprint copy of which is attached):

> James E. Cloern, Alan D. Jassby, Jacob Carstensen, William A. Bennett, Wim Kimmerer, Ralph Mac Nally, David H. Schoellhamer, Monika Winder, "Perils of correlating CUSUM-transformed variables to infer ecological relationships (Breton et al. 2006, Glibert 2010)," in press *[N.B. This has since been published in: Limnol. Oceanogr. 57(2):665–668 (2012) and is available at: http://onlinelibrary.wiley.com/doi/10.4319/lo.2012.57.2.0665/pdf]*

As discussed in my comments on the third staff draft of the Plan, Cloern, an internationally recognized expert on Delta ecosystem issues, also reported on this issue at a National Academy of Science (NAS)–National Research Council (NRC) meeting, "Sustainable Water and Environmental Management in the California Bay-Delta," held on July 13-15, 2010 in Sacramento, CA. At that meeting Cloern explicitly stated that Glibert's approach for evaluating the impact of N/P ratios on Delta fish is not technically valid.

The disregard of technical information and comments provided in this process, and the narrow focus on

technically invalid approaches are of great concern if the goal of this process is to provide the DSC with reliable and complete technical information concerning the impacts of nutrients on Delta water quality.

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More recently we have written the following discussions of these issues:

Lee, G. F., and Jones-Lee, A., "Comments on P. Glibert Defense of N/P Ratios as Major Influence on Aquatic Ecosystems Composition in Delta," Report of G. Fred Lee & Associates, El Macro, CA, September 17 (2012). http://www.gfredlee.com/SJR-Delta/Comments_Glibert_NPRatio.pdf

Lee, G. F., and Jones-Lee, A., "Comments on Bay Delta Conservation Plan (BDCP) Draft EIR/EIS Chapter 8 – Water Quality, Chapter 25 – Public Health, July 25, 2014," Comments submitted as part of comments provided by California Sportfishing Protection Alliance, Stockton, CA to Ryan Wulff, NOAA National Marine Fisheries Service, Sacramento, CA, July 28 (2014). http://www.gfredlee.com/SJR-Delta/Comments_BDCP_draftEIR_EIS_July2014.pdf

Educational Background & Professional Experience

Dr. G. Fred Lee's education background is summarized in http://www.gfredlee.com/Education/GFL-Education.pdf. He earned a BA degree in environmental science from San Jose State University in 1955, an MS in Public Health degree from the University of North Carolina Chapel Hill in 1957, and a PhD degree in environmental engineering with minors in aquatic chemistry and public health from Harvard University in 1960. For 30 years he held university graduate school faculty and research positions at several US universities during which time he conducted about $5 million in water quality research and developed about 500 professional papers and reports. Many of those publications are available on our website www.gfredlee.com. A summary of our work in developing university graduate-level water chemistry/environmental engineering teaching and research programs is available at:

Lee, G. F., and Jones-Lee, A., "Development of the Water Chemistry Program at the University of Wisconsin Madison & Follow-on Activities of Dr. Lee in Developing the Water Chemistry Field," Report of G. Fred Lee & Associates, El Macero, CA, January 1 (2012). http://www.gfredlee.com/Education/WaterChemProgramDevel.pdf

In 1989 Drs. Lee and Jones-Lee refocused their professional activities onto full-time private consulting in water quality and solid & hazardous waste evaluation and management issues. They are the principals of their firm, G. Fred Lee & Associates. Information on the firm's activities is available on their website, www.gfredlee.com. Since 1989 they have developed an additional 700 professional papers and reports on their professional activities, which are also available on their website.

Over the past five decades a major area of Dr. Lee's research and consulting activities has been on impacts of aquatic plant nutrient on water quality. He did pioneering research, and has continued his involvement, in describing eutrophication processes, quantification of nutrient utilization in eutrophication, assessment of nutrient availability to aquatic plants, and quantification of impacts of nutrients and eutrophication on numerous aspects of water quality including drinking water supply, recreation, public health, and fisheries. This experience is

summarized in:

Lee, G. F., "G. Fred Lee's Expertise and Experience in Investigating & Managing Excessive Fertilization in Waterbodies and Developing Nutrient Criteria," Submitted to SWRCB Nutrient Objectives Stakeholder Advisory Group (SAG), Sacramento, CA by G. Fred Lee & Associates, El Macero, CA, June (2014).
[http://www.gfredlee.com/exp/GFL_Nutrient_Expertise.pdf]

Many of their papers and reports on their work on this issue are available in the *Nutrients & Eutrophication* section of their website (http://www.gfredlee.com/pexfert2.html).

As discussed in the summary cited above, Dr. Lee's work on nutrient-related water quality issues began in 1960 when he joined the University of Wisconsin Madison, and established and directed the Water Chemistry graduate degree program. During his 13-year service in that capacity, he guided the master's and PhD work of 69 graduate students; he supervised the work of another 25 graduate students at the University of Texas, Dallas and Colorado State University while holding professorial positions there. The thesis/dissertation research of many of those graduate students was focused on nutrient-related water quality issues. Dr. Lee has pioneered in the evaluation and quantification of relationships between various aspects of water quality/beneficial uses and nutrients (forms, loads, sources, cycling) for five decades. His work has included freshwater (lake, reservoir, and lotic systems), nearshore marine, and estuarine environments. Some of his and his associates' work in these areas is summarized below, followed by an overview of nutrient-related water quality work he has done over the past 25 years in the Delta.

Eutrophication Reviews

Dr. Lee has developed several invited reviews on the evaluation and management of eutrophication of natural waters including:

Lee, G. F., "Eutrophication," Transactions of the Northeast Fish and Wildlife Conference, pp 39-60 (1973). [Also published as: Lee, G. F., "Eutrophication," Encyclopedia of Chem. Tech. - Supplement, John Wiley & Sons, pp 315-338 (1971)]
http://www.gfredlee.com/Nutrients/Eutrophication_Review.pdf

Jones-Lee, A., and Lee, G. F., "Eutrophication (Excessive Fertilization)," Water Encyclopedia: Surface and Agricultural Water, Wiley, Hoboken, NJ pp 107-114 (2005).
http://www.gfredlee.com/Nutrients/WileyEutrophication.pdf

Quantification of Nutrient Load–Response Relationships for Water Quality Management

Drs. Lee and Jones-Lee have extensive experience in examining and quantifying the nutrient-related water quality in lakes and reservoirs throughout the US and in several other countries as part of, and ancillary to, the USA's participation in the OECD international study of the impact of nutrients on lake and reservoir water quality. Dr. Lee was appointed by the US EPA as the US representative to the steering committee for the 22-country 200-waterbody five-year OECD

Eutrophication Study undertaken to quantify cause-and-effect relationships between nutrient loads and waterbody response. He also had the US EPA contract to develop the summary report of findings on the US waterbodies which served as a model for the overall Study. The US waterbody summary report was published as:

> Rast, W., and Lee, G. F., "Summary Analysis of the North American (US Portion) OECD Eutrophication Project: Nutrient Loading--Lake Response Relationships and Trophic State Indices," EPA 600/3-78-008, US EPA Corvallis, OR (1978). http://www.gfredlee.com/Nutrients/Rast_Lee_OECD_Report.pdf

> Lee, G. F., Rast, W., and Jones, R. A., "Eutrophication of Water Bodies: Insights for an Age-Old Problem," Environ. Sci. & Technol. 12:900-908 (1978). http://www.gfredlee.com/Nutrients/Eutrophication-EST.pdf

Following on his OECD Eutrophication Study work, Lee and his associates continued to explore, develop, and apply the Vollenweider-OECD eutrophication modeling approach to additional waterbodies. Significantly using independent data from before and after nutrient load modifications to waterbodies, they were able to document the validity, reliability, and scope of applicability of that modeling approach for quantifying the expected changes in nutrient-related water quality that can be expected in a waterbody from given load alterations, as well as how long it may be before such changes can be seen. They have developed several papers on the use of the OECD modeling approach for guiding and evaluating nutrient control options for water quality management, including:

> Jones, R. A., and Lee, G. F., "Recent Advances in Assessing the Impact of Phosphorus Loads on Eutrophication-Related Water Quality," Journ. Water Research 16:503-515 (1982). http://www.gfredlee.com/Nutrients/RecentAdvWaterRes.pdf

> Jones, R. A. and Lee, G. F., "Eutrophication Modeling for Water Quality Management: An Update of the Vollenweider-OECD Model," World Health Organization's Water Quality Bulletin 11:67-174, 118 (1986). http://www.gfredlee.com/Nutrients/voll_oecd.html

> Jones, R. A. and Lee, G. F., “Use of Vollenweider-OECD Modeling to Evaluate Aquatic Ecosystem Functioning,” Functional Testing of Aquatic Biota for Estimating Hazards of Chemicals, ASTM STP 988, Amer. Soc. Test. & Mat., Philadelphia, pp. 17-27 (1988). http://www.gfredlee.com/Nutrients/EcosystemFunctionOECD.pdf

> Jones-Lee, A., and Lee, G. F., “Information Needed to Apply the Vollenweider–OECD Eutrophication Modeling Approach to Nutrient-Related Water Quality Evaluation in Domestic Water Supply Waterbodies,” Report of G. Fred Lee & Associates, El Macero, CA, March 16 (2009). http://www.gfredlee.com/Nutrients/OECD

One of the significant deficiencies of common nutrient models is that they do not incorporate true assessment of their ability to reliably predict water quality impacts of nutrient load alterations based on data other than those upon which the models were developed. Rast, Jones, and Lee evaluated and demonstrated the predictive reliability of the Vollenweider-OECD

modeling approach by comparing measured planktonic algal chlorophyll concentrations after nutrient load reductions to a dozen or so waterbodies with those which were predicted by the model. They found that the magnitude of decrease in plankton algal chlorophyll could be predicted given nutrient load reductions. Their findings were published as:

Rast, W., Jones, A., and Lee, G. F., "Predictive Capability of US OECD Phosphorus Loading-Eutrophication Response Models," Journ. Water Pollut. Control Fed. 55(7):990-1003 (1983).
http://www.gfredlee.com/Nutrients/PredictiveCapabilityOECD.pdf

The rate of recovery or equilibration of a waterbody after a phosphorus load reduction was described by Sonzogni, Uttormark, and Lee; they reported that the rate of recovery of a waterbody was about 3 times the phosphorus residence time of the waterbody.

Sonzogni, W. C., Uttormark, P. C., and Lee, G. F., "A Phosphorus Residence Time Model: Theory and Application," Journ. Water Res. 10:429-435 (1976).
http://www.gfredlee.com/Nutrients/P-ResidenceTime.pdf

Effects of Eutrophication and Nutrient Load Reduction on Fisheries
Lee and Jones reviewed the impact of altering the phosphorus load to a lake or reservoir on the fish biomass in the waterbody, and described how this impact could be quantitatively estimated using the Vollenweider-OECD load-response modeling approach. Their findings were reported in:

Lee, G. F. and Jones, R. A., "Effects of Eutrophication on Fisheries," Reviews in Aquatic Sciences, 5:287-305, CRC Press, Boca Raton, FL (1991).
http://www.gfredlee.com/Nutrients/fisheu.html

Lee, G. F. and Jones-Lee, A., "Additional Information on Impact of Waterbody Fertilization on Fish Production," Report of G. Fred Lee & Associates, El Macero, CA, Published as "Water Body Fertilization: Impact on Fish Production," SCOPE Newsletter 56:6-7, June (2004).
http://www.gfredlee.com/Nutrients/ScopeFertilization.pdf

Algal-Availability of Phosphorus and Nitrogen Compounds
Dr. Lee and a number of his graduate students conducted studies on forms of phosphorus that are available to algae, and transformations between available and unavailable forms. Papers on those studies include:

Lee, G. F.; Jones, R. A. and Rast, W., "Availability of Phosphorus to Phytoplankton and its Implications for Phosphorus Management Strategies," IN: Phosphorus Management Strategies for Lakes, Ann Arbor Science Publishers, Inc., Ann Arbor, MI (1980).
http://www.gfredlee.com/Nutrients/Avail-P.pdf

Lee, G. F., "A Proposal for Assessing Algal-Available Phosphorus Loads in Runoff from Irrigated Agriculture in the Central Valley of California," Report of G. Fred Lee &

Associates, El Macero, CA, November (2006).
http://www.gfredlee.com/Nutrients/AlgalAssayAvailP.pdf

Lee, G. F., "Assessing Algal Available Phosphorus," Submitted for Inclusion in the Proceedings of US EPA Science Symposium: "Sources, Transport, and Fate of Nutrients in the Mississippi River and Atchafalaya River Basins," Minneapolis, MN, November 7-9 (2006). http://www.gfredlee.com/Nutrients/AvailPEPASymp06.pdf

Cowen, W. F., and Lee, G. F., "Phosphorus Availability in Particulate Materials Transported by Urban Runoff," Journ. Water Pollut. Control Fed. 48(3):580-591 (1976).
http://www.gfredlee.com/Nutrients/AvailPParticulatesCowen.pdf

Cowen, W. F., Sirisinha, K., and Lee, G. F., "Nitrogen Availability in Urban Runoff," Journ. Water Pollut. Control Fed. 48(2):339-345 (1976).
http://www.gfredlee.com/Nutrients/NAvailCowenSirisinha.pdf

Those studies, as well as studies by others, have found that the inorganic phosphorus in agricultural and urban runoff is not, and does not become, available to support algal growth. As discussed in our writings, the focus of USEPA-adopted nutrient policy on total phosphorus is not technically valid and will cause agricultural and urban interest to spend large amounts of money controlling particulate phosphorus in stormwater runoff without improving algae-related water quality.

Nutrient Criteria Development

Dr. Lee has long been involved in the development of water quality criteria/standards/objectives. He and Dr. Jones-Lee have written and commented extensively concerning the development of technically valid nutrient management strategies and regulations for waterbodies. Some of their publications on these issues include:

Lee, G. F. and Jones-Lee, A., "Developing Nutrient Criteria/TMDLs to Manage Excessive Fertilization of Waterbodies," Proceedings Water Environment Federation TMDL 2002 Conference, Phoenix, AZ, November (2002). http://www.gfredlee.com/WEFN.Criteria.pdf

Lee, G. F., "Proposed Regionalization of Nutrient Criteria Development within the Central Valley of California," Submitted to the US EPA RTAG Nutrient Criteria Program, Report of G. Fred Lee & Associates, El Macero, CA (2001).
http://www.gfredlee.com/nut-cri-reg8-4-01.pdf

Lee, G.F. and Jones-Lee, A., "Determination of Nutrient Limiting Maximum Algal Biomass in Waterbodies," Report of G. Fred Lee & Associates, El Macero, CA (1998).
http://www.gfredlee.com/Nutrients/nut_limit.pdf

Lee, G. F., and Jones-Lee, A., "Comments on 'California Environmental Quality Act Scoping Meeting, Statewide Policy for Nutrient Control in Inland Surface Waters in California,'" Comments submitted to SWRCB, Sacramento, CA by G. Fred Lee & Associates, El Macero, CA, November 9 (2011).

http://www.gfredlee.com/Nutrients/CEQA-NutrientControlCom.pdf

Lee, G. F., and Jones-Lee, A., “Comments on Establishing a Nutrient Runoff Water Quality Management Program,” Report of G. Fred Lee & Associates, El Macero, CA, August 3 (2008). http://www.gfredlee.com/Nutrients/NutrientROffMonitorCom.pdf

Lee, G. F., “Proposed Regionalization of Nutrient Criteria Development within the Central Valley of California,” Submitted to the US EPA RTAG Nutrient Criteria Program, Report of G. Fred Lee & Associates, El Macero, CA, August (2001). http://www.gfredlee.com/Nutrients/nut-cri-reg8-4-01.pdf

Lee, G. F., “Comments on Developing Nutrient Criteria for SJR Delta,” email to Christine Joab, Central Valley Regional Water Quality Control Board, Rancho Cordova, CA, March 29 (2011). http://www.gfredlee.com/SJR-Delta/Delta-Nutr-Criteria-Com.pdf

Lee, G. F., and Jones-Lee, A., “Experience in Reviewing Delta Water Quality Issues,” G. Fred Lee & Associates, El Macero, CA, April 3 (2011). http://www.gfredlee.com/SJR-Delta/GFLAJL-Delta-EXP-REV.pdf

Lee, G. F., and Jones-Lee, A., “Discussion of Water Quality Issues That Should Be Considered in Evaluating the Potential Impact of Delta Water Diversions/Manipulations on Chemical Pollutants on Aquatic Life Resources of the Delta,” Report of G. Fred Lee & Associates, El Macero, CA, February 11 (2010). http://www.gfredlee.com/SJR-Delta/Impact_Diversions.pdf

Lee, G. F., and Jones-Lee, A., “Comments on Water Quality Issues Associated with SWRCB’s Developing Flow Criteria for Protection of the Public Trust Aquatic Life Resources of the Delta,” Submitted to CA State Water Resources Control Board as part of Public Trust Delta Flow Criteria Development, by G. Fred Lee & Associates, El Macero, CA, February 11 (2010). http://www.gfredlee.com/SJR-Delta/Public_Trust_WQ.pdf

Lee, G. F. and Jones-Lee, A., “Overview of Sacramento-San Joaquin River Delta Water Quality Issues,” Report of G. Fred Lee & Associates, El Macero, CA (2004). http://www.gfredlee.com/SJR-Delta/Delta-WQ-IssuesRpt.pdf

Lee, G. F., and Jones-Lee, A., “Delta Nutrient-Related Water Quality Problems,” PowerPoint Slides Presented at CALFED Science Conference, Sacramento, CA, October 24 (2008). http://www.gfredlee.com/SJR-Delta/CALFED_SciConf10-08.pdf

Water Quality Criteria Development

A discussion of Drs. Lee and Jones-Lee expertise and experience in the development of water quality standards and NPDES permits, and implementation of standards into NPDES Permitted Discharges is available as http://www.gfredlee.com/exp/wqexp.htm, and in:

Lee, G. F. and Jones-Lee, A., "Appropriate Use of Numeric Chemical Water Quality Criteria," Health and Ecological Risk Assessment, 1:5-11 (1995).

http://www.gfredlee.com/SurfaceWQ/chemcri.pdf

Evaluation & Management of Nutrients in Domestic Wastewater
Dr. Lee has been involved in research on the evaluation and management of nutrients in domestic wastewaters since the 1960s; among the papers and reports he has developed on these issues are:

Lee, G. F., "Summary of Experience in Evaluating the Impact of Domestic Wastewater Discharges on Receiving Waterbody Quality," Report of G. Fred Lee & Associates, El Macero, CA, January (2010). http://www.gfredlee.com/exp/GFL-Exp-Wastewater.pdf

Malhotra, S. K., Lee, G. F., and Rohlich, G. A., "Nutrient Removal from Secondary Effluent by Alum Flocculation and Lime Precipitation," Air & Water Pollut. 8:487-500 (1964). http://www.gfredlee.com/Nutrients/MalhotraNutrRemAlum.pdf

Jones-Lee, A., and Lee, G. F., "Septic Tank Wastewater Disposal Systems as Phosphorus Sources for Surface Waters," Journ. Water Pollut. Control Fed. 51(11):2764-2775 (1979). http://www.gfredlee.com/Nutrients/SepticTanks-P-Source.pdf

Lee, G. F., "G. Fred Lee Experience in Fate & Water Quality Impacts of Ammonia," Report of G. Fred Lee & Associates, El Macero, CA, March 16 (2009). http://www.gfredlee.com/Nutrients/GFL-AmmoniaExperience.pdf

Evaluation & Management of Nutrients in Urban Stormwater Runoff
In the mid-1960s, Dr. Lee and his graduate students at the University of Wisconsin, Madison were among the first to investigate the composition of urban stormwater runoff and, most importantly, to evaluate the impact of potential pollutants in urban runoff on receiving water quality. His work in this area has continued over the years, and from 1998 to 2011 he and Dr. Jones-Lee published an online newsletter, "Stormwater Runoff Water Quality Newsletter," devoted to current issues in stormwater-runoff evaluation and management. Those newsletters are available on their website at http://www.gfredlee.com/newsindex.html. In addition to addressing nutrients in stormwater runoff in many of the issues of their newsletters, Drs. Lee and Jones-Lee have published other papers and reports concerning the evaluation, management, and regulation of nutrients in stormwater runoff, which are available on their website in the Stormwater section: *"Stormwater-Associated Contaminants Issues Concerning Reliable Assessment & Regulation, Nature of Stormwater Runoff & Runoff Events Render Conventional Criteria/Standards & Evaluation/Management Approaches Unreliable – Some Key Issues in Evaluating & Regulating Stormwater-Associated Contaminants,"* [http://www.gfredlee.com/Stormwater_Impacts.html]. Included among their publications available pertaining to impacts, assessment, and regulation of nutrients in stormwater runoff are:

Lee, G. F., and Jones-Lee, A., "Urban Stormwater Runoff Water Quality Issues," IN: Water Encyclopedia: Surface and Agricultural Water, Wiley, Hoboken, NJ pp 432-437 (2005). http://www.gfredlee.com/Runoff/WileyStormwater.pdf

Lee, G. F. "Evaluating Nitrogen and Phosphorus Control in Nutrient TMDLs," Stormwater,

3:10-24, January/February (2002).
http://www.stormh2o.com/SW/Articles/3127.aspx?format=2
http://www.gfredlee.com/Nutrients/StormwaterNutrientTMDL.pdf

Detergent Phosphate as a Cause of Excessive Fertilization
The role of phosphate in household detergent formulations in causing excessive fertilization of waterbodies is an area in which Dr. Lee and his associates have been involved since that issue was first raised. They have developed several publications on these studies, including:

Lee, G. F., and Jones-Lee, A., "Eutrophication, Detergent Phosphate" a summary of Lee, G. F. and Jones, R. A., "Detergent Phosphate Bans and Eutrophication," Environ. Sci. Technol. 20(4):330-331 (1986) (updated) IN: SCOPE Newsletter, No. 67, pp 5-6, February 2007 CEEP of Cefic Bruxelles - Belgium. www.ceep-phosphates.org (2007).
http://www.gfredlee.com/Nutrients/ScopeDetergentPBan.pdf

While at one time in the 1970s, at some locations, the use of phosphate in detergents could have contributed to excessive fertilization of a waterbody, since the 1980s the concentrations of phosphorus in detergents has become insufficient to significantly contribute to excessive fertilization of waterbodies.

Work on Delta Nutrient Water Quality Issues

Delta Wetlands
In the spring of 1989, while he was Distinguished Professor of Civil and Environmental Engineering at the New Jersey Institute of Technology, Dr. Lee served as a consultant to Delta Wetlands on water quality issues associated with its proposed in-Delta water supply reservoirs. The Delta Wetlands concept was to capture winter/spring high-flow waters in Delta-island reservoirs from which stored water would then be released in the summer/fall for use by water utilities that take water from the Delta. The EIR that Delta Wetlands had had a local firm develop had been reviewed by DWR and found to be deficient in addressing the characteristics of the water that would be released from the reservoirs; Dr. Lee's work evaluating anticipated water quality characteristics of water that would be released from the reservoirs. .

San Joaquin River Deep Water Ship Channel Low-DO Studies
In the 1990s Drs. Lee and Jones-Lee were selected to be the principal investigators for a CALFED-supported $2-million two-year study of the low-DO problem in the SJR Deep Water Channel near the Port of Stockton. They developed the synthesis report for the project as well as a number of ancillary and follow-on reports including:

Lee, G. F., and Jones-Lee, A., "Synopsis of Issues in Developing the San Joaquin River Deep Water Ship Channel DO TMDL," Report to SJR DO TMDL Steering Committee and the CVRWQCB, G. Fred Lee & Associates, El Macero, CA, August (2000).
http://www.gfredlee.com/SJR-Delta/SJRsynopsis.pdf

Lee. G. F., and Jones-Lee, A., "Synthesis and Discussion of Findings on the Causes and Factors Influencing Low DO in the San Joaquin River Deep Water Ship Channel near

Stockton, CA: Including 2002 Data," Report Submitted to SJR DO TMDL Steering Committee/Technical Advisory Committee and CALFED Bay-Delta Program, G. Fred Lee & Associates, El Macero, CA, March (2003). http://www.gfredlee.com/SJR-Delta/SynthesisRpt3-21-03.pdf

Lee, G. F. and Jones-Lee, A., "Supplement to Synthesis Report on the Low-DO Problem in the SJR DWSC," Report of G. Fred Lee & Associates, El Macero, CA, June (2004). http://www.gfredlee.com/SJR-Delta/SynthRptSupp.pdf

Additional information on his work on Delta water quality issues and additional publications are available on his website at http://www.gfredlee.com/psjriv2.html.

CWEMF Delta Nutrient Water Quality Workshop

Dr. Lee was invited to become a member of the California Water Environmental Modeling Forum (CWEMF) steering committee. He and Dr. Jones-Lee developed and organized the Delta Water Quality Modeling Workshop in 2008 that brought together recognized experts on various aspects of Delta nutrient-related water quality to present summaries of the state of understanding in their areas of Delta nutrient-related water quality expertise. Background information on the development of and information provide at this workshop is available as:

Lee, G. F., and Jones-Lee, A., "Delta Nutrient Water Quality Modeling Workshop — Background Information," Report of G. Fred Lee & Associates, El Macero, CA, September (2007). http://www.gfredlee.com/Nutrients/NutrWorkshopRev4.pdf

Lee, G.F., "Overview of Delta Nutrient Water Quality Problems: Nutrient Load – Water Quality Impact Modeling," Agenda for Technical Workshop sponsored by California Water and Environmental Modeling Forum (CWEMF), Scheduled for March 25, 2008 in Sacramento, CA (2008). http://www.gfredlee.com/SJR-Delta/CWEMF_Workshop_Agenda.pdf

Lee, G. F., and Jones-Lee, A., "Synopsis of CWEMF Delta Nutrient Water Quality Modeling Workshop – March 25, 2008, Sacramento, CA," Report of G. Fred Lee & Associates, El Macero, CA, May 15 (2008). http://www.gfredlee.com/SJR-Delta/CWEMF_WS_synopsis.pdf

The power point presentations made at the workshop are available as, "Overview of Delta Nutrient Water Quality Problems: Nutrient Load – Water Quality Impact Modeling," http://www.cwemf.org/workshops/NutrientLoadWrkshp.pdf

Agricultural Runoff Nutrient Issues

Dr. Lee conducted some of the early work on the availability and impacts of nutrients in urban, rural, and agricultural runoff. In more recent years, he and Jones-Lee have developed several reviews of the role of phosphorus and nitrogen in agricultural stormwater runoff and tailwater discharges in the Delta watershed in contributing to excessive fertilization of the Delta including:

Lee, G. F., and Jones-Lee, A., "Assessing the Water Quality Significance of N & P

Compound Concentrations in Agricultural Runoff," Invited Paper Presented at Agrochemical Division, American Chemical Society National Meeting, San Francisco, CA, September (2006). http://www.gfredlee.com/Nutrients/N-PRunoffACS.pdf

Lee, G. F., and Jones-Lee, A., "Assessing Water Quality Significance of N & P Compound Concentrations in Agricultural Runoff," PowerPoint Slides for Invited Paper Presented at Agrochemical Division, American Chemical Society National Meeting, San Francisco, CA, September (2006). http://www.gfredlee.com/Nutrients/N-PSlidesACS.pdf

Lee, G. F. and Jones-Lee, A., "Nutrient TMDLs and BMPs," PowerPoint slide presentation to the UC Agricultural Extension farm advisors and researchers, Woodland, CA (2005). http://www.gfredlee.com/Nutrients/FarmAdvisorsWoodland.pdf

Lee, G. F., and Jones-Lee, A., "Interpretation of Nutrient Water Quality Data Associated with Irrigated Agricultural Ag Waiver Monitoring," Submitted to Central Valley Regional Water Quality Control Board, Rancho Cordova, CA, by G. Fred Lee & Associates, El Macero, CA, November (2005). http://www.gfredlee.com/Nutrients/InterprNutrWQData.pdf

Lee, G. F. and Jones-Lee, A., "Assessing the Water Quality Impacts of Phosphorus in Runoff from Agricultural Lands," IN: Hall, W. L. and Robarge, W. P. (eds.), Environmental Impact of Fertilizer on Soil and Water, American Chemical Society Symposium Series 872, Oxford University Press, Cary, NC, pp. 207-219 (2004).
http://www.gfredlee.com/Nutrients/P_Runoff_Ag_ACS.pdf

Lee, G. F. and Jones-Lee, A., "Assessing the Water Quality Impacts of Phosphorus in Runoff from Agricultural Lands: Expanded Discussion," Presented in part at American Chemical Society Agro Division Symposium, "Environmental Impact of Fertilizer Products in Soil, Air and Water," Chicago, IL, August (2001). (Published in part in Symposium Proceedings (Lee and Jones-Lee, 2004) [http://www.gfredlee.com/Nutrients/P_Runoff_Ag_ACS.pdf]) (http://www.gfredlee.com/ ag_p-1_012002.pdf)
http://www.gfredlee.com/Nutrients/ag_p-1_012002.pdf

Delta Macrophytes Water Quality Issues

At the January 9, 2015 CVRWQCB meeting considerable attention was given to the need for management of aquatic macrophytes (water hyacinth and Egeria) in the Delta. As part of developing the CWEMF Delta Nutrient Modeling Workshop, Dr. Lee reviewed the current state of knowledge on the relationships between nutrient input and excessive growths of those water weeds. Egeria, a rooted macrophytes, obtains its nutrients, at least in part, from the sediment. Dr. Lars Anderson was invited to discuss at the workshop the potential for controlling water hyacinths by nutrient control. As part of his synopsis of CWEMF Delta Nutrient Water Quality Modeling Workshop referenced above, Dr. Lee reported the following:

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"Aquatic Weed Problems in the Delta

Dr. Lars Anderson, Lead Scientist/Plant Physiologist with the USDA, Agricultural Research Service Exotic and Invasive Weed Research, Davis, CA (lwanderson@ucdavis.edu) presented a comprehensive review of the presence of aquatic weeds, including water hyacinth, egeria, and other native and invasive aquatic plants, in the Delta. He was assisted in his presentation by Marcia Carlock, Aquatic Weed Control Program Manager, California Department of Boating and Waterways, Sacramento, CA (MCARLOCK@dbw.ca.gov). The Delta is highly impacted by invasive floating, emergent, and submerged aquatic plants that are significantly adverse to the beneficial uses of the Delta, specifically aquatic life habitat, recreation, and other uses. Dr. Anderson pointed out that the Delta is still being invaded by aquatic plants new to the area.

Dr. Anderson reviewed the current approach for controlling excessive growths of aquatic weeds in the Delta. He indicated that herbicides are effective for controlling water hyacinths and egeria, but they are costly. The California Department of Boating and Waterways is currently spending about $6-million per year for aquatic pest (weed) control in the Delta (http://www.dbw.ca.gov/aquatic.asp). By California Legislative requirements, the use of herbicides in the Delta is restricted to water hyacinth and egeria. Funds made available are not available to control excessive growths of other water weeds.

Dr. Anderson reviewed the issues relating the nutrient loads to the Delta and excessive growths of water weeds. He indicated that the current models available for relating nutrient loads to the growths of water hyacinth are not necessarily applicable to the conditions in the Delta. Because of the tidal characteristics of the Delta, modeling of nutrients loads/concentrations and water hyacinth biomass is markedly are more complex than the systems typically addressed in the current models. He is not optimistic that reduction of nutrient loads to the Delta will significantly reduce the growth of invasive water weeds in the Delta."

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Summary of Drs. Lee and Jones-Lee's Experience in Investigating
and Managing Excessive Fertilization of the Delta

As summarized herein, since the early 1960s Dr Lee has be active in the investigation, management, and regulation of excessive fertilization of waterbodies in the US and many other countries; he has developed approximately 100 professional papers and reports on those studies. He and Dr. Jones-Lee started investigating excessive fertilization of the Delta more than 25 years ago and have published more than 50 papers and reports specifically addressing Delta water quality issues related to aquatic plant nutrients. Those publications provide considerable insight into, and guidance on issues that should be considered in, developing a nutrient management strategy for the Delta. Questions or comments on these issues may be directed to Dr. G. Fred Lee.