AN INTEGRATED APPROACH FOR TMDL DEVELOPMENT FOR AGRICULTURAL STORMWATER RUNOFF, TAILWATER RELEASES, AND SUBSURFACE DRAIN WATER*

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ABSTRACT

Irrigated agriculture in the San Joaquin River watershed is subject to compliance with TMDLs for selenium, total dissolved salts, organophosphorus pesticides (diazinon and chlorpyrifos), boron and oxygen demand (nutrients/algae). The proposed Central Valley Regional Water Quality Control Board irrigated agriculture waiver water quality monitoring program will likely show that irrigated agricultural stormwater runoff and tail water/subsurface drain water discharges cause violations of existing and soon to be developed water quality objectives (standards). As a result, agricultural interests in this watershed also potentially face compliance with TMDLs for nutrients (nitrogen and phosphorus), total organic carbon, unknown-caused toxicity, sediment toxicity, organochlorine (legacy) pesticides (such as DDT, chlordane, toxaphene etc.) and pathogen-indicator organisms. There is need for agricultural interests and the regulatory agencies to approach the development of the TMDLs in an integrated, coordinated effort. This effort should include a comprehensive monitoring/water quality impact evaluation program that addresses the stormwater runoff, tailwater and subsurface drain water discharges for all constituents that are potentially subject to Clean Water Act 303(d) listing. The development of BMPs for the control of agricultural releases/discharges should evaluate the control of all constituents that are potentially subject to future TMDL regulation.

INTRODUCTION

Irrigated agriculture in the San Joaquin River watershed of the Central Valley of California faces significant challenges in staying economically viable and meeting the variety of regulatory constraints that are being implemented to control excessive concentrations of a variety of chemical constituents that are present in irrigated agricultural lands' stormwater

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runoff and irrigation return waters (tailwater)/ subsurface drain waters. Tailwater refers to irrigation water that is in surface water runoff from the irrigated fields, while subsurface drain water is water that is derived from a subsurface collection system designed to lower the water table. Irrigated agriculture in the San Joaquin River watershed faces multiple total maximum daily loads (TMDLs) designed to control chemical constituents so that their concentrations in waters receiving agricultural runoff/discharges do not exceed water quality standards/objectives. This discussion of potential TMDLs in the San Joaquin River watershed is based on the authors experience/expertise. This discussion does not necessarily reflect the Central Valley Regional Water Quality Board views on these issues.

CURRENT, PENDING AND POTENTIAL FUTURE TMDLs

Table 1 presents a listing of current, pending and potential TMDLs faced by agricultural interests in the San Joaquin River watershed.

Table 1. San Joaquin River Watershed TMDLs

Current TMDLs

- Selenium
- Salinity, Total Dissolved Solids
- Boron
- OP Pesticides (Diazinon, Chlorpyrifos)
- Oxygen Demanding Substances, (BOD, Ammonia, Organic N)

Pending

- Organochlorine Pesticides, (DDT, Chlordane, Dieldrin, Toxaphene, etc.)
- PCBs
- Mercury
- Unknown-Caused Toxicity
- Toxicity to Algae (Herbicides)

Potential Future

- Nutrients, Excessive Fertilization (Nitrogen and Phosphorus Compounds)
- High pH, Low DO caused by Excessive Fertilization (Photosynthesis)
- Alternative Pesticides to OP Pesticides
- Total Organic Carbon, Trihalomethanes in Domestic Water Supplies
- Excessive Sediment, Erosion, Turbidity
- Pathogen-Indicator Organisms, *E. coli*
- Sediment Toxicity, Pesticides, Nutrients/Algae/Sediment Ammonia
- Temperature (?)
- Dioxins/Furans, Combustion Residues (?)

Current SJR Watershed TMDLs

Agriculture in some parts of the San Joaquin River watershed is already facing TMDLs designed to control discharges of selenium, total salts, organophosphorus pesticides (diazinon and chlorpyrifos) and boron. The Central Valley Regional Water Quality Control Board (CVRWQCB) has proposed TMDLs to control salinity and boron in the San Joaquin River watershed. Further, there are TMDLs pending that are based on controlling organophosphorus pesticides (diazinon and chlorpyrifos) and organochlorine (legacy) pesticides, such as DDT, chlordane, dieldrin, toxaphene, etc., in the San Joaquin River watershed.

Low dissolved oxygen concentrations below the water quality objective in the San Joaquin River (SJR) Deep Water Ship Channel(DWSC) near Stockton have caused the CVRWQCB to develop a TMDL to control discharges of the oxygen-demanding materials and/or conditions that contribute to the DWSC low-DO problem. Lee and Jones-Lee (2000, 2001 and 2002a) have provided a review of this matter. As they report, a major cause of the DWSC low-DO problem is the discharge of nutrients from agricultural lands that develop into algae in the SJR tributaries and the mainstem that are transported into the DWSC, where they die and decompose, leading to low DO. The Mud and Salt Slough watersheds and the SJR upstream of Lander Avenue (Highway 165) are the primary sources of the algae that cause this problem.

Pending TMDLs

In a few years, (likely by 2006) in accord with US EPA's (2001) announced program, it is highly likely that TMDLs will need to be developed to control the concentrations of nitrogen and phosphorus compounds in agricultural stormwater runoff, irrigation tailwater and subsurface drain water to control excessive fertilization of the San Joaquin River and its tributary and downstream waters in the Delta and in water supply reservoirs that use Delta water as a water supply source. Lee and Jones-Lee (2002b) have recently reviewed the issues pertinent to managing phosphorus runoff from agricultural lands. They discuss that there are a variety of factors that need to be investigated in order to develop technically-valid, cost effective phosphorus runoff management programs.

The San Joaquin River and some of its tributaries have been found to be toxic to aquatic life standard test organisms used in US EPA toxicity testing procedures. Studies on this toxicity have thus far failed to identify the cause of the toxicity. This has led the CVRWQCB to develop a TMDL to control this toxicity as "unknown-caused toxicity." Possibly a substantial part of the unknown caused toxicity could be derived from releases from agricultural lands.

The organochlorine pesticides such as DDT, dieldrin, toxaphene, chlordane, etc., are "legacy" pesticides that were banned from use many years ago because of their persistence and their potential to cause cancer in people. However, because of their widespread use by agriculture and persistence in soil they are still present in agricultural soils and in waterbodies that have received runoff from irrigated agriculture in many areas of the Central Valley of California. Past and current runoff/discharges from irrigated lands in the San Joaquin River watershed have resulted in excessive concentrations of several of the legacy pesticides in edible fish tissue taken from waterbodies influenced by agricultural runoff in the Central Valley. This bioaccumulation is of concern since these pesticides are a threat to cause cancer in those who use the fish as food. This has caused the CVRWQCB and the State Water Resources Control Board (SWRCB, 1998) to list about a dozen waterbodies in the Central Valley as 303(d) "impaired" waterbodies, which requires that a TMDL be developed to control the excessive bioaccumulation of the organochlorine pesticides.

Potential TMDLs

Increasing attention is being given to aquatic sediment water quality impacts. This is causing the US EPA and the California State Water Resources Control Board to develop sediment quality guidelines. These guidelines will focus on determining excessive concentrations of chemical constituents in sediments that affect water quality. These guidelines will likely include sediment toxicity. Pesticides, heavy metals and nutrients that develop into algae are common causes of sediment toxicity. The algae cause sediment toxicity through their death and decay in the sediments, which results in the release of ammonia which is highly toxic to aquatic life.

Another potential TMDL that the San Joaquin River watershed irrigated agriculture faces could be the need to reduce the concentrations of total organic carbon (TOC) that are discharged by the San Joaquin River to the Sacramento-San Joaquin River Delta, which in turn cause water utilities that utilize Delta water as a raw water source to have to develop more expensive water treatment processes to control trihalomethane formation. Delta water contains excessive total organic carbon compared to the regulatory limits that the US EPA is imposing on water utilities to minimize trihalomethane formation as part of disinfection of the water supply. The San Joaquin River and the Delta could potentially be listed as 303(d) impaired due to excessive TOC. This listing will require that a TMDL be developed to control TOC discharges from irrigated agriculture and other sources. Of particular concern are drainage from wetlands areas.

Some agricultural lands, especially on the west side of the San Joaquin River are experiencing significant erosion. This leads to westside tributaries and the SJR being highly turbid. This erosion also leads to excessive siltation within the Delta. It is possible that a

TMDL could be developed to control the excessive turbidity/sediment in the San Joaquin River and Delta.

The US EPA (2002) is requiring that states adopt and enforce more appropriate contact recreation sanitary-indicator organism water quality standards than the fecal coliform standard that is being used today. The SWRCB and the CVRWQCB are in the process of adopting US EPA recommended contact recreation (swimming, wading, etc.) water quality standards to protect the health of those who contact recreate in the State's waters. The US EPA recommends that the fecal coliform standard be abandoned as a contact recreation standard and that an *E coli* standard be adopted. It is possible that irrigated agricultural lands, especially those receiving animal manure and/or biosolids (sewage sludge) will have elevated *E coli* in the stormwater runoff and tailwater discharges. This will lead to a 303(d) listing and a TMDL to control the excessive *E coli* in irrigated agricultural runoff/discharges.

There are several other potential TMDLs listed in Table 1, such as mercury, PCBs, dioxins/furans, temperature, etc., which could affect some agricultural interests. There is insufficient information at this time to evaluate whether there would be excessive concentrations of any of these constituents in irrigated agricultural stormwater runoff and tail water/subsurface drain water discharges compared to water quality standards/ objectives.

This paper suggests approaches that irrigated agriculture and regulatory agencies may wish to consider to integrate water quality management in stormwater runoff, irrigation tailwater and subsurface drain water discharges. This paper recommends an integrated approach for monitoring and development of BMPs to control the concentrations of potential pollutants.

ORIGIN OF THE TMDL PROCESS

As part of revising the federal water pollution control act in 1972, which through subsequent revisions has become known as the Clean Water Act (CWA), the US Congress established a regulatory approach that, by the early 1980s, was supposed to bring under control all discharges of wastewaters that cause or contribute to violations of water quality standards in receiving waters for the discharges. At that same time, the US Congress required that the US EPA develop water quality criteria that will protect the designated beneficial uses of the nation's waters. This water quality-based approach is the foundation for the current TMDL program. In 1987, as part of revision of the Clean Water Act, the TMDL requirements were set in place, where all waterbodies that were found to contain concentrations of constituents in excess of the water quality standard/objective were to be placed on the 303(d) list and classified as "impaired"

waterbodies. This classification then must lead to the development of a total maximum daily load (TMDL) of constituents causing the violations of the water quality standards, where a control program is to be developed to limit the amount of constituents entering the waterbodies that have violations of water quality standards for the constituents of concern.

While the TMDL regulations have been in place for many years, they have not been enforced by either the US EPA or the state pollution control agencies. Finally, by the mid-1990s, environmental groups began to take the US EPA to court to require that TMDLs be developed for all constituents that are causing a waterbody to be listed on the 303(d) list of impaired waterbodies. The US EPA Region 9 (and elsewhere) reached settlement agreements with environmental groups, which mandated that a technical TMDL be developed for all constituents and waterbodies that were on the 303(d) list of impaired waterbodies.

The authors are involved in and/or are closely following a number of TMDLs that are being developed at this time. In each of these, there is inadequate time to properly develop a technically valid, cost-effective TMDL that will cause the waterbody to come into compliance with appropriate water quality standards. Further, regulatory agencies and, in many instances, dischargers, especially in the agricultural community, do not have the necessary technical or financial resources to properly develop a technical TMDL to control the concentrations of constituents that are leading to excessive concentrations compared to water quality standards.

Ag Waiver Issues

A significant factor in bringing the need for additional TMDLs to the forefront in the Central Valley of California is the ag waiver monitoring program that is being developed by the CVRWQCB. For many years irrigated agriculture in the Central Valley has been exempt from waste discharge requirements (WDRs) based on the premise that stormwater runoff and tailwater discharges do not cause excessive sediment discharges compared to CVRWQCB Basin Plan water quality objectives and do not cause aquatic life toxicity. In the summer of 2001, in response to a petition filed by the DeltaKeeper, the CVRWQCB issued a Resolution which required that the agricultural community and/or the CVRWQCB develop a comprehensive monitoring program of constructed agricultural drains and agricultural-dominated waterbodies within the Central Valley. This Resolution requires that a monitoring program be developed which will assess whether agricultural tailwater, subsurface drain water and/or stormwater runoff contains constituents that impair the beneficial uses of receiving waters, including causing these waters to violate water quality objectives. Particular attention is to be given to aquatic life toxicity and sediment discharges that violate the Basin Plan turbidity water quality objective. The implementation of this requirement is underway.

Based on what is known about the characteristics of agricultural stormwater runoff and agricultural subsurface drain/tailwater, it is likely that the soon-to-be-implemented monitoring program will demonstrate that there are a variety of constituents (see Table 1) that are being discharged from irrigated agriculture that violate water quality standards (objectives). Lee and Jones-Lee (2002c) have recently developed a report pertinent to developing the Phase II of the ag waiver monitoring program.

An important aspect of the ag waiver water quality monitoring program is that the CVRWQCB specified that the monitoring include irrigated agricultural "field" runoff. While the initial monitoring is focusing on the large constructed agricultural drains, eventually this will have to be expanded to include edge-of-the-field monitoring, in accord with having to meet the CVRWQCB's Resolution. According to Wanger (2002), constructed agricultural drains have been determined to be "waters of the State," and therefore have to meet the same water quality objectives as the State's rivers and streams. Within 5 to 10 years, under the current Clean Water Act requirements, there likely could be a large increase in the number of agricultural-related TMDLs that will be developed to bring the waters of the State, including agricultural drain waters, into compliance with water quality objectives.

SUGGESTED APPROACH

Agriculture in the Central Valley faces several significant economic hurdles that arise from overproduction and foreign competition, leading to low prices for some agricultural crops. Managing water pollution is another of these economic hurdles that will have to be faced. It is not going to go away. It is suggested that it is in the best interests of agriculture to take a proactive approach toward defining existing water quality problems/violations of water quality objectives that are being caused by various agricultural practices. This will require acquisition of funding to properly characterize the concentrations, loads, beneficial use impacts, and technically-valid, cost effective BMPs for agricultural runoff/discharge waters.

While there may be some in the agricultural community who hold the position that conducting such a comprehensive monitoring/evaluation program would develop data that would show that there are water quality problems associated with agricultural runoff/discharges, and therefore, such a water quality monitoring program should not be initiated by the agricultural community, this "ostrich" approach can readily prove to be significantly detrimental to agricultural interests and can lead to over-regulation of agricultural runoff/discharge-associated constituents. It is in the best interest of agriculture to initiate a comprehensive monitoring/management program that defines the water quality problems that exist in irrigated agricultural stormwater runoff and tailwater/subsurface drain water discharges.

Addressing Exceedances of Water Quality Objectives

Of particular importance is ascertaining whether there are exceedances of the existing or soon-to-be-implemented water quality criteria/objectives in irrigated agricultural runoff/discharge-impacted waters. If exceedances are found, then the next step is to determine if the exceedances are "administrative" exceedances related to the overly protective nature of federal and state water quality criteria/standards/objectives, or represent real, significant impairment of the beneficial uses of the receiving waters for the agricultural discharges/runoff. This evaluation will require site-specific studies at a variety of locations throughout the Central Valley to define, for potentially toxic substances such as pesticides, whether the numbers, types and characteristics of aquatic life in the agricultural-dominated waterbodies or those influenced by such waterbodies are significantly impacted by the agricultural runoff/discharges.

If it is found that the violations of the water quality objectives are administrative, then work needs to be done to adjust the objectives so that they will protect the designated beneficial uses of the receiving waters without unnecessary expenditures for control of potential pollutant in runoff/discharges. If it is found that certain agricultural practices are leading to an impairment of the beneficial uses of the receiving waters, then management programs to control the agricultural practices to prevent runoff of pollutants – i.e., those constituents that impair the beneficial uses of the receiving waters – need to be developed and implemented. This program could require support of the public through the legislature to help some farming interests fund the water pollution evaluation and control programs.

The evaluation of the water quality impacts of stormwater runoff/tailwater discharges and subsurface drain water is a key component in developing a technically valid, cost-effective water quality management program. Those who understand how the US EPA water quality criteria and state standards/objectives are developed, understand that these are mandated by Congress to be based on a worst-case-based evaluation that does not necessarily consider site-specific factors that cause a potential pollutant to be a non-pollutant. The US EPA recognized this situation in adopting the water quality criteria development approach, which was mandated by Congress as part of developing the Clean Water Act.

The Agency (US EPA, 1994) developed the second edition of its "Handbook of Water Quality," which provides guidance on how to make site-specific adjustments of worst-case-based water quality criteria to consider the variety of factors that can cause constituents that are pollutants at some locations to be non-pollutants at others. Lee and Jones-Lee (1996) have provided background information on this issue, where they recommend that the first step in addressing an exceedance of a water quality standard is to evaluate whether the standard is appropriate for a particular discharge to a particular

waterbody. Further, the previous and current administrations of the US EPA have been working to improve the ability to make site-specific adjustments of worst-case-based water quality criteria. These efforts are reducing the cost of the site-specific adjustments.

Need for Water Quality Impact Evaluation

A prime example of the need to conduct site-specific studies of water quality impacts is associated with the use of diazinon as a dormant spray in orchards in the Central Valley. Diazinon is an organophosphate pesticide that is applied to orchards during the winter to control certain pests that damage crops the following summer. It has been found that diazinon is highly toxic to certain types of zooplankton (small animals) that are part of small fish food. A review of the types of organisms impacted by diazinon shows that only certain types of zooplankton are affected. While under the current regulatory regime, unless demonstrated otherwise, any aquatic life toxicity must be controlled at the source, it is possible that the pulses of diazinon that are occurring today in stormwater runoff from dormant-sprayed orchards are not causing significant adverse impacts to the numbers, types and characteristics of desirable forms of aquatic life in the receiving waters for the dormant-sprayed field runoff. There can be other forms of zooplankton that can serve as larval fish food which are not affected by diazinon toxicity. It is also possible, however, that diazinon toxicity causes the death of key forms of aquatic life that are essential for some important fish population development.

While this situation has been known for many years, it has not been adequately addressed. There is need to better understand the impacts of diazinon-caused toxicity on the beneficial uses of waterbodies. Thus far, the agricultural community, pesticide manufacturers, and the regulated community have been unwilling to support the studies needed to determine whether the toxic pulses of diazinon associated with its use as a dormant spray in orchards are causing significant adverse impacts on the beneficial uses of waterbodies.

As it stands now under the current regulatory arena, it is likely that diazinon's use as a dormant spray will have to be phased out, and some other pesticide or group of pesticides, such as the pyrethroids, will be used in its place, which may, in fact, cause even greater environmental harm than diazinon. This situation arises out of the fact that the current US EPA Office of Pesticide Programs and California Department of Pesticide Regulation's pesticide evaluation program does not include evaluation of whether stormwater runoff or irrigation water releases from areas where the pesticide has been applied can cause aquatic life toxicity in the receiving waters for these runoff/releases.

Lee and Jones-Lee (2002c) are developing guidance on the monitoring program that should be conducted to determine if stormwater runoff or irrigation tailwater discharges/subsurface drain water releases are causing potential water quality impacts in

the receiving waters. They emphasize the importance of developing a comprehensive monitoring program to monitor for all the parameters of concern, as opposed to the current, somewhat piecemeal approach of only addressing some of the parameters that are likely present in agricultural stormwater runoff/releases.

As Lee and Jones-Lee stressed, it is important to develop the monitoring program based on how various chemicals are used on agricultural properties and the hydrology of runoff/discharges from the areas of use. The routine one-sample-per-month (or some other periodic sampling) typically does not provide the information needed to properly evaluate exceedances of water quality objectives. A properly conducted monitoring program focuses on event-based sampling, which is tied to use and understanding of the transport/fate of the constituents to the areas applied and in the runoff/discharge waters.

Far too often, water quality management programs focus on chemical constituent control rather than on chemical impact control. As discussed by Lee and Jones-Lee (1999), there is often a poor correlation between the concentrations of constituents and their impacts on aquatic life and other beneficial uses of waterbodies. In order to address this situation Lee and Jones-Lee (1998) have developed what they call the Evaluation Monitoring approach, which specifically focuses on determining the impacts of chemical constituents, rather than their concentrations. This is the approach that should be adopted in managing violations of water quality objectives from irrigated agricultural runoff/discharges.

Need for Financial Support

It is important in conducting the monitoring/evaluation programs to involve all stakeholders in helping to design, implement and interpret the results of the monitoring/evaluation program. It is in everyone's interests to develop a program that is acceptable to all of those concerned about the potential impacts of irrigated agricultural runoff/discharges. It will be necessary in getting stakeholders' buy-in to these programs, to help financially support certain groups of stakeholders, such as environmental groups, some agricultural groups and, in some areas, regulatory agencies. Without this support/buy-in the current confrontational approach will continue. This approach is contrary to the interests of irrigated agriculture, environmental groups, regulatory agencies and the public, since it frequently leads to court-ordered decisions. Courts, under the current legal system, are generally not well-equipped to properly address complex technical issues of water quality management.

CONCLUSIONS

Irrigated agriculture in the Central Valley of California, as well as elsewhere in the State and the US, faces a multitude of TMDLs that arise out of existing or potential exceedances of water quality standards/objectives that are in place now or that will be developed over

the next few years. It will be important for irrigated agriculture, regulatory agencies, environmental groups and members of the public to work together to evaluate the various types of irrigated agricultural stormwater runoff/discharges, the existing and potential exceedances of water quality standards/objectives, and the water quality significance of these exceedances in terms of impact on the designated beneficial uses of the receiving waters for the runoff/discharges. If the exceedances are found to be administrative, related to the overly protective nature of worst-case-based water quality criteria/standards, then work needs to be done to properly adjust the standards to protect the beneficial uses without unnecessary expenditures for constituent control in agricultural runoff/discharges.

If it is found that there are significant adverse impacts due to runoff/discharge-associated constituents, then appropriately evaluated and implemented management programs need to be developed to ensure that the alternative agricultural practices are cost-effective and reliable in improving the beneficial uses of the receiving waters for the runoff/discharges. A highly coordinated, integrated, stakeholder-based approach needs to be developed and implemented, where all interested parties can work together to help support viable irrigated agriculture in the Central Valley.

REFERENCES

Jones-Lee, A. and Lee, G. F., "Evaluation Monitoring as an Alternative to Conventional Water Quality Monitoring for Water Quality Characterization/Management," Proc. of the NWQMC National Conference "Monitoring: Critical Foundations to Protect Our Waters," US Environmental Protection Agency, Washington, D.C., pp. 499-512, (1998).

Lee, G. F. and Jones-Lee, A., "Appropriate Use of Numeric Chemical Water Quality Criteria," *Health and Ecological Risk Assessment*, 1:5-11 (1995). Letter to the Editor, Supplemental Discussion, 2:233-234 (1996).

Lee, G. F. and Jones-Lee, A., "Evaluation Monitoring vs Chemical Constituent Monitoring Chemical Concentrations vs Chemical Impacts," Presented at CA Water Environment Association Training Seminar, "Recent Advances in Receiving Water Monitoring," Anaheim, CA, February (1999).

Lee, G. F. and Jones-Lee, A., "Issues in Developing the San Joaquin River Deep Water Ship Channel DO TMDL," Report to Central Valley Regional Water Quality Board, Sacramento, CA, August (2000).

Lee, G. F. and Jones-Lee, A., "Issues in Developing the San Joaquin River, CA, DO TMDL: Balancing Point and Nonpoint Oxygen Demand/Nutrient Control," Proceedings of the WEF and ASIWPCA TMDL Science Conference, St. Louis, MO, March (2001).

Lee, G. F. and Jones-Lee, A., "Synthesis of Findings on the Causes and Factors Influencing Low DO in the San Joaquin River Deep Water Ship Channel Near Stockton, CA." Report to SJR DO TMDL Steering Committee/Technical Advisory Committee and CALFRED Bay-Delta Program, (2002a).

Lee, G. F. and Jones-Lee, A., "Assessing the Water Quality Impacts of Phosphorus in Runoff from Agricultural Lands," proceedings of American Chemical Society Agro Division Symposium, "Environmental Impact of Fertilizer Products in Soil, Air and Water," Chicago, IL, August (2001), to be published by the American Chemical Society (2002b).

Lee, G. F. and Jones-Lee, A., "Issues in Developing a Water Quality Monitoring Program for Evaluation of the Water Quality - Beneficial Use Impacts of Stormwater Runoff and Irrigation Water Discharges from Irrigates Agriculture in the Central Valley, CA.," California State University, Fresno, California Water Institute Fresno California, and The Central Valley Regional Water Quality Control Board, Sacramento, California (2002d).

SWRCB, "1998 California 303(d) List and TMDL Priority Schedule," State Water Resources Control Board, Sacramento, CA, April (1998).

US EPA, "Water Quality Standards Handbook: Second Edition," US Environmental Protection Agency, Office of Water, EPA-823-B-94-005b, Washington, D.C., (1994).

US EPA, "Nutrient Criteria Development; Notice of Ecoregional Nutrient Citeria," US Environmental Protection Agency, *Federal Register*, 66(6):1671-1674 (2001).

US EPA, "Implementation Guidance for Ambient Water Quality Criteria for Bacteria," Draft, US Environmental Protection Agency, Washington, D.C. (2002). http://www.epa.gov/water/science/standards/bacteria

Wanger, O. W. "Memorandum Decision and Order Re: Defendant's Motion for Summary Judgement; Plaintiff's Motion for Summary Judgement,"California Sportfishing Protection Alliance v. Diablo Grande, Inc., CIB-F-00-5979 OWW SMS, United States District Court, Eastern District of California (2002).