Issues in Regulating Water Quality Impacts from Irrigated Agricultural Runoff and Discharges in the Central Valley of California

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Introduction

The Central Valley of California is one of the most productive irrigated-agriculture areas in the US. Irrigation practices in the Central Valley, however, result in the transport of a variety of pollutants to the state's waters through stormwater runoff, and tailwater and subsurface drainwater discharges. Pollutants from these sources are causing significant water quality problems in the Central Valley streams, rivers, Sacramento San Joaquin Delta (Delta), and in water supply reservoirs downstream of the Delta. The California State Water Resources Control Board (SWRCB) and the Central Valley Regional Water Quality Control Board (CVRWQCB) are implementing an Irrigated Agriculture Conditional Waiver from Waste Discharge Requirements ("Ag Waiver") program through which discharges/runoff from irrigated agriculture that cause violations of the Regional Board's Basin Plan objectives (water quality objectives (WQOs)-standards) are to be controlled.

The San Joaquin River (SJR) is one of the largest rivers in California and is one of the primary recipient waterways for discharges/runoff from Central Valley irrigated agriculture. Lee and Jones-Lee (2007a,b) discussed the 12 pollutants responsible for Clean Water Act (CWA) section 303(d) "listings" for the SJR for violations of water quality standards/objectives; 8 of those are pollutants derived from runoff/discharges from irrigated agriculture in the SJR watershed. Such listings trigger the development of total maximum daily loads (TMDLs) for the violating pollutants. Owing to these violations, the CVRWQCB has slated the following parameters for TMDL development in the SJR: selenium and boron that occur naturally in some Central Valley soils; salinity derived from soil leaching and accumulation of salts from irrigated agriculture; two organophosphorus pesticides, diazinon and chlorpyrifos, used for pest control in crop production; oxygen-demanding substances (nutrients that develop into algae) that contribute to low dissolved oxygen (DO) conditions in the Stockton Deep Water Ship Channel (DWSC); legacy pesticides (DDT, dieldrin, toxaphene, etc.) formerly used for pest control; unknown-caused aquatic life toxicity; and fecal coliforms (*E. coli)*. TMDLs may also be needed to control the following irrigated agricultural discharge-related contaminants: nutrients (N and P compounds) that lead to excessive algae and aquatic weeds; currently used pyrethroid-based pesticides; elevated pH; low DO; TOC/DOC that leads to trihalomethane formation during domestic drinking water disinfection; excessive sediment associated with soil erosion; and sediment toxicity due to unknown causes.

Several of the SJR tributaries also have significant water quality problems due to agricultural discharges. The SJR and Sacramento River join to form the Sacramento San Joaquin Delta, which, as discussed by Lee and Jones-Lee (2007c) contains pollutants that violate WQOs. Many are the same as those noted above for the SJR as being from agricultural discharges to the Delta and tributaries to the SJR. The Sacramento River has 2006 303(d) TMDL listings [http://www.swrcb.ca.gov/water_issues/programs/tmdl/303d_lists2006_epa.shtml] that include mercury, and "unknown toxicity" which could be derived from agricultural sources.

In order to define and address these water quality problems, the CVRWQCB has developed an Ag Waiver Monitoring and Reporting Plan (MRP) as part of the Ag Waiver program. The goal of the MRP is to cause agricultural interests to monitor agricultural drains and other waterbodies that receive substantial amounts of runoff/discharges to determine if violations of WQOs attributable to agricultural runoff/discharges are occurring at those locations. The current CVRWQCB Ag Waiver MRP implementation plan requires that if a WQO violation attributed to irrigated agricultural runoff/discharges occurs more than once every three years, the agricultural sources must attempt to develop management plans to prevent future violations. This approach is tantamount to that which has traditionally been applied to point-source discharges, such as publicly owned treatment works (domestic wastewater treatment plants) and industrial wastewaters, whereby discharger are required to not cause violations of US EPA water quality criteria and state standards (in California - water quality objectives) based on those criteria.

Lee and Jones-Lee (2007c) discussed issues that affect the potential effectiveness of the MRP to adequately and reliably define the magnitude and location of the WQO violations, and water quality impacts, caused by Central Valley irrigated agricultural runoff/discharges. They highlighted key shortcomings including that the monitoring and reporting program needs to be significantly expanded to include upstream monitoring locations, and to include greater frequency of monitoring, additional monitoring parameters, targeted event-based monitoring, and especially edge-of-the-field monitoring, to fully define the water quality impacts of irrigated agriculture in the Central Valley. They also discussed how irrigated agriculture in the Central Valley is being over-regulated for some chemicals, and under-regulated for others.

The Lee and Jones-Lee (2007c) comments followed the comprehensive report they developed (Lee and Jones-Lee, 2002a) on behalf of the CVRWQCB that discussed issues that need to be considered in developing an adequate water quality monitoring/water quality evaluation program for assessing water quality/beneficial-use impacts of runoff and discharges from irrigated agriculture. More recently, at the fall 2008 CALFED Science Conference, J. Swanson of the CVRWQCB Irrigated Lands Program discussed the characteristics of the current Ag Waiver program, the MRP as it is being implemented, and their recent findings (Swanson, 2008a,b).

In light of Ag Waiver and MPR undertakings and recent findings, this report revisits key issues that should be considered in regulating runoff/discharges from irrigated agriculture in the Central Valley of California. It is based on the senior author's more than 40 years of experience in investigating the water quality impacts of agricultural runoff/discharges in various areas of the US and over the past 20 years in the Central Valley of California. Lee and Jones-Lee have developed papers and reports pertinent to the appropriate, technically sound regulation of potential pollutants in runoff/discharges from nonpoint sources. This report contains references

to those reports with internet links for their download. While the focus of this discussion is the Central Valley of California, many of the issues discussed are applicable to other locations as well, and, as discussed by Lee and Jones-Lee (2008a), are also pertinent to assessing and managing water quality impacts from urban-area and highway stormwater runoff.

Water Quality Criteria Issues: Application of US EPA Water Quality Criteria.
Lee and Jones-Lee (2002a) discussed pitfalls and limitations in the use of US EPA worst-case-based water quality criteria in the evaluation and regulation of nonpoint-source runoff/discharges. The mechanical application of such criteria/objectives for this purpose, as is now being done in the CVRWQCB Ag Waiver MRP, can lead to over-regulation of such discharges/runoff.

In the 1972 amendments to the Federal Water Pollution Control Act, the "Clean Water Act" (CWA), the US Congress mandated that the US EPA develop national water quality criteria that would be protective in all waters. It had been long-known and well-established that many potential pollutants, such as heavy metals, phosphorus, and many organics, exist in aquatic systems in a variety of chemical forms, only some of which are toxic/available to aquatic life or other beneficial uses of the water. For example, it was understood in the 1960s that, unlike many of the dissolved forms, particulate forms of heavy metals and those that are complexed with organics are not toxic. It also was becoming clear that for many contaminants, impact is a function of the duration of organism exposure. Nevertheless, to meet that all-encompassing CWA objective, criteria were developed for the most toxic/available forms of the subject chemicals; they were established to be protective when organisms were exposed to the available forms for chronic durations (i.e., worst-case conditions). State regulations then became comparisons of such worst-case-based numeric criteria to total concentrations of chemicals in ambient waters for regulatory purposes, an approach that presumes that the subject potential pollutants are in their most toxic/available forms and that organisms stand to be exposed for chronic durations.

As the national water quality criteria began to be used and misused by states in their regulations, the US EPA (1993) finally updated its regulation of heavy metals to focus only on dissolved forms. However that adjustment did not address the fact that not all dissolved forms of heavy metals are toxic largely due to their complexation with organics in natural waters. The US EPA also recognized that application of the worst-case-based water quality criteria in regulations could readily lead to overregulation of potential pollutants; its Water Quality Criteria Handbook (US EPA, 1994) provides guidance on the site-specific adjustment of criteria for application to potentially toxic chemicals such as heavy metals.

In an invited review Lee and Jones-Lee (1996) discussed issues that need to be considered in the use of US EPA worst-case-based water quality criteria and standards/objectives based on them to protect the beneficial uses of waterbodies without significant over-regulation of wastewater discharges and stormwater runoff. In describing approaches that should be taken to reliably use those criteria, they recommended, in keeping with the US EPA-allowed approach, that when a worst-case-based numeric water quality criterion/state standard was found to be exceeded in an ambient water, specific-studies be undertaken to adjust that criterion/standard to reflect the site-specific conditions that impact the toxicity/availability of the chemical(s) of concern. Such

adjustment would be especially important in the regulation of runoff/discharges from irrigated agriculture owing to the typically high particulate levels in such discharges and the high costs of controlling some of the pollutants from those sources, including nutrients (N and P compounds), and organic carbon.

The site-specific Water Quality Handbook guidance for studies to adjust worst-case-based water quality criteria to consider organic complexing of heavy metals that creates non-toxic forms has been followed in a variety of situations. Work in the San Francisco Bay and New York Harbor, for example, has demonstrated that the national criteria for copper can be relaxed and still protect aquatic life from toxic conditions. Jones-Lee and Lee (2008) and the authors' Stormwater Runoff Water Quality Newsletter Volume 10, Number 9 [available at http://www.gfredlee.com/Newsletter/swnewsV10N9.pdf] reviewed that work.

As noted above, the current CVRWQCB Ag Waiver MRP implementation plan is based on application of worst-case-based water quality objectives. Without proper adjustment their use presents a significant problem for the appropriate regulation of sources such as agricultural and urban stormwater runoff in which substantial amounts of the chemicals are present in unavailable forms. Those types of runoff/discharges typically contain elevated concentrations of particulates from erosion and plant debris such as crop residues, and total organic carbon and dissolved organic compounds, all of which tend to detoxify contaminants rendering them non-toxic/unavailable. Further, aquatic organisms would typically receive short-term, episodic exposure to contaminants from those sources, which also lessens the potential for impact.

Specific Regulatory Issues in Ag Waiver Program

Legacy Pesticides. The current US EPA guidance for site-specific adjustment of worst-case-based criteria does not address several issues critical to the technically valid, cost-effective regulation of runoff/discharges from irrigated agriculture. For example, organochlorine legacy pesticides, such as DDT, dieldrin, and toxaphene, are being regulated in the CVRWQCB Ag Wavier program based on their total concentrations in the water column. These chemicals are of concern because of their tendency to accumulate in the flesh of edible fish, where they can accumulate to levels that pose a threat to the health of people who consume the fish. It has been known for decades that the excessive bioaccumulation of these chemicals in edible fish cannot be reliably assessed or regulated based on their concentrations in the water. Instead, as discussed by Lee and Jones-Lee (2002b, 2007c) the regulation of legacy pesticides should be based on the measurement of the concentrations of those chemicals in edible tissue of fish relative to public health guidelines. This approach accounts for the myriad factors controlling bioaccumulation to define whether or not these chemicals are causing a water quality problem in a particular waterbody. It also enables the reliable evaluation of the sources of the legacy pesticides that are causing water quality problems.

Sediments, as well, may be a source of legacy pesticides and other chemicals that tend to bioaccumulate in edible fish. However, as discussed by Lee and Jones-Lee (2002b), it is not possible to mechanically translate concentrations of legacy pesticides and PCBs (which have many of the same chemical characteristics as legacy pesticides) in a sediment to concentrations in fish tissue. The bioavailability of the sediment-associated chemicals needs to be determined using US EPA-recommended bio-uptake procedures. Lee et al. (2002) described the use of such

procedures in the evaluation of the uptake of PCBs by the freshwater worm, *Lumbriculus variegates*, in their investigation of the bioavailability of PCBs in Smith Canal sediment in the city of Stockton slough.

Nutrients. While the CVRWQB Ag Waiver MRP requires that agricultural coalitions monitor for nutrients (N and P compounds), there are no numeric water quality objectives that can be used to reliably evaluate the occurrence or significance of WQO violations. While the CVRWQCB Basin Plan contains a narrative water quality objective for nutrients in its "biostimulatory substance" objective, the CVRWQCB has not provided guidance on how to implement that objective. This means that two of the most important pollutants (N and P compounds) in irrigated agricultural discharges/runoff are not now regulated in the CVRWQCB Ag Waiver program.

Lee and Jones-Lee (2002c; 2005; 2006a,b) provided guidance on the evaluation of nutrient concentration data for assessing whether a nutrient concentration at a particular monitoring location is adversely impacting water quality at the monitoring location or downstream of it. As they discuss, site-specific evaluation of nutrient impacts at a monitoring point and downstream must be made to establish nutrient criteria for a particular waterbody. In an effort to stimulate greater attention to this aspect of water quality management in the Delta, and draw on the expertise and experience of professionals involved in this issue, they worked with the California Water and Environmental Modeling Forum (CWEMF) to present the "Delta Nutrient Water Quality Modeling Workshop" in Sacramento on March 25, 2008. During the course of that workshop nutrient-related water quality problems in the Delta and in domestic supply reservoirs that receive Delta water were described and discussed to better define the impact of nutrients on Delta water quality. Lee and Jones-Lee (2007d; 2008b,c) provide a synopsis of the Delta Nutrient Water Quality Modeling Workshop and a summary of nutrient-related water quality problems in the Delta. Additional information on evaluating and managing the excessive fertilization of waterbodies is available on Drs. Lee and Jones-Lee's website, www.gfredlee.com in the "Excessive Fertilization" section [http://www.gfredlee.com/preclaim2.htm].

TOC. Lee (2004) contains a summary of the author's experience investigating the occurrence and impacts of total organic carbon (TOC) in natural waters. TOC is an operationally defined parameter that quantifies the amount of organic carbon in a water, independent of its reactivity or ability to affect water quality. This parameter is used by water treatment works to estimate the amount of organic matter from algae and other sources in a raw water that may react with chlorine to increase the chlorine needed for treatment and to produce trihalomethanes (THMs), a suspected human carcinogen. Information exists on critical concentrations of TOC above which domestic water treatment works face the development of THM levels that violate drinking water MCLs, and face additional expenditures for supplementary or alternative treatment to prevent violations in the finished water. However, the CVRWQCB has not adopted a WQO that can be used to determine if a TOC source is contributing to a THM violation.

Lee and Jones-Lee (2003, 2004) discussed the importance of evaluating and considering the refractory (non-reactive) aspects and nature of TOC in developing regulatory programs for excessive TOC in Delta waters that are used for domestic water supply. As they discussed, some of the TOC in Delta tributary and Delta waters is due to algae and other organic compounds that

are degradable – non persistent. Regulatory programs for TOC should be based on the TOC that persists in Delta waters and thus can contribute to excessive THMs in a treated water supply. To accomplish this, the CVRWQCB needs to amend the Basin Plan for TOC to incorporate appropriate TOC regulations.

***Mercury*.** The bioaccumulation of mercury in edible fish to excessive levels is one of the most significant causes of water quality impairment in Central Valley waterbodies. The CVRWQCB has not addressed this issue as part of its Ag Waiver MRP despite the fact that runoff/discharges from irrigated agriculture can contain mercury in concentrations that can contribute to the excessive bioaccumulation of mercury in Central Valley waterbody fish. The CVRWQCB is not requiring that irrigated agricultural runoff/discharges, receiving waters, or receiving water fish be monitored for mercury to determine if irrigation water contributes to excessive mercury in Central Valley fish. Lee and Jones-Lee (2008d,e) have discussed these issues in connection with the use of Putah Creek water for irrigation of crop lands near the Yolo Bypass.

DO and pH

Aquatic plant photosynthesis and waterbody respiration can have significant impacts on the dissolved oxygen and pH levels in a waterbody, and the diel changes (over a 24-hr period) in those parameters. These impacts can cause or contribute to violations of WQOs for those parameters and can adversely affect beneficial uses of waters. As discussed by Lee and Jones-Lee (2007c) and in prior comments to the CVRWQCB cited therein, the Ag Waiver MRP still does not advance a technically valid approach for evaluating whether aquatic plant photosynthesis stimulated by nutrients in agricultural runoff/discharges leads to violations of Basin Plan WQOs for pH and DO. Such violations should be regulated under the WQO for excessive "biostimulatory substances," or the WQOs should be changed to avoid violations of the pH and DO WQOs. In order to properly evaluate WQO violations for DO and pH it will be necessary to require that the monitoring be conducting in early morning to examine for low DO and in the late afternoon for pH violations.

Sediment Quality Evaluation

As required by the California legislature's Bay Protection and Toxic Clean Up Program, the SWRCB staff is developing sediment quality objectives (SQOs) for assessment and control of sediment-associated pollutants. While thus far their focus has been on the sediments in coastal marine and enclosed bay areas, it has recently expanded to the sediments of the Sacramento San Joaquin Delta. Eventually it is expected that the SQOs will be applied to the sediments of all of the state's waterbodies. The SWRCB staff has used a multi-component, "triad" approach for developing SQOs that incorporates information on sediment toxicity, benthic organism assemblages, and the chemical characteristics of the sediments. While this approach is sound in theory, the SWRCB staff has used the total concentrations of selected chemicals in sediments for the "chemical characteristics" portion of the assessment. It has been well-known since the mid-1970s that the total concentration of a chemical, or a group of chemicals, in a sediment is not a reliable indicator of the potential impact of that chemical on aquatic life or other beneficial uses of waterbodies. The incorporation of that parameter in sediment evaluation skews the result of the other more reliable aspects of the triad assessment in undeterminable ways, rendering the resultant assessment unreliable. The inclusion of this technically invalid component can readily lead to inappropriate sediment quality evaluation which can, in turn, lead to inappropriate

sediment classification, remediation, and source control requirements. Such unreliable SQOs could ultimately affect the regulation of Central Valley agriculture by leading to unreliable requirements for control of chemical constituents in runoff/discharge waters that accumulate in downstream sediment and contribute to violations of SQOs.

Lee (2008) discussed the technical issues surrounding the approaches that the SWRCB staff and board have adopted for sediment quality evaluation. Based on his more than 30 years of work on the nature and sediment/water-quality/beneficial-use impacts of sediment-associated chemicals, Lee recommends that sediment quality evaluation be based on sediment toxicity and alterations in benthic organism assemblages that are caused by chemicals in the sediments. The chemical component of the sediment quality evaluation should be based, not on total concentrations, but rather on properly conducted toxicity identification evaluations (TIEs) that determine the cause of observed toxicity. The total concentration of a chemical or group of chemicals should not be part of the evaluation. Additional information on these issues is available at www.gfredlee.com in the "Contaminated Sediment" section [http://www.gfredlee.com/psedqual2.htm].

Development of Management Practices

Lee and Jones-Lee (2002c) developed a report for the SWRCB/CVRWQCB that described management practices for controlling water quality impacts of potential pollutants in irrigated agriculture stormwater runoff and tailwater discharges in other areas of the US and discussed their potential effectiveness in the Central Valley of California. They reported that while some management approaches have shown some success in controlling pollutants in agricultural land runoff in other areas of the US, some conditions characteristic of the Central Valley, including weather and agricultural practices, raise questions about the effectiveness of those practices for controlling pollutants in this area. It will be important that a data base be developed to describe and track the approaches that are undertaken for controlling the runoff/discharges of each of the major types of potential pollutants, characteristics of the area in which the management approach is applied, and the results of the practice in reducing the discharge and most importantly in improving receiving water quality characteristics.

As discussed by Lee and Jones-Lee (2002d) the evaluation of any of the "best management practices" (BMPs) programs should include a comprehensive evaluation of the impact of the practice on the water quality characteristics of the waters receiving the BMP-"treated" runoff/discharge. The parameter of "percent removal of constituents of concern" from a discharge or runoff, especially the percent removal of the total concentration of a constituent, can provide misleading assessments of benefit; that parameter may have little relevance for assessing the impact of the action on water quality/beneficial uses of public waters. Lee and Jones-Lee (2002a; 2006a,b) discussed the characteristics of receiving-water studies that are essential to adequately define the impact of irrigated land runoff/discharges on receiving water quality at the point of discharge and downstream. For example, the regulation of nutrient discharges from agricultural and urban sources requires comprehensive studies of the downstream impacts of nutrients on water quality, including domestic water supplies, located at considerable distances downstream of the point of discharge. The water quality impact studies should be conducted for several years prior to implementing the management practice, and continued for several years after implementation of the management practice to account for variability in climate, agricultural practices and other factors that influence pollutant runoff and its impacts. It is only

through these types of studies that a proper evaluation can be made of potential water quality benefits that can be realized through specific management practices.

In their review of potential management practices for controlling water quality impacts of Central Valley irrigated agriculture, Lee and Jones-Lee (2002d) noted that the evaluation of the potential effectiveness of various types of management practices for contaminants in urban stormwater runoff is considerably ahead of that for those pollutants of concern in agricultural runoff/discharges. The experience with evaluation and management of contaminants in urban stormwater runoff can be of value to those concerned with evaluation and management of water quality impacts of agricultural discharges/runoff.

Groundwater Quality Impacts

Lee and Jones-Lee (2007e,f,g) discussed the current state of groundwater quality protection from impacts of activities on land surface; particular attention was given to waste disposal practices permitted in the state by regulatory agencies and agricultural activities. As they discussed while California's Porter-Cologne Water Quality Act explicitly requires the protection of groundwater quality, the CVRWQCB, other regional boards, and the SWRCB continue to permit land surface activities, such as waste disposal, that will lead to groundwater pollution.

Experts in the topic report that it is not possible to practice irrigated agriculture in the Central Valley without polluting groundwaters with nitrate and salts; the best that can be achieved is a reduction in the amount of groundwater pollution by nitrate. Lee and Jones-Lee (2007e,f,g) discussed this finding and summarized suggested approaches for reducing the magnitude of nitrate pollution, including altering fertilization practices and the management of irrigation water.

Another group of chemicals that has impacted groundwater quality is pesticides used in irrigated agriculture. As discussed by Lee and Jones-Lee (2007e,f; 2009) the California Department of Pesticide Regulation (DPR) has been attempting to work toward eliminating groundwater pollution by pesticides through the evaluation of the potential of a new or expanded-use pesticide to cause groundwater pollution based on the structural characteristics of the pesticide and the geological characteristics of the area to which it would be applied. While its adoption of this approach has been impeded by pesticide users, DWR has adopted a modified approach to require such information be provided as part of pesticide registration (Lee and Jones-Lee, 2007e,f).

The regional boards should adopt a more effective process to evaluate the potential of a proposed or permitted land-surface activity to lead to groundwater pollution. As part of permitting an activity, the permittee should be required to conduct a comprehensive, pro-active monitoring program that would detect incipient groundwater pollution before widespread pollution occurs. The requirement of the Porter-Cologne Act to provide protection of groundwater quality needs to be met through the development of an implementable, statewide approach for protection of groundwater quality.

Designated Beneficial Uses

One of the foundations of the Clean Water Act is the focus of regulation for discharges/sources on the prevention of adverse impacts on designated beneficial uses of receiving waters. Water

quality criteria/objectives were intended for the protection of specific beneficial uses, such as domestic water supply, propagation of aquatic life, wholesomeness of edible fish, and recreation. When the designated beneficial uses were assigned to waterbodies in the mid-1970s in accord with the requirements of the CWA, limited attention was given to whether the designated uses assigned could actually be attainted. The US EPA recognized that regulation of contaminants based on the mechanical comparison of worst-case-based water quality criteria/objectives to ambient water concentrations, without attention to contaminant availability and the sensitivity of the designated beneficial uses of waterbodies, can lead to over-regulation of runoff discharges with the attendant wasteful spending on unnecessary management. In addition to developing the Water Quality Standards Handbook to address contaminant availability discussed above, the US EPA developed guidance on "Use-Attainability Analysis" to address the beneficial use component of criteria application and the need to consider the attainability of designated uses for receiving waters. Several years ago, the Agency periodically held water quality standards workshops that addressed use-attainability analysis as some states were making the process of updating and changing the designated uses of waterbodies far more difficult than was necessary. Some states, with US EPA approval, have developed approaches by which they can change the designated beneficial uses of parts of waterbodies to more appropriately reflect the actual beneficial uses that can be attained.

One of the issues of concern in implementing the CVRWQCB Ag Waiver Program MRP for detection of violations of water quality objectives is that the designated beneficial uses of a number of waterbodies that serve as agricultural drains have not been clearly defined. The significance of the exceedance of a numeric, worst-case-based WQO in a particular ag drain, channel, or other waterbody cannot be reliably evaluated absent appropriate designated beneficial use designation. This is of particular concern to agriculture in California since the SWRCB includes "domestic water supply" in the use-designation of every waterbody, even when a waterbody is not used for domestic water supply and does not contribute potential pollutants that could impair the use of downstream waters for domestic water supply. It is not technically justifiable to force agricultural interests control concentrations of chemicals and pathogen indicators to meet drinking water MCLs when the receiving waters are not, and cannot be reasonably expected to be, used for domestic water supply.

Another designated-use-related problem faced for ag drains and other waterbodies in which the flow is dominated by irrigated agriculture drainage/runoff, is their classification for "aquatic life propagation" through the "tributary rule." That "rule" requires that tributaries to waterbodies classified for aquatic life propagation meet WQO's protective of that use. In applying that rule for ag drains, inadequate attention is given to the potential impact of those sources on the propagation of aquatic life in the downstream waters of concern.

There is confusion in the CVRWQCB irrigated lands program on the designated beneficial uses of several waterbodies in the Central Valley whose designated beneficial uses have apparently not been classified. In resolving this issue it is important that the CVRWQCB and SWRCB consider the real value of creating and maintaining a given ag drain or other waterbodies whose flow is dominated by agricultural runoff/drainage, as an aquatic life resource. Obviously if a waterbody is a spawning area for anadromous fish then the applicable water quality criteria/objectives should protect the aquatic life propagation use. However, if the primary

beneficial use of a drainage-way or an otherwise dry or uninhabitable stream-course is the drainage of runoff from agricultural lands, and the water contributes little or nothing to the aquatic life-related beneficial uses of downstream waters, there is no technical justification for the classification of the drainage-way or drainage-dominated watercourse for aquatic life-related beneficial uses. If there are political or social reasons for greater control of those waters, those reasons should be acknowledged.

Some potential guidance on this issue is available in the current federal regulatory approach for implementing the Use Attainability Analysis (UAA).

According to Dr. Thomas J. Gardner of the US EPA National Water Quality Standards Branch Washington DC (Gardner, 2008 – personal communication):

> *"The most recent thinking from EPA on UAAs can be found here: UAAs and Other Tools for Managing Designated Uses, March 2006 http://www.epa.gov/waterscience/standards/uaa/index.htm (Click on "Case Studies" and then "Download all the case studies" (.pdf)) I would also click on the "Improving the Effectiveness of the UAA Process" memo The EPA Guidance from 1986 can be found at: Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses (EPA 440/4-86-037, 038, 039): http://www.epa.gov/waterscience/library/wqstandards Here is the Interim Economics guidance from 1995, which relates to 40 CFR 131.10 (g) (6) Interim Economic Guidance for Water Quality Standards: Workbook (1995): EPA 823/B-95-002 //www.epa.gov/waterscience/library/wqstandards*
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> *Available CSO guidance also contains useful information about UAAs: Guidance: Coordinating CSO Long Term Planning with WQS Reviews (EPA-833-R-01-002): http://www.epa.gov/npdes/pubs/wqs_guide_final.pdf/ Many States have developed UAA guidance: For example, Colorado has developed Recreational Use classification guidance; Kansas has developed an Aquatic Life UAA Protocol."*

Overall Recommended Approach

The first step in beginning to more appropriately regulate the real, significant water quality impairments caused by Central Valley irrigated agricultural runoff/discharges is to develop and implement a sound, comprehensive water quality monitoring/evaluation program in the Central Valley. As discussed by Lee and Jones-Lee (2007c) such a program must include much more than the currently prescribed one-grab-sample-per-month at a downstream location. It must include focused, upstream, event-based monitoring and edge-of-the-field monitoring/evaluation specifically targeted to identify and assess those agricultural practices/activities and locations that are likely to contribute discharges/runoff that cause WQO violations.

The focus of this monitoring/evaluation program should be on providing detailed information on selected watersheds that are representative of the types of agricultural areas in the Central Valley. The monitoring program should be carried out for several years, until there is reasonable certainty that the occurrence, location, and magnitude of violations of WQOs in Central Valley watersheds that have substantial amounts of irrigated agricultural runoff/discharges have been defined.

The second phase of the recommended approach is a detailed evaluation of the actual water quality impairments that would be expected to be caused by given WQO violations, and those which are in fact being caused by WQO violations, so as to distinguish administrative exceedances of WQOs from real water quality concerns. As discussed above, mechanical comparison of the worst-case-based, numeric national criteria/water quality standards and WQOs to concentrations in receiving water will lead to excessive over-regulation of agricultural discharges/runoff. Jones-Lee and Lee (1998) described an Evaluation Monitoring approach that is a more technically sound alternative for defining water quality issues that need to be addressed. It shifts the focus of monitoring from the total concentrations of potential pollutants to the water quality impairments that that are caused by actual pollutants, i.e., those constituents that cause a beneficial-use-impairment. Employment of this approach will identify situations in which a WQO "exceedance" is simply an artifact of the worst-case nature of the WQOs and indicates that the WQO needs a site-specific adjustment. It will importantly, also reveal water quality impairments that were not know to exist owing to the limitations of the numeric WQO approach.

In the 1990s Lee and Taylor (2001a,b) studied stormwater runoff from various watersheds in the Upper Newport Bay - Orange County, CA area to evaluate the need to develop management practices (BMPs) for a new toll road in that watershed. Of particular concern was the potential for the heavy metals in stormwater runoff from highways and streets to cause aquatic life toxicity in the receiving waters. As expected, they found that the concentrations of several heavy metals in the highway runoff exceeded the worst-case-based water quality criteria, indicating that those chemicals had the potential to cause toxicity in the waters receiving the stormwater runoff. A focused, stormwater runoff event-based monitoring program conducted at the edge-of-the-highway and in nearby receiving waters showed that receiving waters were toxic to certain forms of aquatic life. However, the results of toxicity identification evaluations (TIEs) revealed that the toxicity was not caused by the heavy metals that exceeded the WQOs, but was rather due to organophosphate and pyrethroid-based pesticides that were used in urban and agricultural areas in the Upper Newport Bay watershed. The mechanical application of WQOs for water quality management in that situation would have resulted in massive expenditures for the construction of the detention basins and filters planned for the treatment of heavy metals, a non-problem, while missing the real cause of the toxicity, the pesticides that would not have been removed by the planned management practice. The evaluation monitoring approach showed that the construction of the detention basins and filters would not prevent the pesticide toxicity from occurring.

Agricultural interests and other dischargers that find that the discharges/runoff from their lands are being overregulated by imposition of worst-case-based water quality criteria/standards or inappropriate designation of a waterbody's designated beneficial uses should be prepared to contribute significant funding to support the studies needed to establish site-specific objectives and/or update the designated beneficial uses to reflect the actual beneficial uses of ag drains. Without such support and such studies, agricultural runoff/discharges will likely be over-regulated and significant funds could be spent controlling chemicals that are not impairing the beneficial uses of waterbodies receiving the runoff/discharges.

Conclusion

The current mechanical approach for regulating runoff/discharges from irrigated lands being implemented in the Ag Waiver program should be revised to consider how the WQOs that are being used were developed and how they should be used to protect appropriately designated beneficial uses of waterbodies that are impacted by runoff/drainage from irrigated lands, without significant over-regulation of those discharges. Failure to take a more technically valid approach could result in serious damage to the economic viability of irrigated agriculture in the Central Valley with little or no improvement in the true water quality/beneficial uses in some Central Valley waterbodies. Funds to implement this program should be derived from irrigated agriculture and the public.

About the Authors

G. F. Lee has been involved in the development, evaluation, and implementation of water quality criteria and state standards since the early 1960s. A summary of his experience is provided at http://www.gfredlee.com/exp/wqexp.htm. During the 1960s while he held the position of Professor of Water Chemistry and Director of the Water Chemistry Program at the University of Wisconsin, Madison he served as an advisor to the Wisconsin Department of Natural Resources on the development and implementation of water quality criteria and standards. During that time and subsequently he has served as an advisor to numerous governmental agencies including municipalities, industry, and environmental/citizen groups on water quality criteria issues. In the early 1970s Dr. Lee served as an invited peer reviewer for the National Academies of Science and Engineering's "Blue Book of Water Quality Criteria - 1972." In the late 1970s, he served as an invited member of the American Fisheries Society Water Quality Panel that conducted a review of the US EPA's 1976 Red Book of Water Quality Criteria. In the early to mid-1980s he served as a US EPA invited peer reviewer for the 1986 Gold Book of Water Quality Criteria development approach and for several of the specific chemical criteria. Drs. Lee and Jones-Lee have published extensively on the development of water quality criteria and their implementation into state standards to appropriately regulate water quality impacts without significant over-regulation of wastewater and other discharges. Many of those publications are available on their website, www.gfredlee.com in the Surface Water section,
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