AGRICULTURE-RELATED WATER QUALITY PROBLEMS IN THE SAN JOAQUIN RIVER[1]

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Abstract

The California Central Valley is a highly productive irrigated agricultural area. The San Joaquin River (SJR) in the Central Valley has 12 violations of water quality objectives (WQOs) (standards) that have caused the Central Valley Regional Water Quality Control Board to develop total maximum daily loads (TMDLs) to control the WQO violations. Nine of the 12 WQO violations are related to discharges/runoff from irrigated agricultural lands. The WQO violations are due to selenium, boron, salinity, oxygen demand (due to algae that develop on nutrients), organophosphorus pesticides, organochlorine "legacy" pesticides, fecal coliforms, and toxicity of unknown cause. In addition, there are several currently unregulated water quality impairments in the SJR that could lead to Clean Water Act section 303(d) listings and TMDLs. The potential future WQO violations include nutrients that lead to excessive aquatic weed growth, water supply tastes and odors and violation of pH and dissolved oxygen WQOs; total organic carbon; herbicides that are toxic to algae; excessive turbidity; and aquatic sediment toxicity due to pyrethroid-based pesticides. This paper reviews issues that will need to be addressed in meeting TMDL requirements. Irrigated agriculture in the SJR watershed will likely change significantly as a result of complying with TMDL discharge limits.

Key words: San Joaquin River, TMDL, agriculture, water quality impacts

Introduction

Upstream of Friant Dam/Millerton Lake near Fresno, California (see Figure 1) the San Joaquin River (SJR) is of high-quality water, consisting primarily of rainfall and snowmelt from the Sierra Nevada mountains. Downstream of Friant Dam, the water quality of the San Joaquin River is highly impacted by agricultural and municipal discharges and stormwater runoff and by water diversions for irrigated agricultural and municipal use. The federal Clean Water Act (CWA) requires that the Central Valley Regional Water Quality Control Board (CVRWQCB) list waterbodies that have violations of the applicable water quality standards (objectives) (WQOs) as Clean Water Act Section 303(d) "impaired." This listing requires that the CVRWQCB develop a Total Maximum Daily Load (TMDL) to control the sources of the chemicals/conditions that cause the WQO violations. Table 1 lists the current, pending and potential future 303(d) listings of water quality impairments and TMDLs in the SJR and in the Delta, which is impacted by SJR-watershed-derived constituents.

This paper presents a summary of the water quality issues associated with each of the existing, pending and potential future TMDLs for the SJR. It is based on a comprehensive report on these issues (Lee and Jones-Lee, 2006). This report is available at

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http://www.members.aol.com/annejlee/sjr-WQIssues.pdf. Because of limitations on the length of this paper, references to CVRWQCB documents that provide additional information on the TMDLs are not included in the paper. They are, however, available in the Lee and Jones-Lee report, through Internet links to the CVRWQCB website.

Figure 1

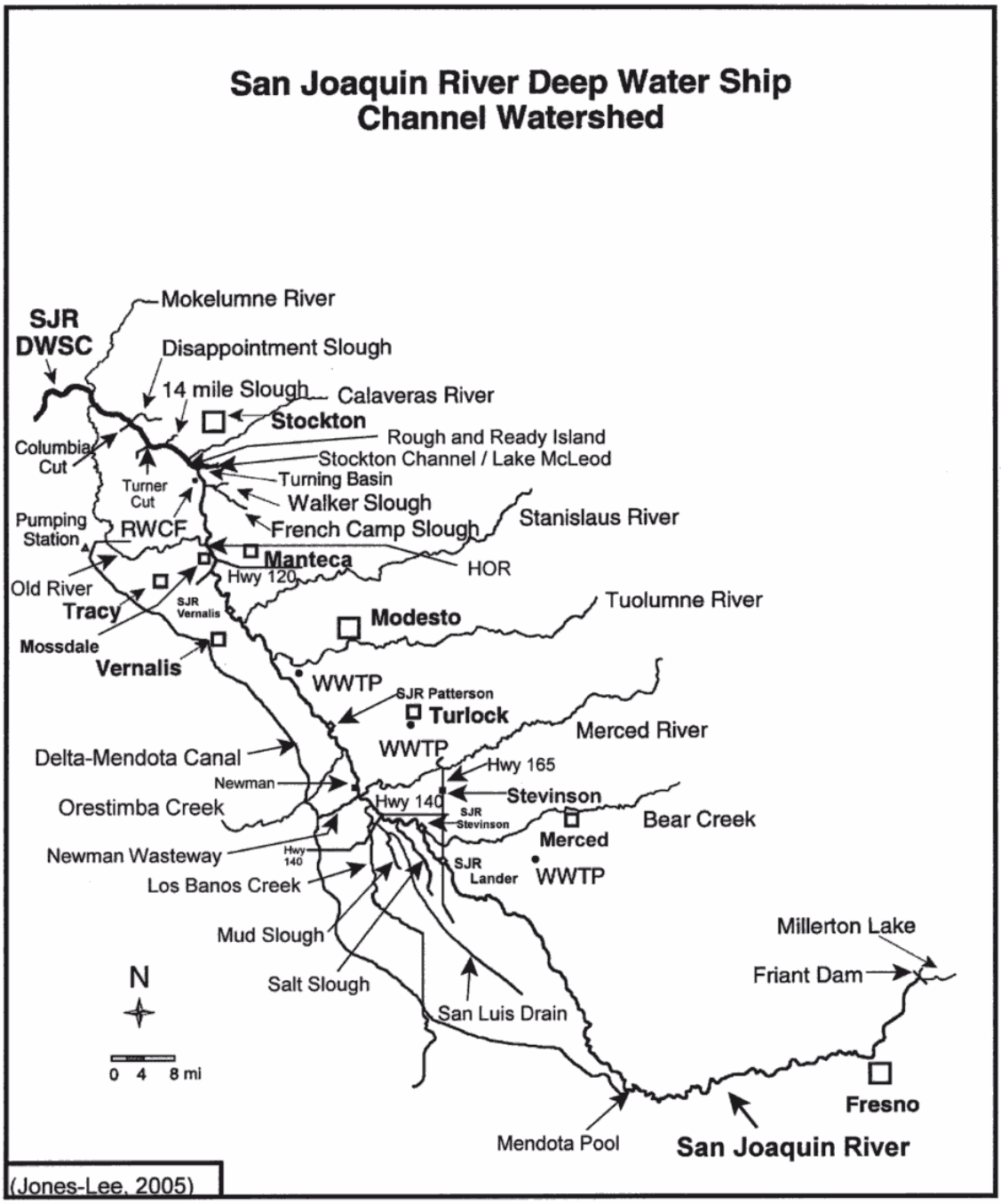

Table 1. San Joaquin River Watershed TMDLs

Current (Active)
Selenium
Salinity at Vernalis, Total Dissolved Solids (TDS), Electrical Conductivity (EC)
Boron
Organophosphorus (OP) Pesticides (Diazinon, Chlorpyrifos)
Oxygen-Demanding Substances (BOD/Algae, Ammonia, Organic N)
Pending (to be Developed)
Organochlorine "Legacy" Pesticides (DDT, Chlordane, Dieldrin, Toxaphene, etc.)
PCBs
Dioxins/Furans
Mercury
Sulfate (Bioaccumulation of Mercury)
Pathogen-Indicator Organisms, *E. coli,* Fecal Coliforms
Toxicity of Unknown Cause
Salinity Upstream of Vernalis
Potential Future (to be Evaluated)
Nutrients, Excessive Fertilization (Nitrogen and Phosphorus Compounds)
High pH, Low DO caused by Excessive Fertilization (Photosynthesis/Respiration)
Alternative Pesticides to OP Pesticides including the Pyrethroid-Based Pesticides that are Causing Water Column and Sediment Toxicity
PBDEs
Total Organic Carbon, and other Chemicals such as Bromide that Develop into Disinfection Byproducts (Trihalomethanes) in Treated Domestic Water Supplies
Excessive Sediment, Erosion, Turbidity
Herbicides (toxicity to algae)
Aquatic Sediment Toxicity (Pesticides, Nutrients/Algae/Sediment Ammonia, Heavy Metals, PAHs and other Chemicals)
Unrecognized Pollutants
Pharmaceuticals and other Unregulated Chemicals Discharged by Confined Animal Facilities (dairies, feedlots, etc.) and Domestic Wastewaters

Selenium

The finding of malformed waterfowl in the Kesterson area, which was attributed to excessive selenium derived from irrigated agriculture in the Grasslands area (located in the Mud and Salt Slough watersheds – see Figure 1) associated with leaching of naturally occurring selenium in the soils, caused the CVRWQCB to develop a TMDL to limit the concentrations of selenium discharged from this area. This is a phased TMDL, where in 2009 additional restrictions on Grasslands area selenium discharges will be implemented. The control of selenium to meet the 2009 TMDL requirements will likely significantly affect the discharges of other constituents from the Grasslands area, such as salts, nutrients, etc., and the amount of water discharged from this area that ultimately reaches the SJR. There is also concern that the current CVRWQCB water quality objective for selenium is not protective of some fish, such as sturgeon, in the Delta.

Salinity and Boron

The SJR and the South Delta have been found to contain sufficient concentrations of salinity (total salts) to be adverse to some irrigated agriculture. There is also the potential for boron concentrations in the SJR to be adverse to some irrigated agriculture. The boron is derived from leaching from the soils in the Grasslands area. The salinity is derived from irrigated agricultural evapotranspiration and soil leaching. The excessive concentrations of boron and

salinity have caused the CVRWQCB to develop a TMDL to control salinity and boron concentrations in the SJR at Vernalis. The State Water Resources Control Board (SWRCB) has required that the CVRWQCB develop more restrictive allowed salinity concentrations in the SJR upstream of Vernalis. The CVRWQCB is in the process of developing this objective. The management of salinity discharges to the SJR, especially associated with meeting the potential projected upstream salinity WQO, could significantly impact the discharges of other pollutants and the amount of water that enters the SJR from Mud and Salt Sloughs.

OP Pesticides

OP pesticides and other pesticides (such as pyrethroid-based pesticides) used in urban and agricultural areas in the SJR watershed and Delta are causing aquatic life toxicity in the State's waters. This toxicity is a violation of the CVRWQCB Basin Plan WQO. The CVRWQCB has adopted a TMDL for control of OP pesticide discharges in the SJR watershed that cause violations of the OP pesticide water quality objective in the mainstem of the SJR. There are significant deficiencies in the approach that the CVRWQCB is following in attempting to develop aquatic life toxicity control programs in the SJR watershed. These include inadequate control of OP and other pesticide discharges from agricultural and urban areas in the SJR watershed, and inadequate monitoring of compliance with the recently adopted TMDL for OP pesticides in the mainstem of the SJR. At this time inadequate requirements have been adopted by the CVRWQCB for sediment toxicity testing associated with National Pollutant Discharge Elimination System (NPDES) permitted urban stormwater discharges.

Oxygen-Demanding Substances

Nutrient discharges (nitrogen and phosphorus), primarily from irrigated agricultural tailwater and subsurface drain water discharges, cause the SJR upstream of the Stockton Deep Water Ship Channel (DWSC) to contain large amounts of planktonic algae. The planktonic algae do not cause low-DO problems in the SJR because of its shallowness and flow characteristics. However, upon entering the DWSC at the Port of Stockton, the planktonic algae in the SJR die, decompose and exert a significant oxygen demand. This oxygen demand causes DO WQO violations in the DWSC. The low-DO problem in the DWSC near the Port of Stockton is caused by the existence of the DWSC, water diversions upstream of the DWSC and oxygen demand loads that develop on nutrients provided to the SJR upstream of Vernalis, as well as the discharge of ammonia to the SJR by the city of Stockton's domestic wastewater treatment plant. Additional information on the low-DO problem in the DWSC is provided in Lee and Jones-Lee (2003, 2004a).

The CVRWQCB has adopted a TMDL, which requires that those responsible for causing or contributing to the low-DO problem in the DWSC develop approaches to eliminate DO WQO violations. This TMDL allows the responsible parties for the low-DO problem (urban and agricultural interests) until 2009 to develop information that can be used to formulate a final TMDL to control the SJR DWSC DO WQO violations. Lee and Jones-Lee (2006) discuss a number of the significant problems with the current CVRWQCB and California Federal Bay-Delta Program (CALFED) approach. These problems need to be addressed now so that the information will be available in 2009 to formulate the final TMDL.

Organochlorine "Legacy" Pesticides

The organochlorine-based pesticides (OCls) such as DDT, dieldrin, toxaphene, etc., were widely used in the Central Valley on agricultural land. Many of these pesticides are highly persistent in soils and aquatic sediments. They tend to bioaccumulate in certain types of fish that are used as human food. Because of their potential to cause cancer in people, these pesticides were banned a number of years ago from further use in the US. However, certain types of fish (such as catfish and bass) taken from Central Valley waterbodies contain excessive organochlorine "legacy" pesticides compared to concentrations that are believed to be adverse to human health. This has caused the CVRWQCB to list the SJR as 303(d) impaired because of excessive bioaccumulation of OCls. The legacy pesticides are still being found in stormwater runoff from some agricultural lands in the SJR watershed at sufficient concentrations to accumulate to excessive levels in edible fish. Lee and Jones-Lee (2002a) have reviewed the information on excessive bioaccumulation of organochlorine pesticides and PCBs in Central Valley waterbody fish.

While this problem has been well established based on fish tissue monitoring that has occurred over the past 20 years, no work has been done by the CVRWQCB to begin to develop TMDLs to control the excessive bioaccumulation of OCls in edible fish. This situation is the result of the CVRWQCB and the funding agencies, such as CALFED, placing a low priority on beginning to address this excessive bioaccumulation problem. Because of the importance of this problem as a human health threat, especially to those who use large amounts of Central Valley fish as a necessary part of their diet, a higher priority should be given to funding the necessary studies to define current sources of OCls that are leading to the bioaccumulation of OCl residues in edible fish. This is an environmental justice issue, since some minorities and economically disadvantaged individuals rely heavily on SJR fish as a source of food.

PCBs

Fish taken from some parts of the SJR and parts of the Delta influenced by the SJR have been found to contain excessive concentrations of polychlorinated biphenyls (PCBs). PCBs are organochlorine chemicals (non-pesticides) that were used in industrial processes and in electrical transformers. While PCBs in aquatic systems are typically derived from industrial/commercial sources, there is a potential for some agricultural activities to be a source. The bioaccumulation of these chemicals in edible fish is of concern, since PCBs are suspected to be human carcinogens. PCBs, like the other OCls, have been listed for a TMDL to control the excessive bioaccumulation, but work on this problem has not received funding from the CVRWQCB or CALFED to enable the initiation of the studies needed to begin to develop the TMDL. This is another environmental justice issue that needs to be addressed.

Dioxins/Furans

Fish taken from the SJR DWSC near the Port of Stockton have been found to contain excessive concentrations of dioxins/furans. The consumption of fish containing dioxins/furans is a significant threat to human health. This situation has caused the US EPA to list the SJR DWSC near the Port of Stockton on the 303(d) list of impaired waterbodies, which requires a TMDL to be developed to control the excessive bioaccumulation. The dioxins/furans present in the fish taken from this area are derived from the McCormick & Baxter former wood-treating

operation. This has led to the situation of the area being designated as a national Superfund site, where the US EPA is the lead agency for site investigation and remediation.

The sediments of Old Mormon Slough, which is part of the McCormick & Baxter Superfund site, contain elevated concentrations of dioxins/furans. Rather than removing the Old Mormon Slough sediments, the US EPA has chosen to cover these sediments with clean sand, in an attempt to prevent further bioaccumulation of dioxins/furans in edible fish of the area. Presumably, implementation of the sand cover of the dioxins/furans in Old Mormon Slough sediments will represent the implementation of the TMDL. There are several questions about the long-term reliability of this remediation approach. Of particular concern is the adequacy of the proposed monitoring of the integrity of the sand cover and its ability to prevent dioxin/furan release to the overlying waters, where they could bioaccumulate in edible fish, for as long as the dioxins/furans are present in the sediments.

Mercury

Mercury is a neurotoxin that is a threat to fetuses and young children. Mercury in its various forms is converted to methyl mercury at the sediment water interface. Methyl mercury bioaccumulates in edible fish and, therefore, represents a threat to young children and pregnant women who consume fish containing elevated concentrations of mercury. Some fish taken from the SJR and the South Delta have been found to contain excessive concentrations of mercury compared to US EPA and California Office of Environmental Health Hazard Assessment (OEHHA) guidelines for protection of human health. This has caused the CVRWQCB to list the SJR and South Delta as 303(d) impaired for mercury. The CVRWQCB is conducting studies to better define the approach for controlling excessive mercury bioaccumulation in SJR and South Delta fish. The mercury is derived from former mercury mines in the Coast Range that discharge waters to the SJR tributaries, as well as former gold mining activities in the Sierras, where the mercury that was used to help recover gold was lost to the soil and sediments of the area. This mercury is now being transported to the SJR and its tributaries. One of the potential sources of mercury is irrigation water that is used on agricultural lands.

One of the issues of concern is that sulfate influences the rate of methyl mercury formation at the sediment water interface, and the SJR contains elevated concentrations of sulfate compared to the concentrations found in Delta waters that are derived from Sacramento River water. This could mean that the movement of SJR water through the South Delta, and its associated sulfate, could influence the bioaccumulation of mercury in edible fish in the South Delta.

There is an environmental justice issue associated with regulating excessive mercury bioaccumulation, in that the current human health protection guidelines are based on a national average fish consumption rate. There are situations in the SJR and Delta where minorities, economically disadvantaged and others are likely consuming more fish than the national average consumption rate. This could require that the allowable fish tissue concentrations of mercury be lowered to protect those who eat more fish than the national average.

Sanitary Quality

The sanitary quality of water is dependent on the presence of human pathogenic

organisms derived from human and some animal fecal matter. In an effort to protect contact recreation in waters (swimming, wading, etc.), the US EPA is requiring that states adopt a sanitary quality contact recreation standard based on *E. coli*. This standard has been shown to be more reliable in protecting human health than the fecal coliform standard that is widely used today. The CVRWQCB has adopted the *E. coli* standard recommended by the US EPA. This standard, however, has not yet been approved by the SWRCB. There is need for the SWRCB to approve this *E. coli* standard in order for it to be implemented for Central Valley waters.

The waters of the SJR and DWSC in the city of Stockton have been listed as impaired for contact recreation because of excessive concentrations of pathogens. It is highly likely that the SJR and its tributaries, as well as some of the waters in the South Delta, also contain excessive concentrations of pathogens that are a threat to contact recreation. There is need to more adequately evaluate the presence of *E. coli* in the SJR and South Delta waters, and list those waters as 303(d) impaired where concentrations of *E. coli* exceed US EPA recommended concentrations.

In addition to the concern about the sanitary quality of water for contact recreation, there is also concern about using waters with elevated pathogen-indicator organisms (such as *E. coli*) as a domestic water supply source. With increased potential use of SJR and Delta waters near Stockton for domestic water supply, there may be need to more effectively control pathogen-indicator organisms at their sources, including runoff from agricultural lands, in order to protect domestic water supplies.

In addition to diseases caused by bacteria, such as typhoid, there are human diseases caused by protozoans, such as giardia and cryptosporidium, as well as viruses, which are a threat to human health through contact recreation. The *E. coli* standard does not adequately reflect the threat that these pathogens represent both to contact recreation and to the quality of domestic water supplies. Ultimately, agricultural interests in the SJR watershed, including those responsible for runoff from irrigated lands and dairies, feedlots and managed public and private wildlife refuges, will need to control *E. coli* as an indicator of human pathogens in stormwater runoff and tailwater discharges.

Toxicity of Unknown Cause

Toxicity tests on SJR and Delta waters using US EPA recommended standard test organisms have shown the presence of aquatic life toxicity that is of an unknown cause. Since the presence of aquatic life toxicity is a violation of the CVRWQCB Basin Plan, this has caused the CVRWQCB to list the SJR and other waterbodies as impaired due to unknown-caused toxicity. As part of developing information needed to begin to formulate a TMDL to control this toxicity, the CVRWQCB has developed a research program focusing on developing toxicity investigation evaluations (TIEs) for selected pesticides used in the Central Valley. It is suggested that a more reliable approach for addressing the unknown-caused toxicity problem would be to focus the funds available on those situations where unknown-caused toxicity is currently found, and then, through a combination of TIEs and forensic studies, as well as information provided by the Department of Pesticide Regulation and the County Agricultural Commissioner on the use of pesticides in the watershed where unknown-caused toxicity is found, work to develop information on the cause of the unknown-caused toxicity.

Nutrients

Nutrients (nitrogen and phosphorus compounds) discharged from irrigated agriculture and from agricultural and urban stormwater runoff and wastewaters are causing significant water quality problems in the SJR and in the Delta, as well as in water utility water supply reservoirs that use Delta water as a domestic water supply source. These problems are manifested through excessive growths of algae and/or water weeds such as water hyacinth and *Egeria*. At this time the CVRWQCB's regulation of excessive fertilization water quality impacts is to be accomplished through a Basin Plan narrative water quality objective for the control of "biostimulatory substances." The CVRWQCB has not developed specific guidelines on how to evaluate the presence of excessive biostimulatory substances in a waterbody. However, at the request of the CVRWQCB staff, Lee and Jones-Lee (2002b) have provided guidance on the approach that can be used for implementation of the biostimulatory substance narrative water quality objective. Basically, this approach involves site-specific evaluation, for each potentially impacted waterbody of concern, of the desired nutrient-related water quality, the nutrient loads to the waterbody to achieve this water quality, and the sources of nutrients that need to be controlled to achieve the desired water quality.

The CVRWQCB Agricultural Waiver water quality monitoring program requires that agricultural interests subject to regulation under this program monitor nutrient concentrations at their monitoring locations beginning in the spring of 2006. Associated with this monitoring is the need to develop guidance on how the agricultural interests and the CVRWQCB staff should interpret the nutrient concentration data developed in the Agricultural Waiver monitoring program. This interpretation will need to be based on guidance provided by the CVRWQCB on implementing the narrative water quality objective for biostimulatory substances. The proper implementation of this objective will require a comprehensive monitoring/evaluation program of the impacts of the nutrients found at a particular monitoring point on water quality at that point and downstream. Through the Agricultural Waiver monitoring program, if adequately implemented, the development of nutrient control programs from irrigated agriculture and urban sources could begin to be developed in the SJR watershed and the Delta.

It has been repeatedly demonstrated over the years that particulate phosphorus derived from land runoff is largely unavailable to support algal growth. It will be important in developing control programs for nutrients from agricultural and urban runoff to focus on available forms of phosphorus, rather than total phosphorus.

Aquatic Sediment Toxicity

Toxicity associated with aquatic sediments is becoming recognized as a potentially significant cause of water quality impairment. This toxicity can affect the numbers and types of benthic and epibenthic organisms, which are important components of fish food. The presence of aquatic life toxicity due to pesticides in sediments is a violation of the CVRWQCB Basin Plan that needs to be controlled. Of particular concern today is the finding that pyrethroid-based pesticides, which are being used in agricultural and urban areas as replacements for organophosphorus-based pesticides, not only cause toxicity in the water column during the time of discharge from areas where they are applied, but also cause toxicity in the sediments where they accumulate following a runoff event. This situation will ultimately require that agricultural

and urban uses of pyrethroid-based pesticides (and any other pesticides that accumulate in aquatic sediments and cause aquatic life toxicity) be controlled.

Another source of sediment toxicity occurs in those sediments that accumulate dead algae, which create anoxic conditions in sediments through their decay. This leads to an accumulation of ammonia in the sediments, which is toxic to a number of forms of aquatic life. It also leads to low-DO conditions, which are also toxic to many forms of aquatic life. At this time, regulatory agencies at the federal and state level are largely ignoring the toxicity caused by nutrient discharges, which leads to growths of algae that die, settle, decay and cause ammonia accumulation and anoxic conditions in sediments. This is the most important cause of sediment toxicity in some areas.

Currently the SWRCB is developing sediment quality objectives that ultimately will be used to regulate the discharge to estuarine and marine waters and the Delta of pollutants that accumulate in sediments and cause sediment toxicity. Also of concern is the control of sediments that serve as a source of bioaccumulatable chemicals, such as organochlorine legacy pesticides and PCBs. The SWRCB's efforts to develop sediment quality objectives are focusing on the integrated use of sediment toxicity, altered benthic organism assemblages compared to habitat characteristics, and chemical information. As discussed by Lee and Jones-Lee (2004b), it will be important that the chemical information be based not on total concentrations of chemicals (co-occurrence-based approaches), but on identifying the amounts of those chemicals that are causing aquatic life toxicity, serving as a source of bioaccumulatable chemicals, and/or altering benthic organism assemblages. The SWRCB has recently made available $2.5 million to develop sediment quality objectives for the Delta, which includes the lower reach of the SJR. Ultimately this effort could significantly impact the discharges of chemicals from the SJR watershed that accumulate in the SJR sediments downstream of Vernalis (i.e., within the Delta), which are adverse to the beneficial uses of the waters.

Some of the SJR DWSC sediments that have been dredged for maintenance of channel depth to enable ocean-going ships to reach the Port of Stockton have been found to be acid-producing when placed in situations such as in on-land dredged sediment disposal areas, as well as on a levee for levee stability enhancement. The acid-production situation associated with exposure of DWSC sediments to oxygen is another consequence of SJR watershed nutrients that lead to algal development that, upon their death and decay, leads to the accumulation of reduced forms of iron and sulfur in the sediments. The acid produced from these sediments arises from the oxidation of iron and sulfur compounds present in the sediments that, when in contact with oxygen, leads to low pH. This low pH can cause toxicity to aquatic life and can cause the release of heavy metals from the sediments, which can also be toxic to aquatic life. There is need to more reliably evaluate how SJR DWSC sediments dredged from the navigation channel can be used for beneficial purposes, without adverse effects on water quality.

Heavy Metals

There is concern that heavy metals derived from the Delta watershed, including the SJR watershed, such as copper and cadmium, which tend to bioaccumulate in aquatic organisms, could cause toxicity to the host organism. These heavy metals are derived from former mining activities in the Sierra Nevada Mountains. These heavy metals may not be adequately regulated

by the current US EPA and State water quality criteria/standards. This is an area that needs further study.

Pyrethroid Pesticides

Pyrethroid-based pesticides have been found to cause aquatic life toxicity in stormwater runoff and other runoff/discharges from urban and agricultural areas where they have been applied, including in the SJR watershed. These pesticides accumulate in sediments following runoff events, causing sediment toxicity. Since water column and sediment toxicity are violations of the CVRWQCB Basin Plan, there is need to begin to control the use of pyrethroid-based pesticides that cause water column and/or sediment toxicity in the receiving waters for runoff from areas where they are applied. It is unclear, however, when the CVRWQCB is going to begin to control the use of pyrethroid-based pesticides that are causing violations of the Basin Plan WQO. This is an issue that needs immediate attention by the CVRWQCB, in order to avoid a long period of continued toxicity due to the use of these pesticides.

Total Organic Carbon

The total organic carbon (TOC) content of a water that is to be used for domestic water supply is of concern since TOC interacts with many types of disinfectants (such as chlorine and ozone/bromide) to produce disinfection byproducts. These are chloroform-like chemicals that are regulated as carcinogens in domestic water supplies. The waters exported from the Delta at the State Water Project (SWP) for domestic water supply use at times contain excessive concentrations of TOC compared to the US EPA's regulatory limit. This requires water utilities to practice additional water treatment at additional cost.

One of the major sources of TOC for the Delta is the SJR watershed. Within this watershed the runoff from irrigated agriculture and discharges from wetland areas, including the large wildlife refuges, are major sources of TOC. Also, domestic and agricultural wastewaters and stormwater runoff are sources of TOC. Another major source of TOC in the Delta is Delta island agricultural areas, associated with organics derived from the peat soils of many of these areas. Water utilities could reduce their cost of treatment if TOC were controlled at the various sources, which will be difficult to achieve.

At this time there are no water quality criteria or objectives covering TOC. This means that, even though the TOC in Delta waters is causing impairment of these waters for use for domestic water supply, the waters with elevated TOC are not listed as CWA 303(d) impaired, with the result that there is no regulatory approach to control TOC discharges from various sources in the SJR watershed and within the Delta. This situation could change if the CVRWQCB, as part of implementing the Source Water Quality Protection provisions of the US EPA Safe Drinking Water Act, adopts a Drinking Water Policy that includes the development of a TOC water quality objective. The development of such a policy is under review by the CVRWQCB, where within a few years the Board will likely consider a proposal to develop a WQO for TOC in Central Valley waterbodies. Adoption of a TOC WQO could have a significant impact on agricultural and urban interests and wildlife refuge (wetlands) managers in the SJR watershed, since they could be required to reduce the TOC content of their discharges/runoff.

Regulation of TOC should not be based on total concentrations. Some of the TOC that develops in the SJR watershed and within the Delta, such as soluble BOD, is labile (non-persistent) and decomposes before reaching a water supply intake. Also of concern is the labile TOC in the form of algae, which die and decompose before the waters are taken for domestic water supply purposes by many of the water utilities that use Delta water as a raw water source. It is important that TOC control programs focus on those sources of TOC that are refractory – i.e., do not decompose before reaching a domestic water supply intake.

One of the major issues that needs to be evaluated is whether controlling TOC at its sources is more appropriate than providing additional treatment at a water treatment facility to control the TOC at that location. About half of the water exported from the Delta is for domestic water supply; the remainder is for agricultural use. The TOC in waters used for agricultural irrigation is not adverse to crop production; in fact, it may be beneficial.

TOC in South Delta waters impacts the potential use of these waters for groundwater recharge using aquifer storage and recovery (ASR) approaches. Elevated-TOC waters, which are acceptable for use in treated domestic water supplies, can be adverse to recharge of these waters through an ASR project, because of adverse impacts on the aquifer characteristics. Potential ASR projects such as the one proposed by the city of Tracy based on Delta Mendota Canal (DMC) water (derived from the South Delta) should treat the water to remove TOC before injection into the aquifer.

Suspended Sediment

Some agricultural lands on the west side of the SJR are subject to severe erosion, resulting in runoff waters from these lands containing high concentrations of suspended sediments, which leads to highly turbid waters and shoaling/siltation where the sediment settles in the Delta. While this is a significant water quality problem, the CVRWQCB has not listed the SJR as impaired due to suspended sediment/turbidity.

Efforts are being made by some of the agricultural interests where erosion is occurring to control erosion through the addition of polymers to the soil. It is important that chemicals used to control erosion be adequately evaluated to be certain that they do not cause water quality problems in the SJR, its tributaries and the Delta.

There is a significant problem with the way in which the CVRWQCB Basin Plan evaluates excessive suspended sediment/turbidity in waters, which needs to be addressed in order to develop a more readily implementable approach for evaluating excessive suspended sediment and turbidity in a waterbody.

An issue of concern is that the control of turbidity in the SJR could lead to increased planktonic algal growth in the SJR, which could increase the oxygen demand load that the SJR discharges to the DWSC. At this time the growth of algae in the SJR is light-limited. With reduced turbidity, there could be increased growth of algae, since surplus nutrients are available to support this growth.

Herbicides

Toxicity testing of the waters in the SJR watershed and Delta has shown that some samples of these waters are toxic to the US EPA standard toxicity test alga (*Selenastrum capricornutum*). TIE studies have shown that at least part of this toxicity is due to diuron, a widely used herbicide for controlling terrestrial weeds in some fields and along highways. Toxicity to algae is a violation of the CVRWQCB Basin Plan, which requires control. At this time the CVRWQCB has not listed algal toxicity as a CWA 303(d) water quality impairment, and therefore no work is being done to control the algal toxicity that is being found in the SJR watershed and Delta. This is an issue that will need to be addressed in future CVRWQCB activity.

The algal toxicity that is being found is often in waterbodies that have excessive growths of algae. It appears that the herbicide effects do not cause sufficient toxicity to greatly reduce the algal biomass in the SJR watershed and South Delta. However, there is a potential for algal toxicity in the SJR to affect the concentrations of algae that represent oxygen demand loads to the DWSC. This situation could create pulses of algae, which would make managing the low-DO problem in the DWSC more difficult and expensive as a result of requiring a more intensive monitoring program to assess oxygen demand loads to the DWSC.

Unrecognized Pollutants

There is increasing concern about pharmaceuticals and other unregulated chemicals from confined animal facilities (CAFs) and from domestic wastewaters to cause water quality problems in the receiving waters for discharges from these areas. The current approach for monitoring potential pollutants in the SJR and Delta is significantly deficient in that it considers only a hundred or so chemicals of the many tens of thousands of chemicals that are discharged to these waters from urban and agricultural sources. Pharmaceuticals and personal care products (PPCPs) are discharged to wastewater systems, which enter surface and ground waters receiving domestic and agricultural wastewaters. For example, pharmaceuticals that are used at CAFs (such as dairies, feedlots, etc.) and are discharged in domestic wastewaters are unregulated chemicals, from a water quality impact perspective, that have the potential to be significantly adverse to aquatic life. Adverse impacts of these chemicals on aquatic life are being found. There is need, however, to greatly expand the scope of potential pollutant monitoring programs to more adequately identify chemicals that could be adverse to aquatic life and other beneficial uses of waterbodies. This monitoring should focus on those areas near where domestic and agricultural wastewaters are discharged to surface waters in the Delta and SJR tributaries. Studies conducted at the University of California, Davis (UCD), have demonstrated sublethal impacts of chemicals in SJR and Delta waters. There is need to better understand the water quality significance of these biomarker responses.

Overall

The SJR, many of its tributaries and those parts of the Delta that receive SJR water are highly impacted by known pollutants derived from irrigated agriculture, other agricultural activities involving animal husbandry, public wetland wildlife refuges and private gun clubs, and urban stormwater and wastewater discharges. These impacts on the beneficial uses of SJR waters and the Delta are significantly affected by SWRCB Water Rights decisions that allow

water diversion/exports. The ability of the CVRWQCB to address these problems is greatly hampered by a lack of funding from state and federal sources.

There is an urgent need to develop a large-scale water quality monitoring/evaluation program to address known water quality impairments, as well as to identify other water quality impairments that are not now recognized. Without such a program the ability of the CVRWQCB to adequately restore the SJR, its tributaries and the Delta to unimpaired beneficial uses will be limited. Funds to support this monitoring, evaluation and management program should be derived from all who discharge wastewaters and stormwater runoff to the SJR tributaries and the SJR, and all who derive benefits from using SJR watershed waters.

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