Alameda County Water District
Alameda County Flood Control and Water Conservation District, Zone 7
Contra Costa Water District
Kern County Water Agency
Metropolitan Water District of Southern California
San Luis & Delta Mendota Water Authority
Santa Clara Valley Water District
State & Federal Contractors Water Agency
State Water Contractors
Westlands Water District

October 8, 2010

Ms. Katherine Hart
Chair, Central Valley Regional Water Quality Control Board
Sacramento Office
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670-6114

Dear Ms. Hart:

Re: *Comments on the Tentative Waste Discharge Requirements Renewal (NPDES No. CA0077682) for the Sacramento Regional County Sanitation District Sacramento Regional Wastewater Treatment Plant*

The ten undersigned water agencies and associations (Water Agencies) appreciate the opportunity to provide the attached comments on the Tentative Waste Discharge Requirements and NPDES permit renewal (Tentative Order) for the Sacramento Regional County Sanitation District's Sacramento Regional Wastewater Treatment Plant (Treatment Plant). Protecting and improving the water quality and ecological health of the Sacramento River and Bay-Delta is a priority for our agencies that provide water to 25 million Californians and 2 million acres of productive farmland. Accordingly, we urge the Central Valley Regional Water Quality Control Board (Regional Board) to require the Sacramento Regional County Sanitation District (Sanitation District) to implement improved wastewater treatment as recommended in the Tentative Order as soon as possible.

The growing body of data and scientific literature demonstrate that ammonia/um and other pollutants have significantly altered the Bay-Delta's food web – contributing to the overall decline of the estuary's health. It is clear that the only way to make long-term improvements in the Bay-Delta is to address all the factors that impact the Bay-Delta ecosystem – including limiting the amounts of ammonia/um and nitrate that are allowed to flow into the Bay-Delta and its waterways. Therefore, the Water Agencies fully support the Tentative Order's requirement for full nitrification and denitrification treatment of the Sanitation District's wastewater for the protection of beneficial uses.

Given the evidence that current ammonia/um discharge levels are having a significant detrimental effect on the Bay-Delta ecosystem, we urge the Regional Board not to adopt interim ammonia/um limits that would allow an increase in ammonia/um loading over the next ten years. Instead, the Regional Board must compel the Sanitation District to undertake every effort to reduce ammonia/um discharges in the interim period and install nutrient removal treatment as expeditiously as possible.

The California Department of Public Health has relayed to you its well-reasoned concerns about the untreated pathogens that are presently contained in the discharge from the Treatment Plant. Removing pathogens from this wastewater is a basic requirement for human health protection both for recreational purposes in the Bay-Delta and downstream drinking water uses. Downstream drinking water treatment plants rely on multiple barriers to ensure public health protection. Controlling sources of contamination is the first barrier. Thus, we fully support the Tentative Order's focus on reducing pathogens, and *Cryptosporidium* and *Giardia* specifically.

The attached comments also address additional issues of importance to the Water Agencies. The Tentative Order's effluent salinity limitation and required salinity minimization plan will contribute to the Regional Board's region-wide effort to address salinity in the Central Valley. The Water Agencies also support the Tentative Order provisions that seek to address toxicity, but urge the Regional Board to expand and strengthen the proposed toxicity remediation program in the final permit. Finally, the Water Agencies support the increased effluent and receiving water monitoring requirements contained in the Tentative Order.

Organizations, public agencies and leaders throughout the state have been working diligently towards a comprehensive solution to the overall Bay-Delta crisis. Reducing ammonia/um, nitrate, and pathogens in the Bay-Delta today is critical to that effort. We are encouraged that Regional Board staff has focused on these harmful aspects of the Treatment Plant discharge, and is supporting new wastewater treatment targeting these major pollutants.

Thank you for your consideration of our comments and requests. We look forward to continuing to work with you to provide input to the development of the Treatment Plant discharge permit renewal.

Sincerely,

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Alameda County Water District

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General Manager
Alameda County Flood Control &
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General Manager
Westlands Water District

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Comments on the Tentative Waste Discharge Requirements Renewal for the Sacramento Regional County Sanitation District Sacramento Regional Wastewater Treatment Plant

I. Introduction

The Central Valley Regional Water Quality Control Board (Regional Board) gave Notice on September 3, 2010, of the proposed renewal of the National Pollutant Discharge Elimination System (NPDES) permit/Waste Discharge Requirements (WDR) for the Sacramento Regional County Sanitation District's (Sanitation District) Sacramento Regional Wastewater Treatment Plant (Treatment Plant).

The Sanitation District currently provides wastewater treatment for 1.3 million residents within a 437-square-mile service area. The Treatment Plant discharges secondary treated wastewater into the Sacramento River near the town of Freeport, and the point of discharge is within the Sacramento-San Joaquin River Delta (Delta). Wastewater flows from the Sacramento River into the Delta and thence to the San Francisco Bay (Bay-Delta). The Sanitation District currently discharges 141 million gallons per day (mgd) Average Dry Weather Flow (ADWF) of secondary treated wastewater and seeks to retain its previously permitted capacity of 181 mgd. The Sacramento River and Bay-Delta are designated for numerous beneficial uses, including municipal and domestic supply, agricultural supply, water contact recreation, warm and cold freshwater habitat, migration of aquatic organisms, and wildlife habitat. The Treatment Plant's existing discharge degrades water quality and impairs the beneficial uses through the loading of ammonia/um and other nutrients, pathogens, toxic contaminants, emerging contaminants of concern such as endocrine disrupting compounds, and salinity. The existing discharge also reduces dissolved oxygen to levels that impact aquatic life, and contributes to increased temperature in the Sacramento River, likely causing lethal to adverse sublethal conditions for listed species, including Delta smelt, Chinook salmon and steelhead.

The adverse effect of the Treatment Plant discharge on threatened and endangered fish species has not been authorized under the federal Endangered Species Act or the California Endangered Species Act, and has in fact resulted in a disproportionate regulatory burden being placed on the communities in the San Francisco Bay Area, the Central Coast, the San Joaquin Valley and Southern California. The degradation of water quality due to the Treatment Plant's discharge has unduly impaired the water supply for 2 million acres of farm land and 25 million Californians living in two-thirds of the state's households.

Alameda County Water District (ACWD), Alameda County Flood Control and Water Conservation District, Zone 7 (Zone 7); Kern County Water Agency (KCWA), Metropolitan Water District of Southern California (MWD), Santa Clara Valley Water District (SCVWD), Contra Costa Water District (CCWD), State Water Contractors (SWC), Westlands Water District (Westlands) and the San Luis & Delta-Mendota Water Authority (SLDMWA), collectively referred to as "Water Agencies", commend the Regional Board for including requirements in the Sanitation District NPDES permit renewal that address the on-going water quality degradation caused by the Treatment Plant discharge and seek to provide protection for beneficial uses. In

particular, the Water Agencies strongly support the requirements for the Sanitation District to upgrade its Treatment Plant to include full nitrification/denitrification and tertiary filtration.

In accordance with the Regional Board's September 3 Notice, the Water Agencies hereby submit these comments on the Tentative Waste Discharge Requirements Renewal (NPDES Permit No. CA0077682) and Tentative Time Schedule Order (collectively, the Tentative Order) for the Sacramento Regional County Sanitation District that the Regional Board has proposed to authorize and control the Sanitation District's Treatment Plant discharge into the Sacramento River and Bay-Delta.[1] The Water Agencies were assisted in the preparation of these comments by a number of technical experts, whose curricula vitæ are provided in Attachment 1. Following is a summary of certain key comment issues that are more fully presented below and in attachments.

A. The Tentative Order properly requires Treatment Plant upgrades that incorporate treatment already being employed at many other publicly owned treatment works .

The Water Agencies strongly support the Tentative Order's requirement that the Sanitation District upgrade its Treatment Plant to incorporate additional treatment that already is in use or has been mandated at many other publicly owned municipal treatment plants in the watershed. The Sanitation District's Treatment Plant was designed and built in the late 1970s and early 1980s. The Treatment Plant's last NPDES permit was issued a decade ago and expired five years ago. The Water Agencies submit that the Regional Board cannot act soon enough to compel the Sanitation District to incorporate treatment processes needed to protect the Delta ecosystem, human health and the state's largest single source of fresh water supply.

The Tentative Order would require nitrification and denitrification (i.e., nutrient removal) as Best Practicable Treatment or Control (BPTC). In facing that requirement, the Sanitation District is not being singled out to invest in new or unproven technology. To the contrary, the Tentative Order identifies nine other municipal wastewater treatment plants in the region required to incorporate nutrient removal. A review of NPDES permits throughout the region shows 23 treatment plants that are required to incorporate nutrient removal and at least two more plants facing tentative permits that would require it.[2] Many other large publicly owned treatment plants around the country are similarly implementing nutrient removal. There can be no question that nutrient removal is BPTC.

The Tentative Order would also require tertiary filtration as BPTC to ensure the removal of harmful human pathogens, like *Giardia* and *Cryptosporidium*, that otherwise would more than quadruple the risk of infection and illness from human contact with Sacramento River water mixed with the discharge, according to the California Department of Public Health. Increased risk of infection and illness from exposure to wastewater is not protective of the municipal and domestic supply, agricultural water supply for food crops, and water contact recreation beneficial

[1] Certain of the Water Agencies previously submitted comments in these proceedings in February 2010 and June 2010 in response to the Regional Board's issue papers re Drinking Water Supply and Public Health and Aquatic Life and Wildlife Preservation issues. Those Water Agencies request that their prior comment letters and supporting literature and data be considered resubmitted as part of these further comments on the Tentative Order.

[2] See Attachment 2.

uses of the Sacramento River, which are designated in the Water Quality Control Plan for the Sacramento and San Joaquin River Basins, as well as for the Bay-Delta.

Incorporation of tertiary filtration also will reduce the discharge of total organic carbon (TOC), which increases the cost of drinking water treatment and increases the potential for formation of harmful disinfection byproducts in drinking water, will substantially reduce concentrations of copper, mercury, total suspended solids (TSS) and oxygen-demanding substances, referred to as biological oxygen demand (BOD), and may reduce concentrations of other constituents of concern. Again, the Sanitation District is not being singled out. The Tentative Order identifies 13 other treatment plants in the region that already are required to incorporate tertiary filtration. Moreover, a review of NPDES permits throughout the region reveals 22 treatment plants that are required to incorporate tertiary filtration and at least two more plants with tentative permits that would require it.[3] There can be no question that tertiary filtration is BPTC.

B. The Final Order should require that nutrient removal and tertiary filtration be incorporated in the shortest practicable time, with milestones enforceable through a Cease and Desist Order, and require interim measures and more stringent interim limits to address ongoing ammonia discharges.

The Sacramento River and Bay-Delta are of exceptional recreational, economic, and ecological significance to the people of California. Yet every day, the Treatment Plant is discharging *14 tons of untreated ammonia* and other nutrients into the Sacramento River and Bay-Delta. Ammonia concentrations downstream of the Treatment Plant now regularly exceed current toxicity criteria for the protection of aquatic life. Further, Treatment Plant discharges would continue to load thousands of additional pounds of ammonia into the Bay-Delta ecosystem, continuing to degrade water quality and alter the food web and ecology of the Bay-Delta. Likewise, every day, the Treatment Plant continues to discharge harmful levels of human pathogens, copper, mercury, TSS, BOD and other constituents of concern that tertiary treatment could reduce before the discharge enters the Sacramento River.

Unfortunately, the Tentative Order has proposed interim daily effluent limits that would allow the maximum daily concentration and mass loading of ammonia to more than double to *34 tons of untreated ammonia each day*, while the Sanitation District delays incorporating nutrient-removal BPTC for another decade. The Water Agencies urge the Regional Board not to accept those proposed increases. Instead, the Regional Board should issue a Cease and Desist Order imposing detailed milestones that compel the installation of nutrient removal in the shortest practicable time. Further, we urge the Regional Board to prohibit any increases in ammonia discharges and to require the Sanitation District to take feasible interim measures to reduce ammonia discharges until the final treatment is implemented. The same approach should be incorporated for pathogen control, requiring incorporation of tertiary treatment and disinfection in the shortest practicable time.

[3] *Id.*

C. The Regional Board should not grant the Sanitation District an exception to the Thermal Plan due to an insufficient and, in some cases, nonexistent analysis of the impacts of the Treatment Plant's thermal discharge on Delta smelt, Chinook salmon, steelhead, and other important aquatic species.

The Treatment Plant's discharge causes a plume of high-temperature water in the Sacramento River from a diffuser that is installed across the river bottom at the point of discharge at Freeport. The discharge occurs within the designated critical habitat for five fish species listed and protected under the federal Endangered Species Act, including winter- and spring-run Chinook salmon, steelhead, Delta smelt and green sturgeon. Certain of those and other impacted fish species are also listed and protected under the California Endangered Species Act.

Delta smelt occupy the critical habitat in the vicinity of the discharge. Ambient Sacramento River water temperatures at Freeport approach, and may exceed, levels that are fatal to Delta smelt, Chinook salmon and steelhead in late spring and early summer, possibly also in the fall. Even where river temperatures are not immediately fatal, sublethal temperatures may cause harm to these species by increasing their susceptibility to predation by largemouth bass and other predatory fish that congregate at the discharge, and by making them more susceptible to disease. Impacts to green sturgeon should be expected, although the Sanitation District has provided no information to assess the impacts.

The Thermal Plan reflects the long established judgment of the State Board on the appropriate temperature for waste disposed of in estuaries, including the Bay-Delta. Hence, to protect listed fish species and other aquatic resources, dischargers like the Sanitation District must comply with the Plan unless the discharger affirmatively demonstrates that an exception would protect fully all aquatic resources. In this instance, the Sanitation District has requested an exception from the Thermal Plan, but failed to meet its burden of establishing that the discharge's thermal effects will not harm Delta smelt, Chinook salmon, steelhead, green sturgeon, and other aquatic species. As a result, the Regional Board should deny the requested exception to the Thermal Plan.

D. The Regional Board has a reason beyond those stated in the Tentative Order to require nutrient removal; it is needed to address continued dissolved oxygen violations occurring for 40 miles downstream of the discharge and to prevent aquatic resource impacts from the discharge through Suisun Bay.

The Water Agencies support the Tentative Order's conclusion that the Treatment Plant's discharge is causing serious impacts on dissolved oxygen levels in the Sacramento River and Bay-Delta. Dissolved oxygen (DO) is a necessity for Delta smelt, steelhead, salmon, sturgeon and other aquatic life to survive. DO samples immediately below the Treatment Plant's discharge show violations of the Basin Plan's 7.0 mg L^{-1} water quality objective for DO. The Regional Board has determined that the Treatment Plant's discharge of ammonia is a substantial contributing cause of low DO levels in receiving waters within the 40 miles below the discharge.

Naturally occurring bacteria in the river convert some of the ammonia/um discharged by the Treatment Plant each day into nitrite and then into nitrate through a biological process that consumes DO from the receiving water. The discharge also includes other oxygen-demanding

substances, (BOD), that consume DO from receiving waters. The current absence of a nitrification and denitrification process within the Treatment Plant functionally results in the Sanitation District's use of the Sacramento River as an extension of its sewage treatment process. That is not only a direct violation of the Clean Water Act, but by failing to complete nutrient removal within the Treatment Plant, the Sanitation District drives down DO levels in the Sacramento River and Bay-Delta below the Basin Plan objective that is established to protect fish and other aquatic resources.

Moreover, the DO problem occurs at the Treatment Plant's current discharge level. Absent improved treatment, expanding the discharge would make the DO problem more severe. That is significant in its own right. However, the DO problem adds to impacts from temperature and toxicity to Delta smelt, steelhead, salmon, sturgeon, and other aquatic resources. To stop the harm to beneficial uses of the Sacramento River and Bay-Delta from the Treatment Plant's discharge of ammonia/um, the Tentative Order properly finds that year-round nutrient removal within the Treatment Plant is BPTC that is required to address DO violations. We urge the Regional Board to adopt this finding and require year-round nutrient removal in the Final Order.

In addition, full year-round nutrient removal also is necessary to prevent the Treatment Plant's ammonia/um discharge from inhibiting the growth of the specific phytoplankton species and zooplankton species that sustain the Delta smelt. The impact of the Treatment Plant's increasing ammonia/um discharge on those plankton species is now well-documented. As the discharge has increased, these phytoplankton and zooplankton species have declined. And because the declining zooplankton are the favored food of the Delta smelt, the Delta smelt has declined. Despite the Sanitation District's characterization of the science explaining these declines as "novel," the fundamental biological mechanisms by which the ammonia/um discharge is changing the Delta food-web are well understood and well documented in a long history of scientific literature. Increasing ammonia/um discharges that suppress zooplankton species consumed by Delta smelt, alone, is a beneficial use impairment justifying nutrient removal at the Treatment Plant. The fact that the ammonia/um discharge has reduced the zooplankton food supply to the point of reducing the Delta smelt population makes the beneficial use impairment more significant, and rises to the level of an unauthorized take under the federal and state Endangered Species Acts.

The Tentative Order correctly identifies the nitrosamine, N-nitrosodimethylamine (NDMA), as a "highly mutagenic and potentially carcinogenic" (see Tentative Order, F-92) constituent of concern in the Sanitation District's discharge. Nitrosamines are disinfection byproducts that are created when wastewater effluent contains ammonia and is then disinfected with chlorine, which is the case at the Treatment Plant. The generation of these harmful byproducts by the Treatment Plant is caused in large part by the ammonia/um in the discharge, which is a further reason why the Final Order should require full year-round nutrient removal.

E. The Final Order should expand and strengthen the proposed program for prohibiting the discharge of toxic constituents into the Delta, which is listed as impaired for unknown toxicity under Clean Water Act section 303(d).

The Water Agencies support the Tentative Order provisions that seek to address toxicity, but urge the Regional Board to expand and strengthen the proposed toxicity remediation program in

the Final Order. The Sanitation District has an ongoing problem in its discharge with acute and chronic toxicity to aquatic life. The Tentative Order has correctly characterized the Sanitation District's discharge as being in violation of the toxicity provisions of its NPDES permit 15 percent of the time. The Delta is designated critical habitat for Delta smelt and other listed fish species exposed to the Sanitation District's toxic discharge, and the Delta is currently listed under Clean Water Act section 303(d) as impaired for unknown toxicity. No total maximum daily load has been approved for that toxicity, so no toxicity loading is allowed from the Treatment Plant discharge. The Basin Plan also requires treatment to meet water quality objectives in this segment of the River. Accordingly, the Treatment Plant's Final Order must include end-of-pipe effluent limitations prohibiting further loading of toxicants.

In addition, the Tentative Order correctly prohibits any mixing zone for acute toxicity and for chronic toxicity for many pollutants. However, the Final Order should extend that prohibition of a mixing zone for chronic toxicity for all relevant pollutants. The Sacramento River's 303(d) listing for unknown toxicity means the Basin Plan requires additional treatment to meet water quality objectives in the limited segment of the river. The Final Order also should prescribe a whole effluent toxicity (WET) testing program that is designed to maximize the ability to identify specific problem toxicants and to remove them from the Treatment Plant's discharge. Use of local species as WET testing specimens should supplement, not replace, the use of standard test species.

F. The cost to upgrade the Treatment Plant to incorporate BPTC passes the EPA's treatment affordability test, and is a reasonable expense given the harm caused by the discharges.

The Treatment Plant can be updated with nutrient removal and tertiary filtration at far less cost than claimed by the Sanitation District. The treatment technology expert retained by the Regional Board concluded that the Sanitation District had overstated the costs of the nutrient removal and tertiary filtration that the Tentative Order prescribes as BPTC. Similarly, the treatment technology expert retained by the Water Agencies concludes that the cost of incorporating nutrient removal and tertiary filtration and disinfection would likely cost about half what the Sanitation District says.

Contrary to the Sanitation District's public relations campaign, the Water Agencies agree with and support the Regional Board's conclusion in the Tentative Order that the additional cost to consumers will be reasonable and well in line with sewerage rates and costs in other nearby service areas whose treatment plants already are mandated to incorporate nutrient removal and tertiary filtration. Consistent with that conclusion, the Water Agencies' treatment expert projects that:

- Full nutrient removal would increase the local sewer rate for current residential users by an *estimated $9.39 per month or about 30 cents a day*.

- Full nutrient removal and filtration would increase the sewer rate for current residential users by *an estimated $16.13 to $22.18 per month or no more than 75 cents a day*.

For literally pennies a day – less than the cost of a soda or cup of coffee – these essential improvements to protect our freshwater resources can be completed. These costs are in line with the U.S. Environmental Protection Agency's test to determine a locality's economic ability to make this kind of infrastructure investment. Yes, the Sacramento area will eventually pay sewerage rates that are more in line with those being paid in many other nearby service areas. And in return, the Sanitation District's Treatment Plant will be updated to meet modern standards that avoid degradation of the Bay-Delta ecosystem and the largest single source of fresh water supply in California. That is a reasonable result in light of the importance of water to the entire state's economy.

II. Nutrients

The Tentative Order properly finds that the Treatment Plant's discharge of ammonia/ammonium (ammonia/um) and other nutrients adversely impair the beneficial uses of water by the citizens of California. The untreated nutrients discharged every day have degraded the water quality in the Sacramento River and Bay-Delta and are contributing to the decline of aquatic life, including salmon, Delta smelt, and other pelagic species listed under the federal and state Endangered Species Acts.[4]

The Sanitation District will no doubt object to the cost to comply with the law. However, as the Tentative Order recognizes, many municipalities in California have made the investments to remove nutrients to protect the precious water resources of our state. (Tentative Order at K-9, K-10.) For too many years, the Sanitation District has chosen not to make the same investment. It has depended on the natural bacterial action – the natural nitrification and denitrification - of the river as a means to treat some of its sewage, rather than investing in appropriate treatment at the plant. Further delay should not be allowed.

The Water Agencies commend the Regional Board staff for proposing requirements for ammonia/um and nitrate effluent reduction by the Treatment Plant through advanced nitrification/denitrification treatment. We urge the Regional Board to approve the Tentative Order and require the Treatment Plant to install the advanced nutrient removal expeditiously. However, in addition to imposing final effluent limits, interim measures should also be required. The grave impacts associated with the discharges should not be permitted unabated at present levels, let alone at increased levels, until the new treatment is designed and implemented, while the beneficial uses continue to be impaired and the waters continue to be degraded.

A. The Tentative Order Correctly Finds the Discharge of Ammonia/um and Other Nutrients is Adversely Affecting Beneficial Uses.

The Tentative Order documents why the Sanitation District must nitrify and denitrify its wastewater in order to remedy the harmful effects caused by the discharge. Att. F at F-54 – F-

[4] The federal Fish and Wildlife Service (FWS) listed the Delta smelt as a threatened species in 1993 and designated critical habitat for the smelt in 1994. *See* 58 Fed. Reg. 12854 (March 5, 1993); 59 Fed. Reg. 65256 (Dec. 19, 1994). Threatened species are defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1532(20). Endangered species are those which are "in danger of extinction throughout all or a significant portion of its range." 16 U.S.C. § 1532(6).

56. The Regional Board's reasons are well documented by the record, including previous submissions by the Water Agencies. *See* Water Agencies' Comments on Aquatic Life and Wildlife Preservation Issues Concerning the Sacramento Regional Wastewater Treatment Plant NPDES Permit Renewal (June 1, 2010). The data and scientific literature establish that the Treatment Plant's nitrogen load, particularly in the form of ammonia/um is both having direct toxic effects on aquatic species in the Sacramento River and Bay-Delta and altering the aquatic food web—the foundation of the Sacramento River and Bay-Delta ecosystem. Accordingly, following the reasons already documented in the Tentative Order, we provide our comments in support of the determination that the discharge of ammonia/um and other nutrients is adversely affecting beneficial uses of water:

(1) ***The Treatment Plant is a major source of ammonia/um to the Bay-Delta.***

The Tentative Order accurately states that a "consensus of scientific experts concluded the SRWTP is a major source of ammonia/um to the Delta." F-55. This conclusion is not surprising. The Plant currently disposes an estimated *10,000,000 pounds of ammonia/um* into the Sacramento River each year, or about 14 tons per day and this amount has been increasing over time (*See* Figure 1).[5] The Tentative Order correctly cites some of the extensive data supporting this conclusion, including data collected by Regional Board staff and by the San Francisco Regional Board. Att. K at K-5, K-6.

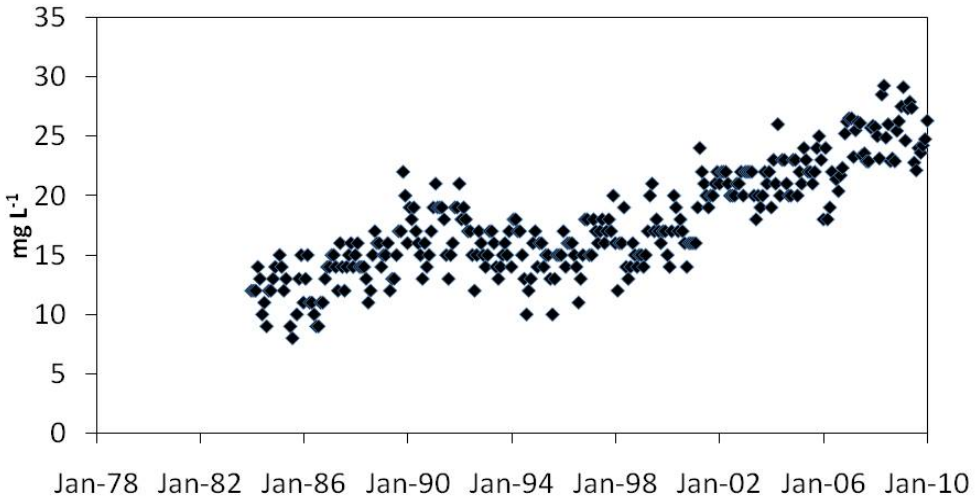

Figure 1 Change in effluent ammonium concentration (mg L^{-1}) over time, based on data reported to the Regional Board. Note that although the Treatment Plant came on line in 1982, data are available from 1984. All data are monthly averages.

[5] 14 tons x 2000 lbs. x 365 day = 10,220,000 lbs./year. That could double to more than **20 million pounds**, if the interim daily limit in the Tentative Order is not reduced and other interim measures are not required, as outlined elsewhere in these comments.

In addition to the studies referenced, additional scientific analyses add further support to the consensus that the Treatment Plant is a significant source of ammonia/um to the Bay-Delta. For example, modeling by Resource Management Associates (2009) indicates that changes in nutrient concentrations due to the Treatment Plant's nutrient discharges can be seen along the Sacramento River corridor to Suisun Bay, as well as at Jersey Point, Potato Point and Georgiana Slough.[6] Dr. Patricia Glibert of the University of Maryland has found that changes in ammonium concentration in the Treatment Plant's effluent are highly correlated with changes in ammonium concentrations in the Sacramento River at Hood and with concentrations in Suisun Bay.[7] Dr. Carol Kendall of the United States Geological Survey determined that nutrients and organic matter downstream of the Treatment Plant are isotopically distinguishable from upstream Sacramento River and Cache Slough tributary nutrients. The differences become even more distinctive further downstream as more ammonium is nitrified; the Treatment Plant's ammonium is distinguishable from other sources of ammonium all the way to Suisun Bay.[8] Mass balance calculations with the available chemical and isotopic data from the Cache Slough tributaries show that the confluence area between the sloughs and the mainstem river at Rio Vista acts mainly as a sink, not a source, of slough-derived nutrients and organic matter to sites downstream of Rio Vista[9]. Parker *et al*., (2010b) were also able to track ammonium from Treatment Plant discharges along the entire Sacramento River transect to Suisun Bay.[10]

(2) ***The ammonia discharge is toxic to copepods and fish and does not meet the most current EPA aquatic life criteria for ammonia.***

The Water Agencies agree with the Tentative Order finding that the 14 tons of ammonia/um discharged every day "has reasonable potential to cause or contribute to an exceedance of the Basin Plan's narrative toxicity objective in the receiving water." Att. F. at F-54. The Tentative Order thus appropriately concludes that the Sanitation District's request to continue to use the River to further treat its discharge must be denied. Att. F. at F-54. The Tentative Order properly prevents the continued impairments to water quality and the beneficial uses of the water.

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[6] Resource Management Associates. 2009. Modeling the fate and transport of ammonia using DSM2-QUAL, Draft final report, October 2009. Prepared for State Water Contractors.

[7] Glibert, P., 2010a. "Long-term changes in nutrient loading and stoichiometry and their relationships with changes in the food web and dominant pelagic fish species in the San Francisco Estuary, California," *Reviews in Fisheries Science.*

[8] Kendall, C., Silva, S.R., Young, M.B., Guerin, M., Kraus, T., and Parker, A., 2010. Stable isotope tracing of nutrient and organic matter sources and biogeochemical cycling in the Sacramento River, Delta, and Northern Bay. U.S. Geological Survey Open-File Report 2010-XX, preliminary draft for colleague review, 52 pages; Kendall, C. 2010a. Causes of seasonal and spatial variation in water chemistry in the Sacramento River, Delta, and Eastern San Francisco Bay and their effects on chlorophyll levels. Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA. September 27-29, 2010.

[9] *Id.*

[10] Parker, A.E., Dugdale, R.C., Wilkerson, F., Marchi , A. 2010b. Biogeochemical Processing of anthropogenic ammonium in the Sacramento River and the northern San Francisco Estuary: consequences for Pelagic Organism Decline species. Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA. September 27-29, 2010.

In support of its findings, the Tentative Order correctly reasons that "[r]ecent studies suggest that ammonia at ambient concentrations in the Sacramento River, Delta and Suisun Bay may be acutely toxic to the native *Pseudodiaptomus forbesi* (copepod)." Att. F at F-54. The Tentative Order supports this important conclusion by referencing studies by Werner, Johnson, and Teh, including Dr. Teh's finding that "ten percent mortality occurred to both invertebrate species at ambient ammonia concentrations present in the river below the SRWTP." Att. K at K-2. Thus, as the Tentative Order also states, "[r]egardless of whether ammonia is directly or indirectly contributing to the [pelagic organism decline], ammonia is shown to affect adult *Pseudodiaptomus forbesi* reproduction at concentrations greater than or equal to 0.79 mg L^{-1}. And nauplii and juvenile *Pseudodiaptomus forbesi* are affected at ammonia concentrations greater than or equal to 0.36 mg L^{-1}. These ammonia concentrations can be found downstream of the discharge. The beneficial use protection extends to all aquatic life and is not limited to pelagic organisms." Att. F at F-55.

The Water Agencies strongly support this analysis. Ammonia/um concentrations above 0.36 mg L^{-1} were measured by the Regional Board all the way to Isleton, *27 miles downstream of the Treatment Plant*. In fact, ammonia/um exceeded 0.36 mg L^{-1} in *44% of the samples* collected at stations between Hood and Isleton on the Sacramento River in 2009-2010.[11] The Tentative Order has correctly noted these toxic impacts are real and provides ample support for the ammonia/um effluent limits and nutrient removal required by the Tentative Order, regardless of the other effects of the discharge.

The Tentative Order also appropriately acknowledges EPA's 2009 Ammonia Criteria Update which relies on current science to define updated ammonia criteria to protect aquatic life. *See* "Draft 2009 Update Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater" in December 2009. Att. F at F-55, Att. K at K-3, K-4. Considering these proposed criteria as part of its evaluation of the actual impact of the Treatment Plant's discharge would be a reasonable application of the Regional Board's authority to protect water quality in this State. Viewing the Treatment Plant's discharge through the lens of these most current criteria, the serious adverse effect on beneficial use of the proposed discharge is clear, as the Treatment Plant's discharge regularly exceeds those criteria. In fact, the EPA draft ammonia criteria would have been exceeded 29% of the time in 2008 at R3 downstream of the Treatment Plant and 16% of the time from January 2007 to April 2010.[12]

Moreover, it is well established that endangered Delta smelt spawn just downstream of the Sanitation District's outfall. As the United States Fish & Wildlife Service noted in its biological opinion regarding the threatened Delta smelt, the Sanitation District's "discharge places it upstream of the confluence of Cache Slough and the mainstem of the Sacramento River, a

[11] Data provided by Chris Foe, Central Valley Regional Water Quality Control Board, collected between March 2009 and February 2010.

[12] These values differ from those provided in the Water Agencies' Comments on Aquatic Life and Wildlife Preservation Issues Concerning the Sacramento Regional Wastewater Treatment Plant NPDES Permit Renewal (June 1, 2010) at 22 because the data provided by the Regional Water Board at the time of the previous comments only included monitoring through 7/22/2008. The calculations in these comments are based on a data file provided by Kathy Harder, Regional Board, entitled "Compilation of SRCSD Effluent and Receiving Water Concentration Data," dated July 13, 2010.

location just upstream of where Delta smelt have been observed to congregate in recent years during the spawning season."[13] This recognized "potential for exposure of a substantial fraction of Delta smelt spawners to elevated ammonia levels" that have repeatedly been found to be toxic, is further support for the conclusions of the Regional Board.[14]

There is substantial additional support documenting the toxic impacts of the Treatment Plant's continuing discharge of ammonia/um on which the Regional Board should rely. For example, Parker *et al*. (2010a) conducted parallel tests with ammonium chloride and the Sanitation District's effluent on primary production and phytoplankton nitrogen uptake.[15] Compared to controls, primary production and ammonium uptake rates were reduced 20 to 36% and phytoplankton nitrate uptake was reduced 80% at effluent ammonium concentrations greater than 8 μmol N L^{-1}, equivalent to a river:effluent dilution greater than 200:1. This dilution rate greatly exceeds actual river:effluent dilutions. According to the Regional Board's "NPDES Permit Renewal Issues: Drinking Water Supply and Public Health" paper dated December 14, 2009, flow ratios nearing 14:1 are not uncommon during dry years under the existing plant capacity. In other words, during dry years, approximately 7% of the river can be effluent.

(3) ***The ammonium and other nutrients from the Treatment Plant are adversely altering the food web that supports aquatic life in the Sacramento River and Bay-Delta***

A significant shift in the pelagic food web has occurred in the Bay-Delta; this has been identified as a significant factor in the well-documented Pelagic Organism Decline (POD). Primary productivity and phytoplankton biomass in the Bay-Delta are among the lowest of all estuaries studied and dropped even lower in the 1980s, and declines in several zooplankton species have followed the chlorophyll ("chl-*a*") declines. Research indicates that Delta-wide chl-*a* levels are now low enough to limit zooplankton abundance[16], and zooplankton are an essential prey item for endangered fish species in the Bay-Delta, including the Delta smelt[17].

The Bay-Delta's algal species composition has shifted from diatoms to flagellates, cryptophytes and cyanobacteria, which are a lower food quality, and to invasive macrophytes such as *Egeria densa*. *See* Water Agencies' June 1 Comments at 13. The shift from diatoms to smaller celled phytoplankton results in a less efficient food web. Cloern and Dufford state, "[s]ize is important

[13] USFWS. 2008. Biological opinion on the proposed coordinated operations of the Central Valley Water Project ("CVP") and the State Water Project ("SWP), December 15, 2008 ("Delta Smelt BiOp") at 245.

[14] *Id.*

[15] Parker, A.E., A.M. Marchi, J.Drexel-Davidson, R.C. Dugdale, and F.P. Wilkerson. 2010a. "Effect of ammonium and wastewater effluent on riverine phytoplankton in the Sacramento River, CA. Final Report to the State Water Resources Control Board.

[16] Müller-Solger, A., A.D. Jassby and D.C. Müller-Navarra. 2002. Nutritional quality of food resources for zooplankton (*Daphnia*) in a tidal freshwater system (Sacramento-San Joaquin River Delta). *Limnol Oceanogr* 47(5):1468-1476.

[17] Sommer. T, C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga and K. Souza. 2007. The Collapse of Pelagic Fishes in the Upper San Francisco Estuary. *Fisheries* 32(6):270-277; Winder, M. and A.D. Jassby. In press. Shifts in zooplankton community structure: Implications for food web processes in the Upper San Francisco Estuary. *Estuaries and Coasts*. DOI 10.1007/s12237-010-9342-x.

because many metazoan consumers, such as calanoid copepods, cannot capture small particles, including the nutritionally-rich nanoflagellates (Fenchel 1988)." [18] Recent studies in the San Francisco Estuary's low salinity zone by Slaughter and Kimmerer (2010) observed lower reproductive rates and lower growth rates of the copepod, *Acartia* sp. in the low salinity zone compared to taxa in other areas of the estuary. They conclude that "[t]he combination of low primary production, and the long and inefficient food web have likely contributed to the declines of pelagic fish."[19] Cloern and Dufford (2005) also state, "[t]he efficiency of energy transfer from phytoplankton to consumers and ultimate production at upper trophic levels vary with algal species composition: diatom-dominated marine upwelling systems sustain 50 times more fish biomass per unit of phytoplankton biomass than cyanobacteria-dominated lakes (Brett & Müller-Navarra 1997)."[20]

In addition to the evidence presented in the Tentative Order, substantial field data have demonstrated the increasing decline of the phytoplankton in the Delta and Suisun Bay. For example, Wilkerson *et al* (2010) categorized three different phytoplankton responses to increasing ammonium concentrations:

- Type I: healthy phytoplankton were able to drawdown all available dissolved inorganic nitrogen and accumulate chlorophyll in 2-3 days;
- Type II: phytoplankton were able to drawdown nutrients, but the chlorophyll accumulation was delayed in time; and
- Type III: phytoplankton were unable to drawdown the nitrate and accumulate chlorophyll by 6 days.[21]

In repeated phytoplankton grow out experiments from Suisun Bay and the River, almost none had healthy Type I responses. Instead, samples from Suisun Bay typically showed Type II responses while samples from the Sacramento River at Rio Vista, where ambient ammonium concentrations are higher, all exhibited Type III responses. In addition, Parker *et al* (2010b) observed predictable and reproducible patterns in phytoplankton rates in response to ammonium concentrations in Sacramento River transects in 2008 and 2009.[22] Increases in nutrient loading and changes in nutrient ratios over time are a primary driver of these observed changes in the food web[23] – and the Treatment Plant's discharge is the principal source of those loadings.[24]

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[18] Cloern, J.E., and R. Dufford. 2005. Phytoplankton community ecology: principles applied in San Francisco Bay. *Mar. Ecol. Prog. Ser.* 285:11-28.

[19] Slaughter, A. and W. Kimmerer. 2010. Abundance, composition, feeding, and reproductive rates of key copepodsspecies in the food-limited Low Salinity Zone of the San Francisco Estuary. Poster Presentation at the 6th Bienniel Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

[20] Cloern and Dufford, 2005, *supra*.

[21] Wilkerson, F., R. Dugdale, A. Marchi, and A. Parker. 2010. "Different response types of phytoplankton to changing nutrient regimes in SF Bay/Delta: Bottom up effects of ammonium and nitrate." Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

[22] Parker *et al*., 2010b, *supra.*

[23] Glibert, 2010a, *supra*; Parker, *et al*., 2010a, *supra*; Parker, *et al*., 2010b, *supra*; Wilkerson, *et al*., 2010, *supra.*

[24] Glibert, 2010a, *supra*; Resource Management Associates, 2009, *supra*; Kendall, 2010, *supra*; Parker *et al*., 2010b, *supra.*

(a) The Treatment Plant is inhibiting nitrogen uptake by diatoms in the Bay-Delta.

The Tentative Order correctly concludes that "recent studies provide evidence that ammonia from the SRWTP discharge is contributing to the inhibition [of] nitrogen uptake by diatoms in Suisun Bay." Att. F at F-55. Inhibiting nitrogen uptake is one of the ways in which the nutrients discharged daily by the Treatment Plant have adversely affected the food web in the Bay-Delta. In support of its conclusion, the Tentative Order relies on peer reviewed articles by Parker *et al* (2010a), Wilkerson *et al* (2006), Dugdale *et al* (2007), and Sommer *et al* (2007). Att. K at K-5, K-6.

The fact that ammonium loading inhibits nitrogen uptake by phytoplankton is a phenomenon long established in the scientific community in research done over many decades and in a variety of systems. Moreover, it continues to be demonstrated in ongoing research, including new data collected in Suisun Bay in the spring of 2010 by the San Francisco Regional Board and by the Dugdale Lab at San Francisco State University's Romberg Tiburon Center.[25]

Accordingly, in addition to the studies referenced in the Tentative Order, the Regional Board should consider and reference the decades of scientific research that confirm that ammonium suppresses algae productivity, a phenomenon which was first observed by researchers as far back as the 1930's.[26] Some of the early field demonstrations were by MacIsaac and Dugdale (1969, 1972),[27] followed by research in the Chesapeake Bay by McCarthy *et al* (1975).[28] Lomas and Glibert (1999a) describe the threshold for inhibiting nitrate uptake at approximately 1 μmol L^{-1} (0.014 mg L^{-1}), many orders of magnitude below the level of the discharge.[29,30]

Ammonium suppression of nitrate uptake when both nutrients are in ample supply should not be confused with the preferential use of ammonium by phytoplankton when nitrogen is limiting. When nitrogen is limiting, phytoplankton will use ammonium preferentially because it requires less energy to use ammonium than nitrate. When both nutrients are in ample supply, the phytoplankton cells must cope with the excess; and in doing so, the phytoplankton metabolism is altered away from an ability to assimilate nitrate and thus their total primary productivity is suppressed. This is particularly problematic for the Bay-Delta as it is already a comparatively

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[25] Marchi, A. 2010. "Spring 2010 phytoplankton blooms in Northern San Francisco Estuary: influences of climate and nutrients." Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA, Sept. 27-29, 2010.

[26] See, e.g., Ludwig, C.A. 1938. The availability of different forms of nitrogen to a green alga (Chlorella) Am.J.Bot. 25:448-458; Harvey, H.W. 1953, Synthesis of Organic Nitrogen and Chlorophyll by Nitzschia Closterium. J. Mar.Biol. Res. Assoc. U.K. 31:477-487

[27] MacIsaac, J.J. and R.C. Dugdale , 1969. The kinetics of nitrate and ammonium uptake by natural populations of marine phytoplankton. Deep-Sea Res. 16:45-67; MacIsaac, J.J. and R.C. Dugdale, 1972. Interactions of light and inorganic nitrogen controlling nitrogen uptake in the sea. Deep-Sea Res. 19:209-232.

[28] McCarthy, J.J., W.R. Taylor and J.L. Taft, 1975. The dynamics of nitrogen and phosphorous cycling in the open water of the Chesapeake Way. In: T.M. Church (ed.) Marine Chemistry in the Coastal Environment. American Chemical Society Symposium Series 18. Washington D.C., pp. 664-681.

[29] Lomas, M.W. and P.M. Glibert. 1999a. Interactions between NH_4 and NO_3 uptake and assimilation: comparison of diatoms and dinoflagellates at several growth temperatures. Marine Biology 133:541-551

[30] The current average discharge concentration is 24 mg L^{-1} NH_4 which equates to 1,713 μmol L^{-1}.

low producing estuary.[31] Laboratory data indicate that Delta-wide chl-*a* levels are now low enough to limit zooplankton abundance.[32]

(4) ***The ammonium discharged by the Treatment Plant is impacting the food web by reducing diatom primary production***

The Tentative Order likewise correctly finds that the ammonium discharge is contributing to reduced diatom production and standing biomass in the Suisun Bay. Att. F at F-55. This conclusion is supported by peer reviewed journal articles by Wilkerson *et al* 2006, Dugdale *et al* 2007, Glibert 2010a, and others, as well as by the sampling and research by the San Francisco Regional Board in 2010.[33] Att. K at K-5, K-6; F-92 *citing* Letter from San Francisco Regional Board, June 4, 2010 ("The ammonia from the SRWTP contributes to the water quality problems in the Suisun Bay."). The Tentative Order estimates, conservatively, that the ammonia/um loadings must be reduced by a factor of as much as 7 to eliminate the contribution from the Treatment Plant. *Id*.

The data confirm that the ammonia/um reduction contemplated by the Tentative Order is necessary to reduce food web impacts. The Tentative Order's estimated reduction in ammonium loading is based on a threshold concentration of 0.056 mg L^{-1} (equivalent to 4µmol L^{-1}). However, ammonium concentrations of as low as 0.014 mg L^{-1} (1µmol L^{-1}) have been found to inhibit phytoplankton nitrate uptake by approximately 60% (Dugdale *et al* 2007). Studies of phytoplankton nitrogen uptake in the Sacramento River conducted in 2008 and 2009 showed values similar to the threshold values described by Dugdale *et al* (2007)[34] for ammonium inhibition of phytoplankton nitrate uptake (Parker *et al* 2010a).[35] Moreover, ammonium concentrations in excess of nitrate inhibition thresholds were consistently encountered at all locations sampled downstream of the Treatment Plant's discharge point by both the Regional Water Board sampling program and transects conducted by the Dugdale Lab at the Romberg Tiburon Center (Foe *et al* 2010 and Parker *et al* 2010a, respectively).[36]

The Tentative Order also acknowledges the recent studies that establish that ammonium in the discharge has reduced the phytoplankton biomass, another essential element in the Bay-Delta food web, as measured by the decline in chlorophyll-*a* concentrations in the River, citing Parker, *et al*. (2010a) and Glibert (2010a). Att. K at K-6. However, the Tentative Order questioned the degree to which plant discharges are causing these observed declines in chlorophyll-*a* levels because of certain data indicating an apparent decline in chlorophyll-*a* upstream of the Treatment

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[31] Jassby, A.D., J.E. Cloern and B.E. Cole. 2002. Annual primary production: Patterns and mechanisms of change in a nutrient-rich tidal ecosystem. *Limnol. Oceanogr.,* 47(3): 698–712.

[32] Müller-Solger, *et al*, 2002, *supra*.

[33] Marchi, 2010, *supra*.

[34] Dugdale, R.C., F. P. Wilkerson, V. E. Hogue and A. Marchi. 2007. The role of ammonium and nitrate in spring bloom development in San Francisco Bay. *Estuarine, Coastal and Shelf Science* 73: 17-29.

[35] Parker ,. 2010a, *supra*.

[36] Foe, Chris, A. Ballard, S. Fong.. 2010. Nutrient concentrations and biological effects in the Sacramento-San Joaquin Delta. Report prepared for the Central Valley Regional Water Quality Control Board; and Parker *et al*. 2010a, *supra*.

Plant. The Tentative Order urges "caution" in concluding the discharge is causing the chlorophyll declines that have been observed downstream of the Plant. Att. K at K-6 ("The cause of the decline is not known, but has been variously attributed to algal settling, toxicity from an unknown chemical in the SRWTP effluent, or from ammonia.").

We respectfully submit that the Treatment Plant is the cause of the rapid declines that have been observed downstream of the discharge, as the Water Agencies described in previous comments to the Regional Board. *See* SLDMWA and SWC Comments on Draft Report Titled, Nutrient Concentrations and Biological Effects in the Sacramento-San Joaquin Delta (June 14, 2010). The dramatic decline in chlorophyll-*a* downstream of the discharge can be explained only by the millions of pounds of ammonium being discharged into the River by the Treatment Plant.

Accordingly, we urge the Regional Board to recognize in Attachment K that although additional work is ongoing, the analyses conducted to date support fully the conclusion that ammonium from the Treatment Plant is the likely cause of chlorophyll declines in the Sacramento River. Closer scrutiny of those data reveals that this apparent upstream decline is likely caused by other factors.

Foremost, the upstream differences between Tower Bridge and Garcia Bend are very small compared to the dramatic and significant changes downstream of the Plant.[37] When the Treatment Plant discharge increases Sacramento River ammonium levels by more than 0.3 mg L^{-1}-N, chlorophyll drops by a factor of one half to three quarters compared to chlorophyll above the Treatment Plant.[38] These kinds of results are compelling evidence of the contribution of the Treatment Plant.

Second, the chlorophyll decline that may be present upstream in the River between Tower Bridge and Garcia Bend may be explained by the incomplete mixing and dilution with high quality American River water. Several pieces of evidence support this, including the fact that salinity at Garcia Bend is lower than salinity at Tower Bridge. The most likely reason salinity would drop from upstream to downstream is that there is dilution from another source of water. The only other major source of water in this area is the American River. There is in fact a strong association between the difference in salinity between Garcia Bend and Tower Bridge and the difference in chlorophyll *a* at these locations.[39] The more that the salinity drops from Tower Bridge to Garcia Bend, the more the chlorophyll *a* drops between these two stations.

Finally, and most importantly, while phytoplankton biomass, as measured by chlorophyll *a*, may be declining above the Treatment Plant, phytoplankton rate processes such as carbon and nitrate uptake remain strong. In contrast, both phytoplankton biomass and rate processes are significantly disrupted in samples downstream of the treatment plant. In other words, phytoplankton are still growing upstream of the plant based on their continued uptake of nitrate and carbon; accordingly, something other than nutrients may be impacting their ability to

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[37] Foe, 2010, *supra*.

[38] *Id.*

[39] *See* SLDMWA and SWC Comments on Draft Report Titled, Nutrient Concentrations and Biological Effects in the Sacramento-San Joaquin Delta at 3 (June 14, 2010) (Figure 2).

accumulate biomass. However, beginning immediately downstream of the treatment plant, primary production and ammonium uptakes rates decline by 20 to 36% and nitrate uptake declines 80%.[40] Analogously, if one were to fertilize their garden daily, a common response would be reduction in production. Whereas some nutrients may stimulate production, adding more and more does not result in a sustained increase in production. The algae downstream of the Treatment Plant are no longer processing nutrients effectively.

(5) ***The nutrient discharge is impacting the food web in the Sacramento River and Bay-Delta by causing a shift in algal communities by changing the nutrient ratios to favor harmful, invasive species.***

The Tentative Order notes in Attachment F that "[d]ownstream of the discharge point, ammonia may be a cause in the shift of the aquatic community from diatoms to smaller phytoplankton species that are less desirable as food species." Att. F at F-55. The Tentative Order references some of the recent research in this area, including that of Dr. Dugdale, Dr. Glibert, and Dr. Lehman (*see* Attachment K at K-6 and K-7). However, while the Tentative Order documents and relies specifically on the toxic effects of ammonia on aquatic life in the River and Bay-Delta, the Tentative Order has not relied substantially on the effects of the discharge on the food web.

The Water Agencies submit that both existing and ongoing research support both the ammonium and nitrate removal required in Tentative Order. We previously detailed much of the data and research to the Regional Board in response to the Board's request for comments earlier this year. *See* Water Agencies' Comments on Aquatic Life, *supra*. Accordingly, we urge the Regional Board to revise Attachment K in the Final Order to document the impacts to the food web as further support for the Tentative Order.

The Treatment Plant's discharge has adversely impacted aquatic life in the River and Bay-Delta by increasing the ratio of nitrogen to phosphorus in the receiving water which triggers the impacts to the food web on which aquatic life depends. These impacts have contributed to the dramatic decline in pelagic organisms, directly impairing the protected beneficial uses of the Bay-Delta waters. The impacts on the food web are due to the fact that the ongoing discharge degrades water quality by changing the ratio between dissolved inorganic nitrogen and phosphorus in the River downstream of the Treatment Plant – the "DIN:DIP" ratio – as well as the Nitrogen (N) to Phosphorus (P) ratio – the ("N:P") ratio. These ratios are known to have profound influences on food webs (Sterner and Elser 2002).[41] Sterner and Elser (2002), state that, "Stoichiometry can either constrain trophic cascades by diminishing the chances of success of key species, or be a critical aspect of spectacular trophic cascades with large shifts in primary producer species and major shifts in ecosystem nutrient cycling." A low ratio is generally considered to cause nitrogen limitation, whereas a high ratio is generally considered to cause phosphorus limitation. When the N:P ratio nears 16:1 on a molar basis, it is recognized as the Redfield ratio, based on the classical observations of Redfield (1934; 1958)[42]. (The Redfield

[40] Parker *et al*. 2010, *supra*.

[41] Sterner, R.W. and J.J. Elser. 2002. Ecological stoichiometry: The biology of elements from molecules to the biosphere. Princeton University Press, Princeton, N.J.

[42] Redfield, A.C. 1934. On the proportions of organic derivatives in sea water and their relation to the composition of plankton. Reprinted from *James Johnstone Memorial Volume*, Liverpool University Press, Liverpool. 176-192;

ratio does not, however, distinguish the importance of different forms of nitrogen, *i.e.*, whether that nitrogen is in the form of ammonium or nitrate.)

Historical data indicate that the N:P ratio of Treatment Plant effluent has increased significantly over time (Figure 2), due to the significant increase in the ammonia/um loading in the discharge, and corresponding declines in phosphorus, most likely because of decreases in phosphates in laundry detergent (Van Nieuwenhuyse 2007, Glibert 2010a).[43] The N:P effluent ratios have been above stoichiometric proportions since the early to mid-1990s, suggesting a tendency towards increasing phosphorus limitation.[44]

Glibert has examined the loadings from the Treatment Plant, the shifting nutrient ratios, and the composition of the base of the food web and found several significant trends.[45] Specifically, Glibert (2010a) reports that there has been a measureable change in the N:P ratio in the Bay-Delta, an increase in total N loading, a decrease in total P loading, and a change in the dominant form of nitrogen from nitrate to ammonium. Glibert found that the variation in these nutrient concentrations and ratios is highly correlated to variations in the nutrient composition of the Treatment Plant's discharges. These nutrient variations are in turn related to variations in the base of the food web, primarily the composition of phytoplankton (Glibert 2010b)[46], to variations in the composition of zooplankton, and to variations in the abundance of several fish species. Thus, changes in Delta smelt and several other fish species' abundance are ultimately related to changes in ammonium load from wastewater discharge in the upper Sacramento River.

Redfield, A.C. 1958. The biological control of chemical factors in the environment. Reprinted from *The American Scientist*. 46(3):205-221.

[43] Van Nieuwenhuyse, E. 2007. Response of summer chlorophyll concentration to reduced total phosphorus concentration in the Rhine River (Netherlands) and the Sacramento-San Joaquin Delta (California, USA). *Can. J. Fish. Aquat. Sci.,* 64:1529-1542; and Glibert, 2010a, *supra*.

[44] *Figure **2*** was created with data reported by Sacramento Regional County Sanitation District in Monthly Discharge Reports to the Regional Board.

[45] Glibert, 2010a, *supra*.

[46] Glibert, P. 2010b. Changes in the quality and quantity of nutrients over time and the relationships with changes in phytoplankton composition. Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010

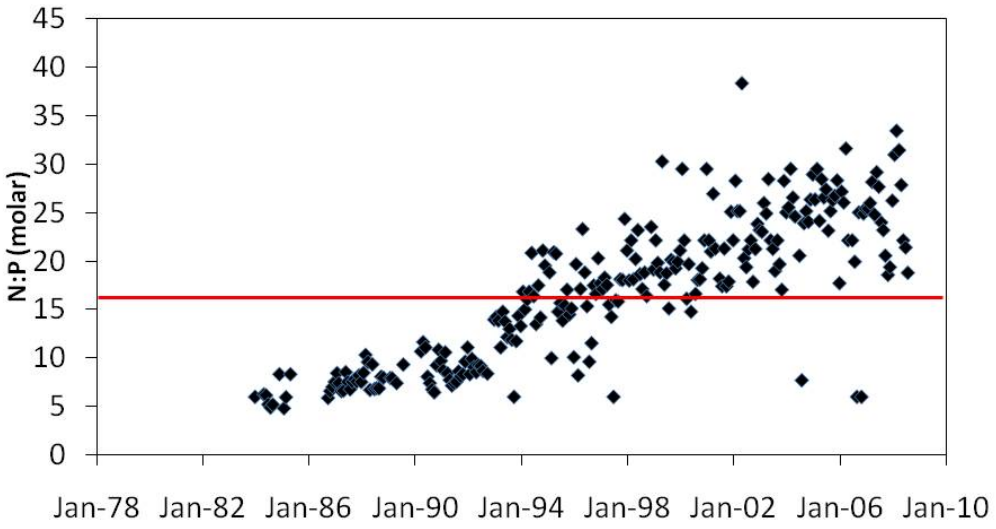

Figure 2 Change in molar ratio of nitrogen to phosphorus in Treatment Plant discharge over time. This ratio is calculated from nitrogen based on TKN and phosphorus from TP, based on data reported to the Regional Board. Note that although the Treatment Plant came on line in 1982, data are available from 1984. All data are monthly averages. The horizontal line is the "Redfield" ratio.

The data also indicate that the algal community that compose the Delta food web has been shifting at the same time that the nutrient ratios have been changing (Glibert 2010a,b).[47] The shift is seen both in the recent increase in annual blooms of *Microcystis,* and in the shift in the algal composition in the Bay-Delta from diatoms that are nutritious to the zooplankton that support the pelagic food web including the threatened Delta smelt,[48] to smaller and lower quality species such as flagellates, cryptophytes and cyanobacteria and to invasive macrophytes such as *Egeria densa*.[49] The shift away from diatoms, which disrupts ecosystem function, is well documented in the literature in general, and in research specifically studying the Bay-Delta

[47] Glibert, 2010a, *supra*; Glibert, 2010b, *supra*.

[48] The Tentative Permit stated that "[d]iatoms are assumed to be more nutritious to primary consumers like zooplankton than flagellates and bluegreen algae." Att. K at K-7. Respectfully, this is much more than an assumption. Numerous studies have found that diatoms support the pelagic food web.

[49] Lehman, P. W. 2000. The influence of climate on phytoplankton community biomass in San Francisco Bay Estuary. *Limnol. Oceanogr*. 45: 580–590; Lehman, P. W., G. Boyer, C. Hall, S. Waller and K. Gehrts. 2005. Distribution and toxicity of a new colonial *Microcystis aeruginosa* bloom in the San Francisco Bay Estuary, California. *Hydrobiologia* 541:87-99; Lehman, P.W., S.J. The, G.L. Boyer, M.L. Nobriga, E. Bass, and C. Hogle. 2010. Initial impacts of *Microcystis aeruginosa* blooms on the aquatic food web in the San Francisco Estuary. *Hydrobiologia* 637:229-248; Jassby *et al*., 2002, *supra*; Glibert, *supra*; Sommer, *et al*, 2007, *supra*; Nobriga, M.L., F. Feyrer, R.D. Baxter, and M. Chotkowski. 2005. Fish community ecology in an altered river delta: spatial patterns in species composition, life history strategies, and biomass. *Estuaries* 28(5):776-785; Jassby, A. 2008. "Phytoplankton in the Upper San Francisco Estuary: recent biomass trends, their causes, and their trophic significance." *San Francisco Estuary and Watershed Science*. 6(1): Article 2, February 2008.

(Kimmerer 2005, Lehman 2000, Glibert 2010a,b, Winder and Jassby (in press), Slaughter and Kimmerer, 2010).[50]

Thus, the species-specific acute and chronic effects of ammonia/um described in the Tentative Order are not the only impacts caused by the Treatment Plant. There is also a more complex shift in communities that occurs when nutrient loading increases and nutrient stoichiometry is altered (Cloern 2001; Sterner and Elser 2002).[51]

The N:P ratio has long been shown to influence phytoplankton composition and the presence – or absence – of native species and vegetation, as extensive studies have repeatedly demonstrated in study after study across a range of systems in North Carolina, Hong Kong, Tunisia, Germany, Florida, Norway, Michigan, Spain, Korea, Japan, Washington DC (Chesapeake Bay), Tampa (Tampa Bay), and Denmark, to name just a few, as well as in the laboratory. Many of these findings are described in more detail below.

Studies have also suggested that the increased N:P ratio altered the native submerged aquatic vegetation in the Bay-Delta (Glibert 2010c).[52] The native vegetation has largely been replaced by invasive submerged and floating vegetation, including the Brazilian waterweed, *Egeria dense*, and the water hyacinth, *Eichhornia crassipes*. Although the water hyacinth was introduced some time ago (Finlayson 1983; Gopal 1987),[53] it has increased in abundance most significantly in recent decades (Finlayson 1983, Toft *et al*. 2003).[54] By the early 1980s, hyacinth covered approximately 500 ha, or about 22% of the waterways, in the Bay Delta (Finlayson 1983).[55] The exact timing of the invasion of the Brazilian waterweed is not well documented, but it too increased significantly during the decades of the 1980s (Jassby and Cloern 2000)[56] and 1990s (Anderson 1999),[57] the period after phosphate removal and the increasing of the N:P ratio. The

[50] Kimmerer, W. 2005. Long-term changes in apparent uptake of silica in the San Francisco Estuary. *Limnology and Oceanography*. 50(3):793-798; Lehman, 2000, *supra*; Glibert, 2010a, *supra*; Glibert, 2010b, *supra*; and Winder and Jassby, In press, *supra*; Slaughter and Kimmerer, 2010, *supra*.

[51] Cloern, J.E., 2001. Our evolving conceptual model of the coastal eutrophication problem. *Mar. Ecol. Prog. Ser.* 210:223-253; and Sterner and Elser, 2002, *supra*.

[52] Glibert, P. 2010c. Nutrients and the food web of the Bay Delta. Oral Presentation to the National Academy of Sciences Committee on Sustainable Water and Environmental Management in the California Bay-Delta, Sacramento, CA. July 13, 2010.

[53] Finlayson, B.J. 1983. Water hyacinth: Threat to the Delta? Outdoor California 44: 10-14; and Gopal, B. 1987. Aquatic plant studies. 1. Water hyacinth. Elsevier Publishing, New York.

[54] *Id*; and Toft, J.D., C.A. Simestad, J.R. Cordekk and L.F. Grimaldo. 2003. The effects of introduced water hyacinth on habitat structure, invertebrate assemblages and fish diets. *Estuaries* 26: 746-758.

[55] Finlayson, 1983, *supra.*

[56] Jassby, A.D. and J.E. Cloern. 2000.Organic matter sources and rehabilitation of the Sacramento-San Joaquin Delta (California, USA). *Aquat. Conser: Mar. Freshw. Ecosyst.*, 10:323-352.

[57] Anderson, L.W.J. 1999. *Egeria* invades the Sacramento-San Joaquin Delta. *Aquatic Nuisance Species Digest*. 3: 37-40

waterweed (*Egeria*), like *Hydrilla*, can reach high biomass levels and is well suited to thrive in a higher N:P environment (Reddy *et al*. 1987, Fiejoo *et al*. 2002).[58]

Invasive vegetation and other species have likewise been observed in other ecosystems that experienced an increase in the N:P ratio, just as in the Bay-Delta (Glibert 2010c).[59] The Potomac River (Chesapeake Bay) was invaded by submerged aquatic vegetation, *Hydrilla* and clams, *Corbicula*, when the N:P ratio of effluent from the large Blue Plains sewage treatment facility increased after phosphorus was reduced in the 1980s (Ruhl and Rybicki 2010)[60]. In the Ebro River estuary in Spain, as well, both *Hydrilla* and *Corbicula* invaded shortly after phosphorus was removed from effluent (Ibanez *et al*. 2008).[61]

Other food web alterations occur in an altered N:P environment. For example, the expansion of species, such as *Microcystis*, which are well adapted to thrive at a wide range of N:P ratios, further disrupts ecosystems, including normal predator-prey interactions. There is a broad scientific literature on the relationship between N:P ratio and *Microcystis.* The scientific literature supports the conclusion that the recent increase in *Microcystis* blooms is likely attributed to shifts in the nutrient ratios and resulting changes in nutrient forms in the Delta. This emerging relationship is complex because the established paradigm is that cyanobacteria increase in lakes when they are enriched with nutrients (e,.g. Paerl 1988, Downing *et al*. 2001).[62] A study by Downing *et al*. (2001), involving data from 99 lakes around the world, showed that total P or N were important predictors of cyanobacteria. Some cyanobacteria, especially those with the capability for nitrogen fixation, do well under low N:P ratios (e.g., Smith 1983, Stahl-Delbanco *et al*. 2003).[63] While there is a plasticity in the ability of cyanobacteria to grow in a wide range of environments, *Microcystis* is able to tolerate elevated N:P levels, and thus its dominance under high N:P may also reflect the decline in other species without such tolerances. Cyanobacteria do not have to grow faster at elevated N:P than at lower N:P values to become abundant, they merely have to grow faster than competing species groups (Glibert 2010a).[64] Glibert (2010a) observed highly significant correlation between ammonium concentration and changes in

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[58] Reddy, K.R., J.C. Tucker, and W.F. Debusk. 1987. The role of *Egeria* in removing nitrogen and phosphorus from nutrient enriched waters. *J. Aquat. Plant Management* 25: 14-19; and Feijoo, C., M.E. Garcia, F. Momo, and J. Tpja. 2002. Nutrient absorption by the submerged macrophyte *Egeria dense* Planch: Effect of ammonium and phosphorus availability in the water column on growth and nutrient uptake. *Limnetica* 21: 93-104.

[59] Glibert, 2010c, *supra*.

[60] Ruhl, H.A. and N.B. Rybicki. 2010. Long-term reductions in anthropogenic nutrients link to improvements in Chesapeake Bay habitat. www.pnas.org/cgi/doi/10.1073/pnas.1003590107.

[61] Ibanez, C., N. Prat, C. Duran, M. Pardos, A. Munne, R. Andreu, N. Caiola, N. Cid, H. Hampel, R. Sanchez, and R. Trobajo. 2008. Changes in dissolved nutrients in the lower Ebro river: Causes and consequences. *Limnetica.* 27(1):131-142.

[62] Paerl, H.W. 1988. Nuisance phytoplankton blooms in coastal, estuarine, and inland waters. *Limnol. Oceanogr*. 33(4, part 2): 823-847; and Downing, J.A., S.B. Watson, and E. McCauley. 2001. Predicting cyanobacterial dominance in lakes. Ca. J. Fish. Aquat. Sci. 58: 1905-1908.

[63] Smith, V.H. 1983. Low nitrogen to phosphorus ratios favor dominance by blue-green algae in lake phytoplankton. *Science* 221: 669-671; and Stahl-Delbanco, A., L.-A. Hansson and M. Gyllstrom. 2003. Recruitment of resting stages may induce blooms of *Microcystis* at low N:P ratios. *J. Plankt. Res*. 25: 1099-1106.

[64] Glibert, 2010a, *supra.*

cyanobacteria occurrence.[65] Based on stable isotope analyses of particulate organic matter and nitrate, Kendall observed that ammonium, not nitrate, is the dominant source of nitrogen utilized by *Microcystis* at the Antioch and Mildred Island sites in the summer 2007 and 2008.[66]

Studies in Korea and Japan, and laboratory experiments have also related increasing N, and increasing N:P ratios, with increasing toxicity of *Microcystis*. In Daechung Reservoir, Korea, researchers found that toxicity was related not only to an increase in N in the water, but to the cellular N content as well (Oh, *et al*. 2001).[67] A very recent report by van de Waal (2010) demonstrated in chemostat experiments that under high CO_2 and high N conditions, microcystin production was enhanced in *Microcystis*.[68] Similar relationships were reported for a field survey of the Hirosawa-no-ike fish pond in Kyoto, Japan, where the strongest correlations with microcystin were high concentrations of NO_3 and NH_4 and the seasonal peaks in *Microcystis* blooms were associated with extremely high N:P ratios (Ha *et al*. 2009).[69] Thus, not only is *Microcystis* abundance enhanced under high N:P, but its toxicity is as well (Oh *et al*. 2001).[70]

Support can also be found in studies of the Neuse River in North Carolina (Paerl 2009).[71] There, as in the Bay-Delta, phosphorus was controlled when phosphates were removed from detergents, but there was no contemporaneous reduction in nitrogen. The estuary ceased to function as an effective filter (e.g. Cloern 2001),[72] resulting in the displacement of nitrogen loads downstream and enhancement of cyanobacterial dominance in the plankton (Paerl *2009*).[73]

Cyanobacteria grow particularly well on ammonium while their competitors, such as the diatoms that are essential to the pelagic food web, do not.[74] Cyanobacteria are able to adapt to high N:P ratios, while diatoms are generally not. In contrast, the literature establishes that diatoms may

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[65] *Id.*

[66] Kendall, C. 2010b. Use of stable isotopes for evaluating environmental conditions associated with *Microcystis* blooms in the Delta. Oral Presentation at the 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

[67] Oh, H-M., S.J. Lee, M-H. Jang and B-D. Yoon. 2000. Microcystin production by *Microcystis aeruginosa* in a phosphorus-limited chemostat. *Appl. Envir. Microbiol*. 66: 176-179.

[68] van de Waal, D.B. , L.Tonk, E. van Donk, H.C.P. Matthijs, P. M. Visser and J. Huisman. 2010. Climate Change And The Impact Of C:N Stoichiometry On Toxin Production By Harmful Cyanobacteria. Oral Presentaton at the 14th International HAB Conference, Greece.

[69] Ha, J.H., T. Hidaka, and H. Tsuno. 2009. Quantification of toxic Microcystis and evaluation of its dominance ratio in blooms using real-time PCR. *Envir. Sci. Technol*. 43: 812-818

[70] Oh *et al.*, 2000, *supra.*

[71] Paerl, H.W. 2009. Controlling Eutrophication along the Freshwater–Marine Continuum: Dual Nutrient (N and P) Reductions are Essential. *Estuaries and Coasts* 32:593–601

[72] Cloern, J.E., 2001. *supra*.

[73] Paerl *2009, supra*.

[74] Glibert, P.M., J. Boyer, C. Heil, C. Madden, B. Sturgis, and C. Wazniak. 2010. Blooms in Lagoons: Different from those of river-dominated estuaries. In: M. Kennish and H. Paerl, eds, *Coastal Lagoons: Critical habitats of environmental change*. Taylor and Francis.

have a nutritional requirement for, and under some circumstances even a preference for, nitrate[75] and diatoms are more often found to be abundant when nutrient ratios are at or near the 16:1 ratio. These relationships are well established from measurements of enzyme activities,[76] directly determined rates of nitrogen uptake using isotope tracers,[77] and growth studies, including Meyer *et al* (2009) who state that ammonia as nitrogen "produces the highest growth and primary production rates for *Microcystis aeruginosa* and other cyanobacteria…"[78]

Scientific literature based on studies in Hong Kong, Tunisia, Germany, and Florida, likewise report on the consequences of shifting the N:P ratio to the low side of the "Redfield" ratio. These studies provide further support for the finding that diatoms are more often found to be abundant when nutrient ratios are at or near the 16:1 "Redfield" ratio and that other species, such as dinoflagellates have an advantage at lower N:P ratios. In the Bay-Delta, flagellates are most abundant at low N:P ratios (Glibert 2010b).[79] In Tolo Harbor, Hong Kong, nutrient loading, particularly phosphorus loading, increased due to population increases in the late 1980's. The result was that a distinct shift from diatoms to dinoflagellates was observed in the harbor, coincident with a decrease in the N:P ratio from roughly 20:1 to <10:1 (Hodgkiss and Ho 1997; Hodgkiss 2001).[80] Once the phosphorous was removed from the sewage effluent that was being discharged into the harbor and stoichiometric proportions were re-established , there was a resurgence of diatoms and a decrease in dinoflagellates.[81] In Tunisian, aquaculture lagoons dinoflagellates have been shown to develop seasonally when N:P ratios decrease (Romdhane, *et*

[75] See, e.g., Lomas and Glibert 1999a, *supra*. Lomas, M.W. and P.M. Glibert. 1999b. Temperature regulation of nitrate uptake: A novel hypothesis about nitrate uptake and reduction in cool-water diatoms. *Limnol Oceanogr* 44:556-572.

[76] Solomon, C. Gallaudet Univ, unpub. data.

[77] See, e.g., Glibert, P., C.A. Heil, D. Hollander, M. Revilla, A. Hoare, J. Alexander, S. Murasko. 2004. "Evidence for dissolved organic nitrogen and phosphorous uptake during a cyanobacterial bloom in Florida Bay." *Mar. Ecol. Prog. Ser.* 280:73-83.

[78] See, e.g., Meyer, J.S., P.J. Mulholland, H.W. Paerl, and A.K. Ward. 2009. "A framework for research addressing the role of ammonia/ammonium in the Sacramento-San Joaquin Delta and the San Francisco Bay Estuary ecosystem." Report to CalFed Science Program; and Berman, T and S. Chava, 1999. "Algal growth on organic compounds as nitrogen sources." *Journal of Plankton Research* 21:1423-1437.

[79] Glibert, 2010b, *supra*.

[80] Hodgkiss, I.J. and K.C. Ho. 1997. Are changes in N:P ratios in coastal waters the key to increased ref tide blooms?. *Hydrobiologia.* 352:141-147: Hodgkiss, I.J. 2001. The N:P ratio revisited. In: K.C. Ho and Z.D. Wang (Eds.), Prevention and Management of Harmful Algal Blooms in the South China Sea. School of Science and Technology, Open University of Hong Kong.

[81] Lam, C. W. Y. and K. C. Ho. 1989. Red tides in Tolo Harbour, Hong Kong, p. 49–52. In T. Okaichi, D. M.Anderson, and T. Nemoto (eds.), Red Tides: Biology, Environmental Science and Toxicology. Elsevier, New York.

al. 1998).[82] Comparable results have been observed in systems in Germany and along the coast of Florida.[83]

Other components of the food web are also affected by changes in N:P ratios (Sterner and Elser 2002).[84] Norwegian studies monitored lakes for many years and found that different zooplankton tend to dominate under different N:P ratios (Hessen 1997), due to the different phosphorus content of different species found in the lake.[85] Hessen (1997), for example, showed that a shift from calanoid copepods to *Daphnia* tracked N:P; calanoid copepods retain proportionately more N, while *Daphnia* are proportionately more P rich. Studies from experimental whole lake ecosystems found that zooplankton size, composition and growth rates changed as the N:P ratio varied (*e.g.*, Schindler 1974, Sterner and Elser 2002).[86]

Altered N:P ratios have also been shown to affect the relationships between piscivores and planktivores in freshwater systems (Sterner and Elser 2002), due to the differing demands for P-requiring bones and skeleton.[87] These differences, in turn, have implications for the ability of different components of the food web to grow on foods that vary in N:P content.[88] Many fish species in the Bay Delta have demonstrated a similarly strong relationship with N:P over time (Glibert 2010a,c).[89]

(6) ***Where implemented in impacted ecosystems, nutrient removal has improved the natural ecosystem and aquatic life.***

Requiring nitrification and denitrification of the Treatment Plant discharge would help restore balance between nitrogen and phosphorus in the discharge. This would not only reduce the ongoing degradation of water quality and impairment of beneficial uses, but would improve the health of the ecosystem and aquatic life in the Sacramento River and Bay-Delta. As the numerous studies cited above demonstrate, it is both the N:P ratios and the form of N that drive the algal community composition which has important effects throughout the food web. Simply nitrifying the ammonia/um and discharging high nitrate loads in its place will not restore the N:P ratios. Total nitrogen loads need to be reduced. Requiring similar nutrient removal on wastewater treatment plants in other ecosystems, such as in the Chesapeake Bay, Tampa Bay, and coastal areas of Denmark, have proven to be effective at reversing the harmful effects of previously undertreated discharges and restoring the native systems.

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[82] Romdhane, M.S., H.C. Eilertsen, O.K.D. Yahia, and Y.N.D. Daly. 1998. Toxic dinoflagellate blooms in Tunisian lagoons: causes and consequences for aquaculture. In: *Harmful Algae* Edited by B.Reguera, J.Blanco, M.L.Fern'andez & T.Wyatt, Xunta de Galicia and Intergovernmental Oceanographic Commission of UNESCO, pp. 80–83.

[83] *See* Water Agencies' Comments on Aquatic Life at 18-19, *supra*.

[84] Sterner and Elser, 2002, *supra*.

[85] Hessen, D.O.. 1997. Stoichiometry in food webs – Lotka revisted. *Oikos* 79: 195-200.

[86] Schindler, D. W. 1974. Eutrophication and Recovery in Experimental Lakes: Implications for Lake Management. *Science*. 184(4139):897-899; and Sterner and Elser, 2002, *supra*.

[87] Sterner and Elser, 2002, *supra*.

[88] Many fish species in the Bay Delta demonstrate a strong relationship with N:P over time (Glibert 2010a, *supra*).

[89] Glibert, 2010a, *supra*; and Glibert, 2010c, *supra*.

For example, nutrient removal at the Blue Plains treatment plant in Washington DC reduced the N:P ratios in the Potomac River and successfully reduced the invasive species, and native vegetation began to re-emerge in the river. Once a nitrification/denitrification system was installed at Blue Plains in the 1990s, with a goal of total N reductions to a maximum of 7.5 mg L^{-1} and an ammonia nitrogen effluent limit (now as low as 4.2 mg L^{-1}), within several years, the abundance of the invasive *Hydrilla* began to decline and the abundance of native grasses increased (Ruhl and Rybicki 2010).[90]

Tampa Bay provides another important example. Eutrophication problems in the Bay were severe in the 1970s, with N loads approximating 24 tons per day, about half of which was due to point source effluent (less than the current Treatment Plant discharge of 14 tons per day) (Greening and Janicki 2006).[91] Full nitrification and denitrification of the discharge was required at the regional treatment plant in the 1980s, and P was also reduced due to other best management practices. The native seagrass increased following nutrient removal, but it took several years.

The Tampa Bay study highlighted several key conclusions:

- It will take time to see improvements in an impacted ecosystem, because there are internal, existing loads of nutrients in sediment reservoirs from historic discharges. These historic loadings can therefore effectively prolong the system's responsiveness to external reductions of total N. This highlights the need to act expeditiously and reduce interim loads, as further discharges will only make restoring the native species of the River and Bay-Delta all the more difficult.
- Initial N reductions must be continually followed by reductions in future loadings if water quality gains are to maintained.
- Continued and frequent monitoring of the system at environmentally relevant detection limits are required to allow managers to assess progress to water quality goals (Greening and Janicki 2006).[92]

Lower nutrient discharges also had positive effects on the coastal waters around the island of Funen, Denmark (Rask *et al*. 1999).[93] Since the mid 1980s, there has been a roughly 50% reduction in the loading of N and P in the region due to point source reductions. Again, native grasses returned and low oxygen problems were reversed.

These examples of successful nutrient removal are not provided to predict with certainty that the ecosystem of the River and Bay-Delta will return to exactly what existed decades before the

[90] Ruhl and Rybicki, 2010, *supra*.

[91] Greening, H. and A.Janicki. 2006. Toward reversal of eutrophic conditions in a subtropical estuary: Water quality and seagrass response to nitrogen loading reductions in Tamp Bay, Florida, USA. *Environ. Mgt.* 38(2):163-178.

[92] *Id.*

[93] Rask, N., S. E. Pedersen, and M. H. Jensen. 1999. Response to lowered nutrient discharges in the coastal waters around the island of Funen, Denmark. *Hydrobiologia* 393: 69–81.

impacts began. Researchers (Duarte *et al*., 2009)[94] have surveyed the literature for systems that have undergone nutrient loading and nutrient reductions and the trajectories of response were complex and varied. They attributed this to "shifting baselines," recognizing that systems have changed due to invasions, extinctions, overfishing, climate change and other factors. Yet, however difficult it may be to predict exactly how an individual system will respond, Duarte *et al*. (2009) concluded that "efforts to reduce nutrient inputs to eutrophied coastal ecosystems have indeed delivered important benefits by either leading to an improved status of coastal ecosystems or preventing damages and risks associated with further eutrophication." (Duarte *et al*. 2009).[95]

(7) ***The Treatment Plant discharge is depleting dissolved oxygen in the Sacramento River and the Bay-Delta.***

The Tentative Order properly finds that the discharge is depleting dissolved oxygen (DO) for 40 miles down the River and into the Bay-Delta. This is a further compelling reason that we urge the Regional Board to adopt full nutrient removal.

As the Tentative Order provides, the Treatment Plant's "effluent contains ammonia and BOD at levels that use all the assimilative capacity for oxygen demanding substances in the Sacramento-San Joaquin Delta. This results in no assimilative capacity for other cities and communities to discharge oxygen demanding constituents, which is needed for them to grow despite the fact that most of these cities and communities are already implementing Best Practical Treatment and Control (BPTC) at their own facilities and SRWTP is not." Att. F. at F-55. The Tentative Order based this analysis on standard calculations relying on the modeling and data provided by the Sanitation District. Att. F at F-91. Based on those calculations, the Tentative Order documents extensive impacts many miles away from the outfall. *E.g.,* F-92 ("Ammonia, along with BOD, from the SRTWP reduces the dissolved oxygen ("DO") in the Sacramento River and Sacramento-San Joaquin Delta for nearly 40 miles below its discharge").

Additional data in the record before the Regional Board that were gathered by other state agencies confirm the Tentative Order's conclusion that the current discharge is contributing to depressed DO levels downstream of the Treatment Plant. The Department of Water Resources (DWR) observed several periods in 2008 and again in 2009 when DO levels were below the Basin Plan's established objective of 7 mg L^{-1} at Hood.[96] The Sanitation District claims that

[94] Duarte, C.M., D.J. Conley, J. Carstensen, and M. Sánchez-Camacho. 2009. Return to Neverland: Shifting Baselines Affect Eutrophication Restoration Targets. *Estuaries and Coasts*. 32:29–36.

[95] *Id.*

[96] DWR monitoring data, 2008-2009, attached to, Department of Water Resources Office Memo from Sal Batmanghilich, Chief Real-time Monitoring Section to Kathleen Harder, Central Water Quality Control Board re Hood water quality station Dissolved Oxygen QA/QC data. July 22, 2010.

these measured data are erroneous,[97] but DWR reviewed their data and found no problems during the periods in question.[98]

Moreover, that the daily discharge of thousands of pounds of untreated ammonia/um would deplete DO in the receiving waters is both standard chemistry and well established by observed data. Findings made by federal regulators in evaluating impacts to the salmon similarly concluded the increase in ammonia concentrations in the wastewater disposed of by the City of Stockton depressed DO levels causing impacts to aquatic life. In its Biological Opinion on salmon, NOAA's National Marine Fisheries Service found that "increased ammonia concentrations in the discharges from the City of Stockton Waste Water Treatment Facility lowers the [dissolved oxygen] in the adjacent [deep water ship channel] near the West Complex. In addition to the negative effects of the lowered DO on salmonid physiology, ammonia is in itself toxic to salmonids at low concentrations."[4] Davis *et al.* (1963) found that progressively lower DO concentrations below saturation had increasingly negative impact on juvenile salmonid swimming speed.[99] Impaired swimming ability impairs the ability of salmon to successfully feed, migrate, and avoid predation (Cramer, 2010).[100]

Moreover, the record before the Regional Board demonstrates the DO assessment proffered by the Sanitation District is not reliable. The Sanitation District uses a proprietary model in the Low Dissolved Oxygen Prevention Assessment ("LDOPA") to predict future DO concentrations and to identify various management options that could be pursued to maintain compliance with the DO objective. However, questionable methodologies used in model calibration and validation do not lend confidence to the Sanitation District's analysis. As the independent Tetra Tech reviewers of the model concluded:

> …no statistical analysis of the model fit is provided and the crowded multi-year plots tend to hide relatively large discrepancies between individual measurements and predictions that are often on the order of 2 mg L^{-1} or more.[101]

And:

> The modeling framework …seems to have been driven more by the desire to do a Monte Carlo statistical analysis across the range of upstream flows and effluent

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[97] Larry Walker Associates. 2009. Low dissolved oxygen prevention assessment- Administrative Draft. Prepared for Sacramento Regional County Sanitation District, p. __.

[98] Department of Water Resources Office Memo from Sal Batmanghilich, Chief Real-time Monitoring Section to Kathleen Harder, Central Valley Regional Water Quality Control Board re ood water quality station Dissolved Oxygen QA/QC data. July 22, 2010.

[99] NOAA Fisheries. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, June 4, 2009 at page 157.

[100] Cramer, Steve, Gaskill, Phil, and Vaughn, Jason. 2010. Impact of Sacramento Regional Wastewater Treatment Plant Effluent Discharges on Salmonids.

[101] Tetra Tech Memorandum, to Diana Messina, Central Valley Regional Water Quality Control Board, from Jonathan Butcher, Ph.D., P.H., Re: Sacramento Regional LDOPA, June 29, 2010, p. 6.

> loads…than by an intent to accurately simulate DO in the lower Sacramento River.[102]

And:

> The 7 mg L^{-1} target is written as an instantaneous criterion. The LDOPA modeling, however, produces only daily average DO concentrations and is calibrated only at the daily average scale. This is an inevitable result of the approach to model development, which ignores tidal reversals, works with daily average travel times, and does not consider diurnal algal growth and respiration cycles. As such, the modeling cannot represent the intra-day variability in DO concentrations, and cannot assess the maximum intra-day DO depression that will occur during tidal reversals and near-reversal stagnation events when reaeration declines.[103]

With these uncertainties, the Sanitation District's modeling is unreliable and cannot be used as a predictive tool to determine either the magnitude or frequency of future violations of the Basin Plan. The Tetra Tech reviewers ultimately concluded that, "As presently formulated, the LDOPA does not ensure attainment of the water quality objective specified in the Basin Plan."[104]

DO levels already drop below the water quality standard in the Basin Plan, thereby indicating that protected beneficial uses, which are ESA listed species, are impaired, and the Sanitation District's model underestimates potential future impacts; these facts weigh heavily in favor of the proposed nutrient removal. Further, as the Tentative Order documents, many other cities and communities have already invested in advanced treatment to address nutrients. The Sanitation District, by far the largest contributor of ammonia/um and other nutrients, should likewise help protect the beneficial uses of water and invest in advanced nutrient removal.

(8) ***The ammonia/um in the discharge when disinfected by the Sanitation District generates harmful nitrosamines in the Treatment Plant effluent .***

The formation of nitrosamines when the ammonia/um in the discharge is disinfected is further support for full nutrient removal. As the Tentative Order correctly identifies, N-nitrosodimethylamine (NDMA) is a "highly mutagenic and potentially carcinogenic" (see Att. F-92) constituent of concern in the Sanitation District's discharge. NDMA in wastewater treatment plant discharges may also be toxic to some aquatic organisms.[105] NDMA is part of a family of organic chemicals called nitrosamines which can be formed as a disinfection byproduct during wastewater treatment. As noted in Att. F-92, ammonia/um in the Sanitation District's effluent combined with chlorine disinfection can react and form nitrosamines within the Treatment Plant.

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[102] Id at p. 4.

[103] Id. at p. 7.

[104] Id. at p. 2.

[105] Mizgireuv, I. V.; Majorova, I. G.; Gorodinskaya, V. M.; Khudoley, V. V.; Revskoy, S. Y. 2004. Carcinogenic effect of N-nitrosodimethylamine on diploid and triploid zebrafish (*Danio rerio*). *Toxicol.Pathol. 32* (5), 514–518. It is anticipated that NDMA, or a broader class of nitrosamines, may likely be the next disinfection byproduct(s) regulated by the U. S. Environmental Protection Agency.

Chlorination of secondary wastewater effluent typically results in the formation of NDMA between 20 ng/L and 100 ng/L.[106] Att. F-62 indicates that a maximum effluent concentration of 82 ng/L was observed at the Treatment Plant in October 2008. NDMA can also often be present in raw sewage before wastewater treatment. Because the generation of these harmful byproducts by the Treatment Plant can be caused by the ammonia/um in the discharge, that is a further reason to remove the ammonia/um from the discharge.

(9) ***Nitrosamine precursors found in the Sanitation District's effluent can form nitrosamines at downstream drinking water treatment plants***

Nitrosamine precursors, also present in the Sanitation District's effluent, would also be addressed by nutrient removal. Nitrosamine precursors are an additional concern to water utilities as they can react with chloramines during disinfection at drinking water treatment plants and form NDMA and other nitrosamines. Studies indicate that most treated wastewater contains NDMA precursors. One study surveyed 11 drinking water treatment plants in the U.S. and showed that the occurrence of NDMA precursors in water supplies impacted by wastewater effluent is much greater than in other drinking water supplies.[107] MWDSC and DWR completed a two-year study in April 2010 of the sources and occurrence of NDMA, other nitrosamines, and their precursors in the Delta. A report is expected to be completed in late 2010, but results indicate that NDMA formation potential (a measure of NDMA precursors) downstream of the Sanitation District's discharge is 3 to 4 times higher than upstream of the Treatment Plant.[108] Another study compared different treatment processes for the control of NDMA precursors.[109] Results from this peer reviewed study indicate that nitrification/denitrification can significantly reduce NDMA precursors and dissolved organic nitrogen in wastewater effluent, further supporting the proposal in the Tentative Order to add nutrient removal to their treatment processes.

(10) ***Nitrogen discharge is creating nuisance algal growth and increasing total organic carbon (TOC) load for drinking water treatment plants.***

In contrast with the situation in the Bay-Delta, when this nutrient rich water is exported to State Water Project (SWP) and Central Valley Project (CVP) facilities, most of the ammonium-nitrogen has been transformed to nitrate-nitrogen. Without the inhibitory effect of ammonium that occurs in the Sacramento River and Bay-Delta, the high loads of available nitrogen produce nuisance algal and aquatic weed growth and impair drinking water beneficial uses. There is already significant evidence of nutrient-related adverse impacts from water conveyed through the Bay-Delta to support the Final Order requirement to reduce both ammonia/um and nitrate loads

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[106] Mitch, W.A. and Sedlak, D.L. 2002. "Factors Controlling Nitrosamine Formation during Wastewater Chlorination," *Water Science & Technology*. 2(3): 191-198.

[107] Krasner, S.W. *et al*. 2007 "Wastewater and Algal Derived N-DBPs" Oral Presentation at the American Water Works Association's Annual Conference, Toronto, Canada.

108 DiGiorgio, C.L. *et al*., "Investigation into the Sources of Nitrosamines and their Precursors in the Sacramento-San Joaquin Delta, California. California Department of Water Resources and Metropolitan Water District of Southern California. Poster developed for 2009 Gordon Research Conference.

109 Krasner, S.W. *et al*. 2006. Impact of Wastewater Treatment Processes on Organic Carbon, Organic Nitrogen, and DBP Precursors in Effluent Organic Matter. Oral Presentation at the American Water Works Association's Water Quality Technical Conference, Denver, CO.

and concentrations in the Treatment Plant discharge. *See* Water Agencies' letter to Pamela Creedon regarding Drinking Water Quality Issues and Requested Permit Conditions for the Sacramento Regional Wastewater Treatment Plant NPDES Permit Renewal, dated December 10, 2007 for more detailed documentation of impacts.[110]

In addition to ammonium inhibition, light limitation is often cited as a reason for the Bay-Delta's high nutrient, low productivity state.[111] However, at the elevated N:P concentrations that now exist in the system, and with the dominance of small-sized algal cells, compared to the larger cells of past decades, light limitation should no longer be the concern it once was. Neither ammonium inhibition nor light limitation exists in many of the shallow, clear SWP conveyance facilities and downstream reservoirs. DWR and SWP water agencies often treat their facilities multiple times each summer to reduce nuisance algal growth. Given the increasing environmental concerns about the use of copper-based algaecides, it is likely that effective control will become increasingly more difficult and reduce the ability of downstream users to manage algae-related problems in the future.

Managing algal blooms through the application of copper sulfate and other aquatic herbicides to reservoirs and conveyance facilities creates other problems. For example, spikes in taste and odor ("T&O") compounds often occur after the application of copper sulfate due to the large mass of decaying algae and release of off-flavor compounds from within their cells. Large masses of decaying algae resulting from copper sulfate treatments can also impact water treatment plant operations, especially during the first couple events of the year. Water that is treated with copper sulfate also limits the ability of water agencies to use the water for groundwater replenishment, which is a significant operational constraint.

Algal cell death can have more serious consequences as well, since algal toxins can be released. As noted above, Microcystin is an algal hepatotoxin that EPA is currently evaluating for regulation under federal law and for which EPA and others have issued warnings of potential health problems to humans. In addition to producing toxins, dying algal cells settle to the bottom of a reservoir and exert an oxygen demand on the water. This oxygen demand results in a decline in dissolved oxygen (DO) within the hypolimnion that can be detrimental to benthic and other aquatic organisms. If DO levels fall too low, the water can become septic and hydrogen sulfide can be produced. Hydrogen sulfide is toxic to aquatic organisms, can increase oxidant chemical demand in the water treatment process and associated formation of disinfection by-products, and can also exacerbate T&O problems.

Treating T&O compounds at the treatment plant creates other risks. Several water agencies use ozone as a primary disinfectant at their treatment facilities, which, together with granular activated carbon filter media or hydrogen peroxide, oxidizes and removes most T&O forming compounds. However, Delta water is influenced by the salty waters of the Bay and therefore contains bromide, which is oxidized by ozone to form bromate. Bromate is a regulated

[110] The Water Agencies request that their December 2007 letter and supporting literature and data be considered resubmitted as part of these further comments on the Tentative Permit.

[111] Cloern, J.E. 1999. The relative importance of light and nutrient limitation of phytoplankton growth: a simple index of coastal ecosystem sensitivity to nutrient enrichment. *Aquatic Ecology*. 33:3-16; and Jassby *et al.* 2002, *supra.*

disinfection by-product and a known human carcinogen. When higher ozone dosages are required to counteract the added demand of increased organic carbon loading, bromate formation is increased (Najm and Krasner, 1995)[112] and may jeopardize compliance with regulatory limits.

(11) *The Treatment Plant discharge also violates federal regulations by using the Sacramento River to assimilate the ammonia/um waste*

Requiring nutrient removal at the Treatment Plant is also required by federal regulation. Federal Clean Water Act regulations require that "In no case shall a State adopt waste transport or waste assimilation as a designated use for any waters of the United States." 40 C.F.R. § 131.10. A consensus of scientific experts conclude from the observed pattern of ammonium and nitrate in the Sacramento River downstream from the Treatment Plant that nitrification of discharged ammonium is occurring within the river, *i.e*. the oxidation of ammonium to nitrate.[113] This processing of ammonia/um should be carried out within wastewater treatment facilities using full nitrification/denitrification treatment as contemplated by the Tentative Order. Currently, the Sanitation District is using the Sacramento River as an adjunct to its Treatment Plant. Instead of carrying out nitrification under the supervision and control of trained treatment plant operators, the Treatment Plant is relying on the river for this step of their treatment process. That is flatly contrary to law.

B. The Interim Ammonia/um Limits in the Tentative Order are Inappropriate for Protection of Aquatic Life

Currently, the Tentative Order proposes interim limits that would allow a very significant increase in both the ammonia/um concentration and the total ammonia/um loading to the Sacramento River and Bay-Delta ecosystem over the next ten years. Yet, as the Tentative Order states, and as the comments provided here further support, the data gathered and studies done in recent years have established that *current* levels of ammonia/um are causing direct toxic effects and other adverse impacts that degrade water quality and impair beneficial uses of water in violation of state and federal requirements. Moreover, the Tentative Order finds that *current* levels of the discharger's "effluent contains ammonia and BOD at levels that use all the assimilative capacity for oxygen demanding substances in the Sacramento-San Joaquin Delta." Att. F at F-55, Att. K at K-9. If *current* levels are causing those impacts, then it is beyond the Regional Board's power under federal and state law to allow the Sanitation District a decade of *increased* discharge of its ammonia/um effluent into the Sacramento River and Bay-Delta. State and federal law require the Regional Board to protect the beneficial uses and prevent degradation of these waters. The law therefore leaves the Regional Board no room to issue a permit to the Treatment Plant that would allow the Plant to continue operating at *current* levels, let alone at *increased* levels, and to continue to degrade these resources.

As such, the Water Agencies respectfully urge the Regional Board to reject the proposed interim limit or any proposed interim limit that would allow the Treatment Plant to increase its discharge of ammonia/um. Accordingly:

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[112] Najm, I. N. and S. W. Krasner, 1995. Effects of bromide and NOM on by-product formation. Jour. AWWA, 87:106-115.

[113] Foe *et al*, 2010, *supra;* Kendall, 2010a, *supra*; Parker *et al*, 2010a, 2010b, *supra*.

1. **The dramatic increase in ammonia/um concentration and ammonia/um loadings above current levels that are proposed in the Tentative Order must not be adopted.** The Tentative Order sets an interim daily limit of 45 mg L^{-1} and a mass limit of almost 68,000 pounds per day. That daily mass limit – which equates to almost 34 tons per day – would allow the Discharger *more than double* its current discharge, which is generally in the range of 14 tons per day. As described in the Tentative Order and as amplified by the Water Agencies in these comments, the *current* ammonia/um discharges are causing significant adverse affects to beneficial uses and aquatic life, including protected endangered species. It would be unconscionable – and contrary to federal and state law – for the Regional Board to allow 10 years of twice the discharge which could result in up to 250,000,000 more pounds of nutrients to be dumped into the River. This will exacerbate the N:P deviation from stoichiometric balance and will continue to threaten food web functioning.

2. **The Discharger can now certainly meet a lower daily ammonia/um concentration limit than the daily limit proposed in the Tentative Order**. The Tentative Order has set an interim limit for ammonia/um based on the *maximum* concentration measured on *one single* day out of nearly 1,000 measurements over the last 9 years. The discharger's own data and any reasonable application of the requirement to protect water resources and prevent degradation of those resources therefore confirm that the proposed daily maximum ammonia concentration is not a reasonable limit. The daily average over the same time period is 23 mg L^{-1}. At a minimum, the Regional Board must set an initial daily maximum ammonia level that does not increase the current discharge.

3. **The Final Order should include weekly and monthly average mass loading and concentration limits for ammonia/um.** It is common for dischargers like the Sanitation District to not only have a daily effluent concentration limit, but to also have either a weekly and/or 30-day average discharge limit. That affords some flexibility to the discharger in the event that an issue arises that causes an unforeseen change in the discharge, but ensures that overall, the system is operated efficiently to ensure maximum possible reductions. The mean monthly average over the last 9 years is 22 mg L^{-1}. The Regional Board should set a monthly concentration that is as protective as possible for the River and the Bay-Delta, but in all events the monthly concentration limit should not exceed the historic average.

4. **The Final Order should also specifically include daily, weekly and monthly mass loading and concentration limits for total nitrogen.** Currently, the Tentative Order only sets interim daily limits on ammonia/um. A mass loading limit on *total nitrogen* should be established to prevent further degradation of the N:P ratio in the effluent and thereby reduce the ongoing harm from the discharge.

5. **The Final Order should include sufficient monitoring of all ammonia/um and nitrogen limits.** Sufficient daily monitoring should be required to determine whether the Treatment Plant is in compliance with the ammonia/um and nitrogen loadings and concentration limits. Further, the monitoring should be representative of the discharge, which can vary at different times during the day.

6. **The Final Order should set interim concentration and mass limits as quickly as possible that reflect the ongoing harm being caused by the toxic discharge by the Treatment Plant.** With the ongoing effects of the *current* discharge, the Regional Board should impose interim limits that are the lowest feasible limits for ammonia/um and nitrogen. In no respect should the Treatment Plant be permitted to increase its mass total ammonia/um and nitrogen loadings beyond the current monthly average discharge. The City and its environs that contribute sewage to this Treatment Plant must take the steps required to meet that restriction or face penalties under the law. As Bruce Wolfe of the San Francisco Bay Regional Water Board wrote to the Central Valley Regional Water Board on June 4, 2010: "Due to the potential effect of SRWTP's current discharge on primary production in the northern estuary, and the fact that the discharge is to a drinking water source, we believe that ***all reasonable and feasible measures should be taken to reduce ammonia loads as quickly as possible***. At the discharge's current level of treatment, we are also concerned about its loadings of copper, pyrethroids and CECs to the estuary."[114]

7. **The Regional Board should issue a Cease and Desist Order that includes firm requirements for developing a plan of interim measures and an expeditious schedule for implementing the measures**. To enhance the ability of the Regional Board to ensure compliance with interim measures, contemporaneous with issuing this Final Order, the Regional Board should issue a Cease and Desist Order and require the Treatment Plant to submit a plan within 60 days that would propose Interim Measures to reduce the mass of total ammonia/um and nitrogen loadings in the effluent until the full nitrification and denitrification are completed. As discussed further below, there are a range of options that the Sanitation District could undertake, including sidestream treatment (that could achieve as much as a 30% reduction) and expanded recycling programs.[115] Given the public water quality resources at stake, the Interim Measures plan should be made available to the public for comment. That will ensure all stakeholders will have an opportunity to present their views on the development of these critical measures.

C. The ammonia/um and nitrate removal alternatives presented in the Tentative NPDES Permitting Options document should not be adopted.

(1) *The ammonia/um removal alternatives to full nitrification in the Tentative NPDES Permitting Options should not be adopted in the Final Order*

The ammonia/um limits presented for the dilution and ammonia removal alternatives (Ammonia Removal Alternative 1 and Alternative 2) in Table 3 of the Tentative NPDES Permitting Options document are not protective of aquatic life beneficial uses in the Sacramento River and Bay-Delta and should not be adopted. As outlined above, the literature establishes the impacts to

[114] California Regional Water Quality Control Board – San Francisco Region. 2010, June 4. Letter from Bruce H. Wolfe to Ms. Kathy Harder at Central Valley Regional Water Quality Control Board re Comments on "Issue Paper – Aquatic life and Wildlife preservation issues – proposed NPDES permit renewal for the Sacramento Regional County Sanitation District Sacramento Regional Wastewater Treatment Plant." (emphasis added)

[115] Trussell Technologies, Inc. 2010b. Letter to Adam Kear, Metropolitan Water District, "Summary of Preliminary Findings in Response to the Tentative SRCSD NPDES Permit," October 1, 2010.

water quality and beneficial uses of continuing the Treatment Plant discharge at current levels. Modeling done by Dr. Dugdale and his colleagues confirms that the alternative permitting options – as well as the proposal to *increase* the discharge during an interim period – would not adequately protect beneficial uses of the water. The modeling finds:

- At the proposed increased interim discharge rate of 47 mg L^{-1} and the proposed alternative permit level of 13 mg L^{-1}, the ammonium loadings at those concentrations would inhibit phytoplankton nitrate uptake and prevent phytoplankton blooms. In contrast, at expected River flow rates, the nutrient removal and reduced discharge concentration of 2.2. mg L^{-1} would allow nitrate uptake by phytoplankton in Suisun Bay, encouraging phytoplankton blooms.

- Further, even assuming dilution were an appropriate solution, the modeling shows there is insufficient River flow to dilute the ammonium down from the higher concentrations of 47 mg L^{-1} or 13 mg L^{-1}, and still protect the phytoplankton. Indeed, even if the requisite flows could be achieved, the modeling establishes the flow rates would be so high that it would "washout" the phytoplankton and prevent the blooms.

Dugdale *et al*. (2010)[116] determined three criteria that must be met in order for primary productivity to be unimpaired by ammonium. First, ammonium concentration must be below the level that inhibits phytoplankton from assimilating nitrate (**Inhibition Criterion**: 4 μmol L^{-1}**).**[117] Second, ammonium loading to Suisun Bay must be less than what phytoplankton are able to assimilate otherwise the ammonium concentration will continue to increase (**Loading Criterion**: 0.49 mmol m^{-2} d^{-1}) for Suisun Bay.[118] And, third, the basin exchange rate must be less than the phytoplankton growth rate otherwise the phytoplankton will be washed out of the system before they can accumulate (**Washout Criterion**: 42,000 cfs).[119]

Using the model developed by Dugdale *et al*. (2010) at San Francisco State University's Romberg Tiburon Center,[120] the amount of flow in the Sacramento River that would be needed to dilute ammonia/um from the Treatment Plant to non-inhibitory levels in the Sacramento River and in Suisun Bay for each of the maximum daily effluent limits (MDELs) in the ammonia and dilution alternatives was calculated.

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[116] Dugdale, R., A. Parker, A. Marchi, and F. Wilkerson. 2010. "Criteria for the occurrence of spring blooms in Suisun Bay." Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

[117] Wilkerson, F.P, R.C. Dugdale, V.E. Hogue and A. Marchi. 2006. Phytoplankton blooms and nitrogen productivity in San Francisco Bay. *Estuaries and Coasts* 29(3): 401–416; and Dugdale, *et al,* 2007, *supra*.

[118] Based on data from Wilkerson *et al*. 2006,*supra*, a value of 0.49 mmol m^{-2} d^{-1} was determined to be the maximum ammonium loading to Suisun Bay that will not overwhelm the ability of the phytoplankton to assimilate and control the ammonium environment of the Bay and prevent the reduction of ammonium concentrations to bloom forming levels (i.e. <4μmol L^{-1}).

[119] The washout point occurs when the river flow divided by the volume of the basin (the dilution rate) exceeds the phytoplankton growth rate (vNH_4 = 0.1 d^{-1}, the mean vNH4 for Suisun Bay phytoplankton from Wilkerson *et al*., 2006, *supra*.

[120] Dugdale, *et al*., 2010, *supra.*

According to the Tentative Order, the typical flows in the Sacramento River range from 10,000-70,000 cfs with 10% probability of flows greater than 70,000 and 10% ≤10,000 cfs. *See* Att. F at F-32 and Table F-10. To evaluate whether this modeling approach gave reasonable estimates of river ammonium concentration, the calculated (modeled) concentrations for certain flow rates were compared with observed data collected during 2008. As summarized in Table 1, the comparison showed good agreement between observed data and modeled results, indicating the model was a useful tool to evaluate the proposed permitting options.

Table 1. Observed (at Hood) and modeled (at the diffuser) surface ammonium (NH4) concentrations based upon current effluent concentration of 24 mg L-1 (the current average concentration) and current discharge rate of 140 MGD.

Date	Observed		Modeled
	Flow, cfs	NH_4, µmol L^{-1}	NH_4, µmol L^{-1}
7/21/2008	13000	25.07	28.3
11/12/2008	10530	47.37	36.8
3/9/2008	30337	10.06	12.3
4/6/2008	12035	21.00	30.7
5/8/2008	25900	9.60	14.2

Source: Observed data from Parker *et al* (2010a), Modeled concentrations from calculations represented in the 24 mg L^{-1} curve in Figure 3.

Based on this model, in the Sacramento River at the diffuser, the river flow necessary to meet the Inhibition Criterion is 11,000 cfs or greater if the effluent concentration is 2.2 mg L^{-1} ammonium and 65,000 cfs for 13 mg L^{-1} ammonium (Table 2). The Criterion cannot be met with flows up to the maximum of 70,000 cfs if the effluent ammonium concentration is 47 mg L^{-1}. To meet the Inhibition Criterion in Suisun Bay, flows greater than 3,000 and 16,000 cfs are needed if effluent ammonium concentrations are 2.2 and 13 mg L^{-1}, respectively. At an effluent ammonium concentration of 47 mg L^{-1}, the flow required is significantly higher than 70,000 cfs. Table 2 also shows the ammonium loads that would occur at the three effluent concentrations provided in Table 3 of the Tentative NPDES Permitting Options, assuming a discharge rate of 181 MGD. The Loading Criterion can only be met when the effluent MDEL is set at 2.2 mg L^{-1}

The Washout Criterion is shown in Figure 3 along with the flows needed to meet the Inhibition Criterion in Suisun Bay. As the effluent ammonium concentrations (MDELs) increase, the window where the Inhibition Criterion is met with dilution flows, but washout has not occurred shrinks. At an effluent concentration of 13 mg L^{-1} flows need to be greater than 16,000 cfs and less than 42,000 cfs to allow bloom formation in Suisun Bay. At an effluent concentration of 47 mg L^{-1}, washout occurs before ammonium can be diluted below inhibitory levels. Of the three alternative permitting options included in the Tentative Order, only the effluent limit of 2.2 mg L^{-1} can meet all the criteria needed for bloom formation in Suisun Bay to not be inhibited by ammonium.

Table 2 Criteria needed for primary productivity to be unimpaired by ammonium in the Sacramento River (at the diffuser) and in Suisun Bay. Any bold in a row indicates that the criteria are not met and productivity will be impaired by ammonium at the corresponding MDEL.

	Inhibition Criterion: Flow needs to be <70,000 cfs		**Loading Criterion: Load needs to be <0.49 mmol m^{-2} d^{-1}**	**Washout Criterion: Dilution flow needs to be <42,000 cfs**
Effluent NH_4 MDEL (mg L^{-1})	Dilution flow needed to get 4 µM at Diffuser (cfs)	Dilution flow needed to get 4 µM at Suisun Bay (cfs)	Loading of NH_4 to Suisun Bay (mmol m^{-2} d^{-1})	Dilution flow to get 4 µM is less than 42,000 cfs washout flow Diffuser/Suisun
2.2	>11,000	>3,000	0.16	Yes/Yes
13	>65,000	>16,000	**0.94**	**No**/Yes
47	**>> 70,000**	**>>70,000**	**3.38**	**No/No**

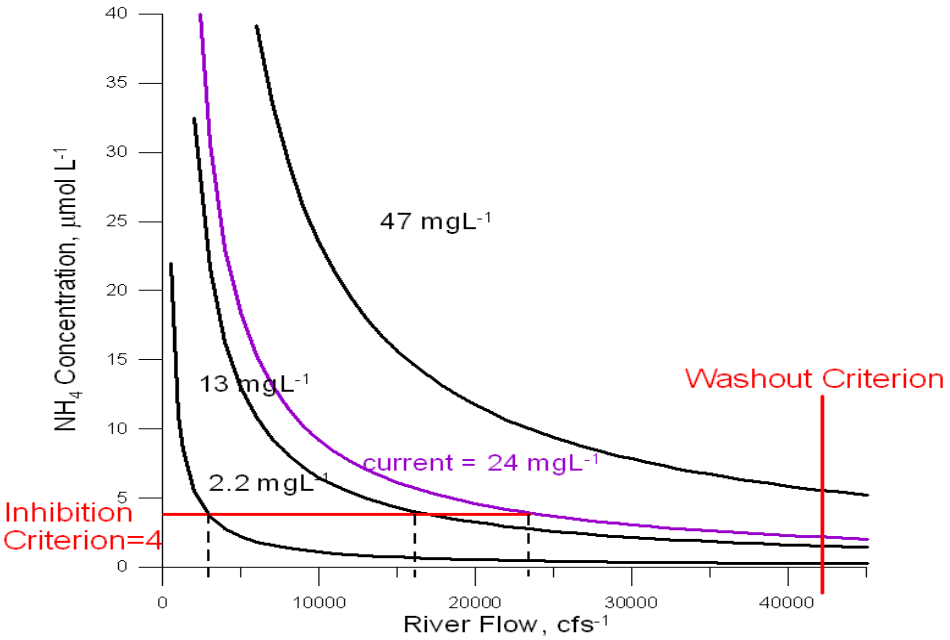

Figure 3 Ammonium concentration at the entrance to Suisun Bay calculated for different river flows. Each curve represents a different effluent ammonium concentration (MDEL of 2.2, 13, 24 and 47 mg L^{-1}), showing the inhibition criterion (NH_4 = 4 µmol L^{-1}) and the washout criterion (flow = 42,000 cfs).

(2) *The nitrate removal alternatives presented in the Tentative NPDES Permitting Options document should not be adopted.*

As described earlier, it is the N:P ratios and the form of N that drive community composition throughout the food web. Simply nitrifying the ammonia/um and discharging high nitrate loads in its place will not restore the N:P ratios. Total nitrogen loads need to be limited. Replacing high ammonium loads with high nitrate loads not only maintains the current detrimental DIN:DIP ratios but also is likely to create nuisance algal growth conditions from excess available nitrogen as nitrate.

D. Additional revisions to the Tentative Order Related to Ammonia/um, Nitrogen, and Phosphorus should be made

(1) *The Final Order needs to include effluent limits for phosphorus, and additional phosphorus monitoring requirements*

The Tentative Order does not set any effluent limits for phosphorus (P) and only appears to require P monitoring on a schedule of 3 times per year. Due to the importance of not only reducing nitrogen (N) in the discharge into the Sacramento River, but of understanding the balance of N:P and its effects on the functioning of the Bay-Delta ecosystem, more frequent monitoring of P in the effluent and receiving water is required. Total P is currently monitored in effluent on a monthly basis. At a minimum, this frequency of monitoring needs to be maintained. Moreover, although P has been reduced in the effluent since the mid 1990s, the Regional Board must set daily, weekly and monthly maximum phosphorus concentration and load limits that do not increase current discharge levels to avoid back-sliding. The detection limit for total phosphorus monitoring needs to be specified and should be at least 0.01 mg L^{-1} to detect environmentally relevant concentrations.

(2) *Environmentally relevant detection limits need to be specified for ammonium monitoring*

Detection limits for ammonium monitoring need to be specified and should be at least 0.01 mg L^{-1} to detect environmentally relevant concentrations.

(3) *The pH effluent limit should not be increased*

The Tentative Order allows an increase in the allowable pH range from 6.0 -7.5 as a 1-hour average to a range of 6.5 - 8.5 as an instantaneous minimum and maximum. Once full nitrification and denitrification is on line, the increase in pH range may not be as significant.

At elevated pH's, the proportion of ammonia to ammonia plus ammonium increases. Rates of nitrification and denitrification are also reduced at high pH, thereby maintaining any ammonium in the water for longer periods without natural processing to nitrate (Kemp *et al*. 2005).[121]

[121] Kemp, W.M., W. R. Boynton, J. E. Adolf, D. F. Boesch, W. C. Boicourt, G. Brush, J. C. Cornwell, T. R. Fisher, P. M. Glibert, J. D. Hagy, L.W. Harding, E. D. Houde, D. G. Kimmel, W. D. Miller, R. I. E. Newell, M. R. Roman, E. M. Smith, J. C. Stevenson. Eutrophication of Chesapeake Bay: historical trends and ecological interactions. *Mar. Ecol. Prog. Ser.* 303:1–29.

Increased pH also alters the biogeochemistry of phosphate, leading to increased fluxes of phosphate from the sediment (e.g., Seitzinger 1991).[122] Indeed, the phosphate flux from the sediment in a *Hydrilla*-dominated site in the Potomac estuary increased from <5 μM m^{-2} h^{-1} to nearly 30 μM m^{-2} h^{-1} in <24 hours when pH increased from 7.8 to 9.5 (J. Cornwell, Univ MD, pers. observation). Moreover, metabolism of macrophytes is also altered at elevated pH values and some species exhibit a significantly higher growth rate when the pH is 9 compared to lower pHs (Spencer and Bowes 1985, Bowes 1987).[123]

There have been recent reports and observations of elevated pH in the Bay-Delta. Lindemuth (2010) described severe eutrophication in shallow areas of the Bay-Delta due to increased nitrate concentrations in shallow, clear areas.[124] In 2009 and 2010, ***Lindemuth measured daytime pH greater than 10,*** nighttime dissolved oxygen less than 45% of saturation, and a near complete absence of aquatic organisms in the shallow areas of Big Break due to excessive algal growth from excess available nitrogen.

The increased pH limit in the Tentative Order, to pH of 8.5, has the potential to further these biogeochemical effects of pH. While the biota may be contributing to high pH values observed in some regions in the Bay-Delta due to high production of macrophytes, the overall concern is that many nutrient biogeochemical processes are influenced by pH. In addition, allowing an increase in the maximum pH will exacerbate the existing acute and chronic toxicity concerns with the existing ammonia discharges. Given that the current permit allows only a pH of 7.5, any allowed increase in pH would not only further the impacts of the nutrient loadings by the Treatment Plant, but is unlawful backsliding.

III. Pathogens

A. Regional Board Properly Found That Discharge of Pathogens Poses an Unacceptable Human Health Risk

(1) *High Quality Source Water is an Essential Component of the Multi-Barrier Approach to Protecting Public Health*

While some of the Water Agencies provide drinking water and subject their supplies to advanced drinking water treatment to ensure that the water provided to their customers meets or exceeds all drinking water standards, maintaining high quality water at the source is an essential barrier in protecting customers from contaminants. The California Department of Public Health (CDPH) recognizes that multiple barriers are fundamental for ensuring water that is reliably safe to drink in light of real and potential threats to source water quality. Threats from wastewater dischargers

[122] Seitzinger, S.P. 1991. The effect of pH of the release of phosphorus from Potomac estuary sediments: Implications for blue-green algal blooms. *Estuarine, Coastal and Shelf Science.* 33:409-418.

[123] Spencer, W., and G. Bowes. 1985. Limnophila and hygrophila: a review and physiological assessment of their weed potential in Florida. *J. Aquat. Plant Manage*. 23: 7-16; and Bowes, G. 1987. Aquatic plant photosynthesis: strategies that enhance carbon gain. In: R.M. Crawford, ed., *Plant life in aquatic and amphibian habitats*. Special Publication of the British Ecological Society. Blackwell Scientific. 5: 79-89.

[124] Lindemuth, T. 2010. Linking nutrients to severe Delta eutrophication, 2009/2010 findings. Oral Presentation at the 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

can arise from operational breakdowns or aging infrastructure resulting in sewage and/or chemical spills, inadequately treated effluent, or inadequately mixed effluent, all of which the Sanitation District has experienced. The multi-barrier approach recognizes that while each individual barrier may not be able to completely remove or prevent contamination, and therefore protect public health, together the barriers of source water protection, multiple drinking water treatment processes, and protection of water quality in the distribution system, work to provide greater assurance that the water will be safe to drink. The Regional Board recognized the importance of the multi-barrier approach to protecting public health in Resolution R5-2010-0079, Establishment of a Central Valley Drinking Water Policy for the Sacramento-San Joaquin Delta and Upstream Tributaries. Requiring the Sanitation District's effluent to meet the recycled water criteria is an important step in providing the first barrier to pathogens in drinking water supplies.

(2) *Pathogen Free Wastewater is Needed to Protect Drinking Water Quality*

The Water Agencies agree with the Regional Board that an increased risk of illness or infection from exposure to wastewater is not protective of the municipal and domestic supply, agricultural supply, and water contact recreation beneficial uses of the Sacramento River, which are designated in the Water Quality Control Plan for the Sacramento and San Joaquin River Basins, as well as for the Bay-Delta. The entire Sacramento River is designated as a source of drinking water under State Water Board Resolution 88-63 and the high quality of that source must be maintained under State Water Board Resolution 68-16. The entire Sacramento River must be protected as a high quality source of drinking water.[125]

While there are currently no receiving water quality objectives for pathogenic protozoans such as *Cryptosporidium* and *Giardia,* there are drinking water treatment requirements that are based on source water levels of these organisms. The Interim Enhanced Surface Water Treatment Rule (http://water.epa.gov/lawsregs/rulesregs/sdwa/mdbp/ieswtrfr.cfm) requires all drinking water treatment plants that treat surface water and serve more than 10,000 people to provide 2-log (99 percent) reduction/inactivation of *Cryptosporidium*. Drinking water treatment plants are classified in one of four bins based on monitoring for *Cryptosporidium* required by the Long-term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (http://www.epa.gov/fedrgstr/EPA-WATER/2006/February/Day-06/w004.htm) as shown in Table 3. If the monitoring results place a drinking water treatment plant in Bins 2 through 4, additional reduction/inactivation of *Cryptosporidium* is required. This rule established a "microbial toolbox", which contains various methods of achieving the additional treatment requirements including watershed management, pretreatment, additional treatment, and optimizing existing treatment processes.

[125] There are currently no drinking water intakes immediately downstream of the Sanitation District's discharge location; however, there may be intakes on the Sacramento River downstream of the discharge in the future. The Bay Delta Conservation Plan is evaluating up to five intakes between Freeport and Courtland.

Table 3. LT2ESWTR Bin Classification and Action Requirements.

Bin Classification	Maximum Running Annual Average (oocysts/L)	Action Required (log)
1	<0.075	none
2	0.075 to <1.0	1
3	1.0 to <3.0	2
4	≥3.0	2.5

Sanitation District data collected upstream of the discharge in the Sacramento River at Freeport Marina (R1), 4,200 feet downstream of the discharge at Cliff's Marina (R3), and in the Treatment Plant effluent were analyzed to determine the bin levels that drinking water treatment plants would fall into if an intake was located upstream and downstream of the discharge. Table 4 shows that water upstream of the discharge is high quality, requiring no additional treatment to remove/inactivate *Cryptosporidium*. At the 9:1 dilution of the effluent allowed in emergencies and at the minimum 14:1 dilution of the effluent during normal operations, a drinking water treatment plant would be required to provide an additional two log (99.99 percent) reduction/inactivation of *Cryptosporidium*. At the 20:1 dilution normally considered by the Regional Board as not requiring additional wastewater treatment, one additional log reduction/inactivation would be required. The data collected from the Sacramento River 4,200 feet downstream of the discharge show that one additional log removal would be required at R3. The R3 data were collected under a variety of flow and discharge conditions between December 2002 and April 2006 and are therefore representative of many different dilutions of effluent and receiving water.

Table 4. Impacts of Current Sanitation District Discharge on Drinking Water Treatment Requirements. [126]

Location	Highest 12-month Mean	LT2ESWTR Bin Classification	Additional Log Removal
R1 (Upstream)	0.05	1	None
9:1 Dilution of Effluent	1.54	3	2
14:1 Dilution of Effluent	1.02	3	2
20:1 Dilution of Effluent	0.73	2	1
R3 (Downstream)	0.18	2	1

The Sanitation District's *Cryptosporidium* data clearly indicate that the discharge is degrading water quality and affecting the potential future use of the Sacramento River as a drinking water supply downstream of the discharge. Requiring the Sanitation District's effluent to meet the

[126] The calculations in this table are based on a data file provided by Kathy Harder, Regional Water Board, title "Compilation of SRCSD Effluent and Receiving Water Concentration Data" dated July 13, 2010. Data from December 2002 to April 2006 were used.

recycled water criteria will protect municipal water supplies as well as agricultural water supplies and recreational use of the Sacramento River.

B. The Treatment Plant's Existing Disinfection System Is Unreliable And Leads to Chlorine Excursions

Effluent disinfection at the Treatment Plant is currently accomplished by adding chlorine at the beginning of the effluent discharge pipe and then removing the chlorine at the end of the pipe by the addition of sulfur dioxide gas. Operation of this system has proven unreliable for controlling the chlorine residual, and the Treatment Plant has difficulty meeting even the current monthly and daily average limitations.[127] The existing system also contributes to violations of the Treatment Plant's effluent pH limitations. The chlorine discharged from the Treatment Plant during these excursions likely affects the aquatic species in the river, causing fish kills, fish avoidance, and losses of species diversity from the release of chlorine and its byproducts into the receiving waters.

Because of "[t]he major concerns of the SRWTP regarding . . . the violations of their chlorine residual requirement,"[128] the Sanitation District's Master Plan 2020 engineering consultants produced a 112-page technical memorandum that studied different disinfection alternatives and recommended significant disinfection system upgrades.[129] Although the engineers' recommendations were carried forward into the Sanitation District's 2020 Master Plan, the Sanitation District has backed away from the recommendations, apparently unwilling to pay the cost.

(1) *Pathogen Monitoring is Needed to Ensure that Public Health is Being Protected*

The Water Agencies support the Regional Board's pathogen monitoring requirements in the Tentative Order. As stated previously, the data collected between 2002 and 2006 show that the drinking water beneficial use has been impacted by the discharge. If the requirement to meet the recycled water criteria is adopted by the Regional Board, it will take up to ten years for the Sanitation District to meet that requirement. Two factors may exacerbate the impacts of the discharge on the beneficial uses of the Sacramento River in the intervening ten years. First, water conservation in the Sacramento area is expected to increase due to the installation of water meters. This could result in greater levels of pathogens in the wastewater because the human waste will be diluted by less water. Second, if the discharge volume increases from the current average dry weather flow of 141 mgd to the permitted flow of 181 mgd due to population growth in the service area, the pathogen load discharged to the Sacramento River will increase, leading to further degradation of the Sacramento River and Bay-Delta. The Sanitation District has not collected pathogen data since the spring of 2006. It is essential that pathogen monitoring be included in the Monitoring and Reporting Program to ensure that public health is protected.

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[127] See Carollo Engineers, Task 600 Technical Memorandum No. 4 Evaluation of Effluent Disinfection Alternatives. Interim Copy. March 2003. P. 4-3 ("Operation of the existing system … has proven difficult for controlling the chorine residual. Historically, the plant has had difficulty meeting the previous chlorine residual requirements.")

[128] *Id.*

[129] *Id.*

DWR Municipal Water Quality Investigations (MWQI) Program is planning to conduct a pathogen study in the vicinity of the discharge in 2011. The Regional Board should require the Sanitation District to cooperate with the MWQI Program in the conduct of that study and provide effluent samples and the data collected by the Sanitation District as part of its routine monitoring program.

(2) *Disinfection Alternative 1 – Existing Level of Disinfection is not Protective of Beneficial Uses*

The Water Agencies concur with the Regional Board that an increased risk of illness and infection from exposure to the Sanitation District's discharge is an unacceptable impairment of the beneficial uses of the Sacramento River. The existing level of disinfection is not currently protecting the drinking water beneficial use of the Sacramento River, as demonstrated previously with the analysis of the *Cryptosporidium* data, and should not be considered as an alternative to providing tertiary filtration.

IV. Toxicity

A. Because the Sanitation District has a history of violating the toxicity standards in its permit, the Regional Board should enhance the toxicity program in the Final Order using a science-based approach

The Sanitation District has an ongoing problem with acute and chronic toxicity. The Regional Board has characterized the Sanitation District as being in violation of its permit 15% of the time.[130] The toxicity originating from the Treatment Plant has been a particular concern for at least the last six years, with toxicity results reaching as high as 50TU.[131] However, the mandated testing approach and analysis to date has not advanced the science at all and the Sanitation District is no closer than it was 6 years ago to identifying the reasons for its toxic discharge.

The Tentative Order includes many essential elements intended to contribute to a greater understanding of the Sanitation District's impacts on endangered and threatened fish species, the Bay Delta food web, and the potential impacts of pyrethroid pesticides. However, the details and design of those special studies will determine the probability of their success. The discharger will be more successful in identifying the causes of toxicity if the permit is carefully drafted to include heightened specificity regarding how the testing is to be conducted. The permit must start with a clear articulation of each monitoring and special study question and the details of an appropriate study design, including indicators, endpoints, methods, quality assurance and

[130] Tentative Permit, p. F-8.

[131] The toxic episodes have occurred many times each year since approximately 2004, with toxicity reaching as high as 50 toxicity units (TU), which is significantly higher than the 8TU trigger for heightened testing contained in the Sanitation District's existing permit. (SRWTP TRE Status Report, August 23, 2007.) The Sanitation District concluded it had finally found the single cause of the toxicity, stating that the problem was an artifact which was not indicative of effluent effect rather it was caused by bacterial growth in the Treatment Plant's dechlorinated final effluent ("DFE") composite autosampler system. But, the toxic episodes did not stop after the District modified its system. The toxicity trigger has been exceeded many times since 2007.

reporting. The special study designs should be provided for stakeholder review and comment prior to implementation.

In developing a plan to address the Treatment Plant's known toxic effects, it is important to acknowledge the regulatory and site-specific ecological context within which the plant is operating. The Sanitation District discharges its effluent into an estuary that has been in decline for a number of years. It was for this reason the Regional Board adopted Resolution R5 2007-0161,[132] to focus attention on the need to enhance efforts for Delta protection. The resolution recognizes that the Delta is in a state of ecosystem collapse. The resolution emphasizes the need for the Regional Board to ensure that actions needed to protect and control Bay Delta water quality are implemented in a timely fashion.

(1) ***The Final Order should explicitly acknowledge that the Sanitation District's wastewater is discharged into a waterbody listed on the Clean Water Act 303(d) list for "unknown toxicity."***

The Final Order should acknowledge that the Delta is currently listed on the Clean Water Act (CWA) 303(d) list for unknown toxicity. The WET program, including the need for special studies and TIEs/TREs, should provide the essential information needed for the development of a Total Maximum Daily Load ("TMDL"). During the life span of this permit, the Regional Board will address the 303(d) listings for the Sacramento River and the Bay-Delta, including the listing for unknown toxicity. The Sanitation District must do all that it can to contribute to the technical basis of the TMDL.

The Basin Plan includes a list of Water Quality Limited Segments ("WQLS"), which are defined as "…those sections of lakes, streams, rivers or other fresh water bodies where water quality does not meet (or is not expected to meet) water quality standards even after the application of appropriate limitations for point sources (40 CFR 130, et seq.)"[133] The Basin Plan also states, "Additional treatment beyond minimum federal standards will be imposed on dischargers to WQLSs. Dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment" (Basin Plan p. IV-7). The Delta is listed as a WQLS for Chlorpyrifos, DDT, Diazinon, Exotic Species, Group A Pesticides, Mercury, Polychlorinated byphenyls (PCBs) and unknown toxicity (EPA 2007).[134]

The Tentative Order's findings related to the CWA 303(d) list should be revisited because, even though many of the TMDLs for listed constituents have yet to be completed, the CWA section 303(d) does not allow any increase in loading of listed constituents until a formal Waste Load Allocation ("WLA") is developed. If a waterbody is listed for a particular constituent, that constituent must be included in the reasonable potential alternative ("RPA") as having the potential to cause an impact, especially when additivity is considered (State Implementation Plan

[132] Central Valley Regional Water Quality Control Board Resolution 2007-0161. Water Board's Actions to Protect Beneficial Uses of the San Francisco Bay/Sacramento-San Joaquin Delta

[133] Basin Plan p. IV-7

[134] U.S. EPA. 2007. California's 2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments Requiring TMDLs.

pg. 6 and pg. 2-1)[135]. Federal Regulation, 40 CFP 122.22(d)(l)(i), mandates that permits include effluent limitations for all pollutants that are or may be discharged at levels that have the reasonable potential to cause or contribute to an exceedance of a water quality standard. Effluent limits including mass loading limits, should be required for ALL listed constituents.

(2) ***The Final Order should explicitly acknowledge that issues of "additivity" are particularly relevant to the Sanitation District's discharge.***

The Final Order should include a finding that the Basin Plan required the consideration of additive toxicity.[136] The finding is relevant to conducting the RPA, determining effluent limits, and in the anti-degradation analysis. Metals such as Cu, Cd, Zn and Pb are known to be additive. Pyrethroids are additive.[137] Cu, as an acetylcholinesterase inhibitor in salmon, should also be considered additive with the OP pesticides.

The Basin Plan, at p. IV-17-18.00, states the following:

> "Where multiple toxic pollutants exist together in water, the potential for toxicological interactions exists. On a case by case basis, the Regional Water Board will evaluate available receiving water and effluent data to determine whether there is a reasonable potential for interactive toxicity. Pollutants which are carcinogens or which manifest their toxic effects on the same organ systems or through similar mechanisms will generally be considered to have potentially additive toxicity."

Toxicity testing of the Sanitation District's effluent by Dr. Werner at UC Davis suggests toxicants (ammonium and an unknown constituent) are present in the Sanitation District's effluent (Werner 2009).[138] Dr. Werner's research further indicated that the mixture of ammonia

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[135] States Policy for Implementation of Toxic Standards for Inland Surface Waters, enclosed Bays and Estuaries of California (SIP); California Water Code section 13377.

[136] See, Tentative Permit, p. 7.

[137] The Tentative Order also relies on a reasonable potential analysis for hardness-dependent metals that uses incorrect statistical multipliers as required by Federal regulations, 40 CFR § 122.44(d)(1)(ii). The Central Valley Regional Water Board (Region 5) NPDES Permits establish Effluent Limitations for **metals based on the hardness** of the effluent and/or the downstream water and rarely use the ambient upstream receiving water hardness as required by Federal Regulations, the California Toxics Rule (CTR, 40 CFR 131.38(c)(4)). The Regional Board's use of hardness other than the upstream is based on an approach developed by Dr. Robert Emerick, of Eco:Logic Engineers. Dr. Emerick developed a different approach for evaluating hardness-dependent metals that used effluent and downstream hardness values in assessing reasonable potential and developing effluent limits. He subsequently presented his approach at the Water Board's Training Academy and the Regional Board has adopted this methodology as a defacto policy in developing and issuing wastewater discharge permits. Dr. Emerick's approach has never been evaluated or adopted through the legally mandated rule-making procedures. Use of Dr. Emerick's approach likely underestimated the toxic effect of metal during the RPA and additional effluent limits are likely required for constituents such as copper, lead, zinc, and aluminum. Effluent limits should also be considered for pesticides and TDS.

[138] Werner, I. 2009. "Effects of Ammonia/um and Other Wastewater Effluent Associated Contaminants on Delta Smelt," presented at the 18-19 August 2009 Ammonia Summit.

and effluent in the Sanitation District's effluent was more toxic than clean ammonia (NH_4) in lab water. Parker *et al* (2010a) at San Francisco State University observed a similar effect in algal grow out experiments with effluent ammonium compared to clean ammonium.[139] Therefore, concerns regarding additivity are directly relevant to this permit.

(3) ***The Regional Board should develop a detailed WET testing procedure to ensure enforceability and to promote greater success in identifying the nature, origin and cause(s) of the toxicity of the Sanitation District's effluent.***

The Tentative Order includes authorization to control ammonia toxicity during toxicity tests for 10 years, requests a transition from standard test species to local test species, and requests study plans for investigating toxic events. It is clear these elements have been included to address the current state of the Sanitation District's effluent and its contribution to in-stream toxicity. However, if implemented without careful experimental design, the studies will fail to produce the desired outcome of eliminating the toxic effect of the Sanitation District's discharge.

The monitoring and special studies plan should describe a WET program that is designed to maximize the ability to identify toxicants, and to answer the questions about toxicity that are implicitly raised in the permit, as follows:

<u>Is the effluent violating the Basin Plan's narrative toxicity objective?</u>

- This should be answered by applying the current EPA methods for conducting acute and chronic toxicity tests.[140]

- No manipulation of the effluent to control for ammonia should be allowed. No pH adjustment should be allowed. This should be part of a TIE. Allowing the effluent to be modified to eliminate ammonia toxicity before testing is inconsistent with the EPA method that is cited in the Tentative Order. (EPA-821-R-02-013 EPA-821-R-02-012) Moreover, to do so would alter the test results as removing ammonia would result in other toxicants being removed as well.

- The upstream ambient river water should be used as the dilution water. Inclusion of a laboratory control water as a dilution water should be part of a TIE as well. Both testing procedures are important to provide information regarding the water quality that the fish will experience in the river.

- The fish for acute testing should be early life stages, as young as possible, consistent with the lower range given in the acute toxicity methods. It is well established that fish

[139] Parker, A.E., A.M. Marchi, J.Drexel-Davidson, R.C. Dugdale, and F.P. Wilkerson. 2010a. "Effect of ammonium and wastewater effluent on riverine phytoplankton in the Sacramento River, CA. Final Report to the State Water Resources Control Board.

[140] Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fourth Edition (EPA-821-R-02-013); Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition (EPA-821-R-02-012).

sensitivity to ammonia decreases with age. Since the purpose of using early life stages in acute testing is to test during the most sensitive life stage, the acute testing methodology should reflect this.

How much of the observed toxicity is due to ammonia/ammonium?

The TIE required to answer this question must be designed in such a way that it is clear when ammonia/ammonium is the toxicant. This will be a challenge because many of the standardized TIE manipulations for controlling or eliminating ammonia will alter or eliminate other potential toxicants as well, such as metals, surfactants and certain types of organics.

How much of the observed toxicity is a result of interaction with river water?

This will require that two dilution series be included in TIE testing—a river dilution series, and a lab control series.

Is the effluent causing acute or chronic toxicity to salmonids?

The Tentative Order acknowledges the need to expand toxicity testing to evaluate potential impacts on salmonids. Rainbow trout testing should be added to the suite of test species. Fathead minnow testing should not be removed from the chronic tests, because the historic testing by the Sanitation District provides a history of toxicity and companion chemistry data, providing a valuable context for looking at toxicity changes over time. It is therefore recommended that both fish species be used in chronic testing.

Is the effluent causing toxicity to resident species sensitive to pyrethroid pesticides?

We agree that *Hyalella* testing can evaluate the impact of the effluent on a local benthic species, and help clarify the role of pyrethroid pesticides. However, the use of *Hyallella* should augment the list of species tested, and not be a replacement for *Ceriodaphnia*. The purpose of WET testing is to characterize toxicity, not just track the "toxicant du jour". The Sanitation District's effluent has historically been toxic to *Ceriodaphnia* at a frequency that should not allow the elimination of it as a test species, especially if the primary rationale is to detect pyrethroid toxicity. Addressing pyrethroid toxicity is essential, but should be part of an ongoing comprehensive TIE program.

Is the effluent causing toxicity during WET testing to *Selenastrum*?

WET testing currently includes the use of *Selenastrum* as a test species. Determination of algal toxicity is complicated and can be effected by test conditions, such as the use of Ethylene diaminetetraacetic acid ("EDTA") in test media. The approach to algal testing merits a re-examination in light of the known toxicity of ammonium to algae and the indication that a second or multiple toxicants are likely present.

Is the effluent contributing to phytoplankton toxicity?

The proposed permit includes a special study to address this question. It is critical that the Regional Board consult with recognized experts in nutrient dynamics in the Delta and Suisun Bay to develop a study that builds on existing knowledge.

What is the relationship between effluent contaminant levels and toxicity?

Concurrent chemistry analysis should be required during all chronic and TIE testing. It is essential that the relationship between levels of toxicity and concentrations of potential contaminants be established. This should be done in two ways. First, the chemical monitoring already required under the permit should be coordinated in location and timing to occur with toxicity tests to the maximum extent possible. In addition, all chronic tests should include chemical analysis for various forms of nitrogen, phosphorus, OP and pyrethroid pesticides, diuron, surfactants and dissolved metals.

The Sanitation District's permit will be in effect for five years. During this time, the State Board will consider and adopt numeric water quality objectives ("WQOs") for toxicity.[141] The State Board's workshop and hearing on the toxicity objective is scheduled to occur in November and December 2010, concurrent with the development of the Sanitation District's permit. The permit's WET program must be designed to address the proposed toxicity objective.[142] Reliance on the draft policy is appropriate because it is, "a calculated numeric water quality criterion, such as a proposed state criterion or policy interpreting the state's narrative criterion."[143]

The toxicity effluent limit should reflect the worst case dilution scenario. If the Final Order is not modified to incorporate an enforceable chronic WET limit equivalent to the worst case instream waste concentration (IWC), as the proposed toxicity policy requires, the 6 TUs in the Tentative Order should change from being a trigger to being an enforceable effluent limit in the Final Order.

B. The Sanitation District's discharge cannot meet the minimum requirements for allowance of a mixing zone.

The Tentative Order states:

> The SRWTP discharge is considered an incompletely-mixed discharge, so the Discharger conducted a mixing zone study. A mathematical dynamic model was

[141] State Water Resources Control Board. 2010. Draft Policy for Whole Effluent Toxicity and Control.

[142] The Tentative Order states**, "**As a result of a Toxicity Reduction Evaluation (TRE), this Order may be reopened to include a chronic toxicity limitation, a new acute toxicity limitation, and/or a limitation for a specific toxicant identified in the TRE." (p. 24, emphasis added.) The Tentative Order also states, "Additionally, if the State Board revises the SIP's toxicity control provisions that would require the establishment of numeric chronic toxicity effluent limitations, this Order may be reopened to include a numeric chronic toxicity effluent limitation based on the new provisions." (p. 24, emphasis added.) The word "may" should be replaced with "shall." This change is particularly appropriate because the Sanitation District discharges into a waterbody listed on the CWA 303(d) list as impaired by unknown toxicity.

[143] See, 40 CFR 122.44(d)(1)(vi).

developed by Flow Sciences Inc. and the Sanitation District requested acute and chronic aquatic life dilution credits for ammonia, copper, cyanide, and chlorpyrifos.[144]

The Tentative Order contains a mixing zone allowance. However, the Regional Board needs to reconsider the Tentative Order language in light of the requirements contained in Federal Regulation 40 CFR Section 131.12 (a)(1) and the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP) or the Basin Plan.[145]

The Basin Plan requires the Regional Board use EPA's *Technical Support Document for Water Quality Based Toxics Control EPA/505/2-90-001 (herein "TSD")* in assessing mixing zones. The TSD states, "A mixing zone is an area where an effluent discharge undergoes initial dilution and is extended to cover the secondary mixing in the ambient waterbody. A mixing zone is an allocated impact zone where water quality criteria can be exceeded as long as acutely toxic conditions are prevented." [146]

To justify the statement that the mixing zone shall not cause acutely toxic conditions to aquatic life passing through the mixing zone, the Tentative Order explains that, "The chronic mixing zone does not allow acute aquatic life criteria to be exceeded and this Order requires acute bioassays to be conducted using 100% effluent. Compliance with these requirements ensures that acutely toxic conditions to aquatic life passing through the chronic mixing zone do not occur." [147]

However, requiring bioassay sampling is not an assurance that toxic conditions are prohibited or prevented. Acute toxicity due to ammonia, chlorpyrifos and pyrethroids is likely to occur and additive toxicity is also likely. The Sanitation District frequently fails their acute toxicity test, and often reports acute mortality (mortality in less than 96 hours) in their chronic tests. Clearly, toxicity monitoring is not preventing routine detection of acute toxicity. The Sanitation District has never identified the cause or causes for the toxicity, and it has never been ordered to adopt any specific corrective actions.

EPA's Water Quality Standards Handbook states that: "It is not always necessary to meet all water quality criteria within the discharge pipe to protect the integrity of the waterbody as a whole." The primary mixing area is commonly referred to as the zone of initial dilution, or ZID. Within the ZID acute aquatic life criteria are exceeded. To satisfy the CWA prohibition against the discharge of toxic pollutants in toxic amounts, regulators assume that if the ZID is small, then significant numbers of aquatic organisms will not be present in the ZID long enough to encounter acutely toxic conditions. EPA recommends that a ZID not be located in an area populated by non-motile or sessile organisms, which presumably would be unable to leave the

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[144] Tentative Order, p. F-34.

[145] Antidegradation is relevant in allowing a mixing zone. This is addressed under the Antidegradation analysis given later in this review.

[146] Basin Plan, p. IV-16.00.

[147] Tentative Order, p. F-36.

primary mixing area in time to avoid serious contamination. The proposed mixing zone is larger than a ZID. Non-motile (planktonic drifters like Delta smelt larvae) and sessile organisms could be present in the mixing zone long enough to encounter acutely toxic conditions.

The Basin Plan, page IV-16.00, requires the Regional Board use EPA's *Technical Support Document for Water Quality Based Toxics Control (TSD)* in assessing mixing zones. The TSD, page 70, defines a first stage of mixing, close to the point of discharge, where complete mixing is determined by the momentum and buoyancy of the discharge. The second stage is defined by the TSD where the initial momentum and buoyancy of the discharge are diminished and waste is mixed by ambient turbulence. The TSD goes on to state that in large rivers this second stage mixing may extend for miles. The TSD, Section 4.4, requires that if complete mixing does not occur in a short distance, mixing zone monitoring and modeling must be undertaken. The State's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays and Estuaries of California* (SIP), Section 1.4.2.2, contains requirements for a mixing zone study which must be analyzed before a mixing zone is allowed for a wastewater discharge.
Water quality criteria for the protection of freshwater aquatic life are generally established on a 1-hour and a 4-day basis for acute and chronic toxic effects, respectively. It is a requirement in the TSD that it be shown that aquatic life does not remain resident within the mixing zone for 1-hour to prevent acute toxicity and 4-days for chronic impacts. There is nothing in the Tentative Order that addresses the amount of time assumed for aquatic life to migrate through the mixing zone. Cramer Fish Sciences (2010) reported that salmon could be within the discharge plume for more than one hour. EPA recommends that a ZID not be located in an area populated by non-motile or sessile organisms, which presumably would be unable to leave the primary mixing area in time to avoid serious contamination. The Tentative Order does not address populations of non-motile or sessile organisms within the mixing zone.

SIP Section 1.4.2.2 requires that a mixing zone shall not:

1. Compromise the integrity of the entire waterbody.
2. Cause acutely toxic conditions to aquatic life.
3. Restrict the passage of aquatic life.
4. Adversely impact biologically sensitive habitats.
5. Produce undesirable aquatic life.
6. Result in floating debris.
7. Produce objectionable color, odor, taste or turbidity.
8. Cause objectionable bottom deposits.
9. Cause Nuisance.
10. Dominate the receiving water body or overlap a different mixing zone.
11. Be allowed at or near any drinking water intake.

The Sanitation District's discharge does not satisfy all of the requirements identified above. In fact, the discharge does all of the following: causes acutely toxic conditions to aquatic life, restricts the passage of aquatic life, adversely impacts biologically sensitive habitats, and dominates the receiving water body or overlaps a different mixing zone.

The SIP specifically requires a mixing zone not restrict the passage of aquatic life. The Tentative Order contains the following statements regarding the accommodations for the passage of fish:

- The chronic aquatic life mixing zone is 400 feet wide and extends 350 feet downstream of the diffuser.

- The Sacramento River is approximately 600 feet wide at the surface. The chronic mixing zone is approximately 400 ft x 350 ft.

- The size of the zone of passage varies on either side of the river depending on the river geometry.

- The surface of the river is approximately 600 feet across and the bottom of the river is approximately 400 feet across.

- Based on the model, the zone of passage at the surface of the river is generally at least 100 feet on both sides of the river, while the zone of passage at the bottom of the river is greater than 40 feet from both sides of the river.[148]

The justification for a mixing zone that is as wide as the river bottom, with a zone of passage at the bottom of at least 40 feet, is not apparent. The Sacramento River at Freeport is within the designated critical habitat for 5 federally-listed fish species including winter- and spring-run Chinook salmon *(Oncorhynchus tshawytscha),* steelhead (0. mykiss), Delta smelt *(Hypomesus transpacificus)* and green sturgeon *(Acipenser medirostris).* The zone of passage for critical habitat is unacceptably small near the bottom of the river, and the Final Order should prohibit a chronic mixing zone.

C. The effect of flow reversals in the Sacramento River should be considered and addressed.

The Sacramento River in the vicinity of the discharge is tidally influenced, resulting in flow reversals. With flow reversals, some volume of river water receives effluent multiple times as the river flows downstream past the discharge, reverses moving upstream past the discharge a second time, then again reverses direction and passes the discharge point a third time as it moves down the river. A particular volume of river water may move back and forth, past the discharge point several times due to tidal action, each time receiving an additional load of wastewater." Flow reversals and multi-dosing of pollutants must be discussed in the Final Order's mixing zones.

[148] Regional Board Issue Paper, SRCSD Permit NPDES Permit Renewal Issues, Aquatic Life and Wildlife Preservation, 2009, p. 6.

D. The Sanitation District's modeling of in-river conditions is unreliable.

As outlined above, the Sanitation District's proprietary modeling has not been shown to be reliable. The Sanitation District's modeling of conditions in the River consists of five models linked in series, with the output from previous models used as part of the inputs to subsequent models. The Tentative Order then states that infield verification of the model was conducted; but fails to discuss or document the verification sampling results or the percentage error between the modeled and observed data. The Tentative Order further acknowledges that the model is proprietary and transmittal for verification to the Regional Board was not allowed. (We urge the Regional Board not to rely on modeling if it cannot vet fully the validity of the modeling – For example, how the Sanitation District's models assess tidal flow reversals in rivers is not discussed in the Tentative Order.) Unfortunately, the Tentative Order does not provide any information that provides any documentation of the accuracy of the model and the modeled results.

The modeling review that could be performed for the Regional Board raised significant questions about the claim by the Sanitation District that there was room for the fish to "bypass" the effluent. Tetra Tech was tasked by the Regional Board to review the Sanitation District's dynamic modeling study for the Treatment Plant. Tetra Tech submitted a final review memorandum to the Regional Board dated June, 30 2008. "Some phenomena were observed in the field that were not reproduced in the model, most notably a region of high dye concentration near the eastern river bank just downstream from the diffuser in the October 2005 dye release. The subsequent November 2006 dye release was conducted in an effort to further resolve this observed behavior, however the model failed in all cases to reproduce the observed high concentration region."[149] It was not discussed that the area close to the river banks are defined as providing a bypass for fish – obviously, the dye shows the effluent plume at the bank. This discrepancy is simply discussed as an anomaly; fish bypass was not addressed. The results of the dye studies confirm that there is no area of bypass for fish.

E. The fact that the discharge attracts fish should be considered.

The United States Fish and Wildlife Service commented that: "We are also concerned about potential aquatic life attraction impacts from the discharge plume. Various species can be drawn to discharge plumes for various reasons, including feeding and temperature and flow refuge. T his attraction can result in impacts from related effluent toxicity and predation. The discharge area's identity as a popular fishing location[150] also suggests an association between the discharge plume and possible predator attraction."[151] The Tentative Order does not show that aquatic life passes through the mixing zone quickly enough to prevent toxicity as required by the TSD which in turn is required by the Basin Plan. The Sacramento River at Freeport is within the designated critical habitat for five federally-listed fish species including winter- and spring-run Chinook salmon *(Oncorhynchus tshawytscha),* steelhead (0. mykiss), Delta smelt *(Hypomesus*

[149] Tetra Tech at pp.9 and 10.

[150] Tentative Order p. F-73.

[151] USFWS (2010) Comment letter on CVRWQCB NPDES Permit Renewal Issues Aquatic Life and Wildlife Preservation.

transpacificus) and green sturgeon *(Acipenser medirostris).* To protect these species, a mixing zone should be prohibited in the Final Order.

F. Allowing chronic toxicity in a 303(d) listed waterbody is problematic.

The 303(d) listing for the Sacramento-San Joaquin Delta includes: Chlorpyrifos, DDT, Diazinon, Exotic Species, Group A Pesticides, Mercury, Polychlorinated byphenyls (PCBs) and unknown toxicity. By definition, an allowance for chronic mixing means that chronic water quality objectives will be exceeded within the mixing zone. An allowance for a chronic mixing zone within the Sacramento River, which is 303(d) listed for unknown toxicity, does not meet the Basin Plan requirements for additional treatment to meet water quality objectives in the limited segment of the river.

V. Constituents of Emerging Concern

Constituents of Emerging Concern ("CECs") are an emerging environmental problem that need to be addressed in a permit to dispose of municipal wastewater, particularly for a significant discharger such as the Sanitation District. We therefore support the proposal in the Tentative Order to require effluent (Tables E-3a and E-3b), and receiving water (Table E-6b) monitoring that includes certain CECs. See e.g., Table E-3b, n.8 and Table E-6b, n.6 (referring to chemicals classified as "Other Constituents of Concern"). In addition, we likewise support the requirement in Attachment I to conduct an "Effluent and Receiving Water Characterization Study." This study will require monitoring three times per year for a variety of constituents, including a number of CECs. However, given the nature of this emerging issue, we urge the Regional Board to take additional steps to address CECs in the Final Order.

A. Recent and ongoing research demonstrate the scope and extent of CECs generally, in the Bay-Delta ecosystem, and in the Sanitation District's discharge

There has been extensive research conducted on CECs in the environment. Numerous studies have reported the occurrence of CECs in effluent from municipal wastewater treatment plants, which are recognized as a primary source of CECs in surface waters. CECs are used as a broad term for contaminants that include pharmaceuticals and personal care products (PPCPs), endocrine disrupting compounds (EDCs), and other organic wastewater-derived contaminants. Although these constituents have likely been present in surface waters for years, the scientific knowledge surrounding these chemicals is relatively new and continues to evolve.

For example, in May 2010, the Metropolitan Water District of Southern California (MWDSC) and Orange County Water District completed a National Water Research Institute (NWRI)-funded study of the occurrence, fate and transport of PPCPs in three California watersheds, including the watershed of the SWP.[152] Eleven SWP sampling locations were selected for the study, including those upstream and downstream of wastewater treatment plants. Forty-nine CECs were evaluated in this project with twenty-one CECs detected within the SWP.

[152] Guo, Y.C. et al. May 2010. Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California. National Water Research Institute: Fountain Valley, CA, The final report can be accessed at http://www.nwri-usa.org/CECs.htm.

Concentrations of many contaminants were higher at sites directly downstream of wastewater treatment plants than those sites upstream of plants, indicating wastewater discharges as the primary source of most PPCPs in the environment. As one example, the highest levels of gemfibrozil (an anti-cholesterol drug) in the SWP watershed were found downstream of the Sanitation District's discharge.

There are similar data for nitrosamines, a class of organic CECs that are of particular concern to drinking water agencies due to its carcinogenic nature. Nitrosamines can be formed as a byproduct of the disinfection of some natural waters with chloramines. It is anticipated that certain nitrosamines such as N-Nitrosodimethylamine (NDMA), or a broader class of nitrosamines, may likely be the next disinfection byproduct(s) regulated by the U. S. Environmental Protection Agency (USEPA). MWDSC and the California Department of Water Resources (DWR) completed a 2-year study in April 2010 of the sources and occurrence of NDMA, other nitrosamines, and their precursors in the Bay-Delta. A report is expected to be completed in December 2010, but results to date indicate that NDMA formation potential (a measure of NDMA precursors) downstream of the Sanitation District's discharge is *3 to 4 times higher* than upstream of the plant. Good correlations between NDMA formation potential concentrations and known wastewater tracers (such as the anti-convulsant drug primidone) suggest that the NDMA precursors found in the Sacramento River came from wastewater.[153,154] This study can estimate wastewater treatment plant loading of NDMA precursors through use of hydrodynamic models like DWRs Delta Simulation Model II; however, direct effluent samples are needed to provide a better understanding of precursor loading. This project has been extended and will resume in January 2011.

In addition to the adverse effects on aquatic organisms described in the Water Agencies' Comments on Aquatic Life and Wildlife Preservation Issues Concerning Sacramento Regional Wastewater Treatment Plant NPDES Permit Renewal (June 1, 2010), additional support for addressing CECs in municipal wastewater in general, and in the Sanitation District's wastewater specifically, comes from two recent reports by the Aquatic Ecosystems Analysis Laboratory at University of California at Davis.[155] Schaefer and Johnson (2009) conducted monitoring up and downstream of the Treatment Plant and detected Caffeine, trimethoprim, sulfamethoxazole, gemfibrozil, fluoxetine, ibuprofen, carbamazepine, xylene, nonylphenol, and nonylphenol ethoxylates at one or more of the downstream monitoring sites. None of these compounds were detected in the upstream samples (See Table 5). Schaefer and Johnson (2009) state, "All of the compounds detected in the monitoring effort have been shown to have an adverse effect on one

[153] DiGiorgio, C.L. et al. Investigation into the Sources of Nitrosamines and their Precursors in the Sacramento-San Joaquin Delta, California. California Department of Water Resources and Metropolitan Water District of Southern California. Poster developed for 2009 Gordon Research Conference. (attached)

[154] Preliminary data representation provided by Metropolitan Water District of Southern California. A peer-reviewed paper will be submitted for publication in 2011. (attached)

[155] Schaefer, M. and M.L. Johnson. 2009. Pharmaceuticals and personal care products in the Sacramento River. Report prepared for the State Water Resources Control Board. October 2009; and Aquatic Ecosystems Analysis Laboratory. 2009. Pharmaceuticals and personal care products in surface water: Occurrence, fate and transport, and effect on aquatic organisms. Report prepared for State Water Resources Control Board. October 2009.

or more aquatic species."[156] In fact, ibuprofen was detected at concentrations far greater than those observed to reduce activity in *Gammarus pulex.*[157]

Table 5 Results of monitoring upstream and downstream of the Sacramento Regional Wastewater Treatment Plant for pharmaceuticals and personal care products and the potential effect on exposed aquatic organisms. Adapted from Table 3 and text in Schaefer and Johnson (2009).

Analyte	**Potential Effect on Aquatic Organisms**	**Concentration (µg/L)**			
		Site ID			
		Upstream	525m downstream	1180 m downstream	1900 m downstream
Caffeine (stimulant)	Unknown	ND	7.50	ND	ND
Trimethoprim (antibiotic)	impacts algae and zooplankton populations	ND	2.00	28.3	26.3
Sulfamethoxazole (antibiotic)	impacts algae and zooplankton populations	ND	5.92	13.0	13.0
Gemfibrozil (lipid regulator)	bioaccumulates in fish	ND	19.3	ND	214
Ibuprofen (non-steroidal antiinflammatory)	decreases activity in the freshwater crustacean *Gammarus pulex* and inhibited enzyme function in Japanese medaka (*Oryzias latipes*)	ND	ND	182	ND
Carbamazepine (antiepileptic)	persistent in surface waters and causes decreased survival of the midge *Chironomus riparius*	ND	ND	45.6	43.2
Fluoxetine (antidepressant)	bioaccumulates in fish and results in decreased activity in fish and freshwater crustaceans	ND	17.6	20.8	20.8
Xylene (polycyclic musk)	have demonstrated adverse effects to aquatic organisms	ND	**1140**	ND	**100**
Nonylphenol (surfactant)	have demonstrated adverse effects to aquatic organisms	ND	ND	**160**	**68.5**
Nonylphenol Ethoxylates (surfactant)	have demonstrated adverse effects to aquatic organisms	ND	ND	**800**	**730**
µg/L – micrograms per liter ND – not detected					

[156] Schaefer and Johnson, 2009, *supra.*

[157] Aquatic Ecosystems Analysis Laboratory, 2009, *supra.*

B. The Regional Board should expand the scope and extent of monitoring and other requirements covering CECs

The Water Agencies respectfully request that the Regional Board address CECs more fully as follows:

(1) *Include N-Nitrosomorpholine on the list in Tables E-3b and E-6b of "Other Constituents of Concern" to be monitored under the permit*

The Central Valley Regional Water Quality Control Board (Regional Water Board) has appropriately included NDMA as one of its priority pollutants to be monitored in the Sanitation District's Waste Discharge Requirements. It is noted that NDMA effluent limits were based on California Toxics Rule criteria. N-Nitrosoethylmethylamine (NEMA) and N-Nitrosodiethylamine (NDEA) are also listed for monitoring in Tables E-3b (footnote 8) and E-6b (footnote 6). N-Nitrosomorpholine (NMOR) is a nitrosamine that is commonly found in wastewater effluent,[158] and should also be listed.

(2) *Require the Sanitation District to participate in CEC studies*

We request that the Regional Board include a condition in the Final Order to require the Sanitation District to cooperate and participate in studies to advance the state of knowledge of CECs in California's water systems. One upcoming study we request the Sanitation District participate in is the MWD/DWR NDMA follow-up study noted above. This study will be conducted by MWDSC and DWR beginning January 2011, and addresses the topic of nitrosamines, their precursors and *Cryptosporidium*/*Giardia* occurrence from wastewater treatment plant facilities in the Delta.

Agencies and academic institutions continue researching sources, fate and transport of CECs in the environment. Cooperation between dischargers and drinking water utilities is critical in leveraging limited funds and resources, advancing the science, and responding to the rapidly changing knowledge associated with CECs. A September 2009 Workshop Report entitled "Managing Contaminants of Emerging Concern in California,"[159] summarized the recommendations from a forum of experts providing input into the State Board-convened Science Advisory Panel for the state's Recycled Water Policy. The report states, "Because we are in the early stages of developing a CEC monitoring strategy, filling the data gaps identified in this and other workshops is clearly the first step. This can be accomplished through investigative monitoring and targeted research." It is essential for wastewater agencies, in particular large dischargers like the Sanitation District, to participate in research studies such as the NWRI-funded study. (The Sanitation District would not agree to participate in the NWRI study.) Drinking water agencies will continue seeking partnerships with wastewater agencies in applied

[158] Krasner, S. W., et al. 2009. Occurrence of Disinfection Byproducts in United States Wastewater Treatment Plan Effluents. *Environ. Sci. Technol.* 2009, 43, 8320-8325.

[159] California CEC Workshop. 2009. Managing Contaminants of Emerging Concern in California. Co-sponsored by the Southern California Coastal Water Research Project, California Ocean Protection Council, California Ocean Science Trust, National Water Research Institute, San Francisco Estuary Institute and the Urban Water Research Center at the University of California-Irvine. Held: April 28-89, 2009. Report published in September 2009 and is available at: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/600_CEC_wkshp2009.pdf

research studies on CECs, and others have agreed to participate. For example, the City of Stockton Municipal Utilities Department will be participating with MWDSC and DWR in a NDMA follow-up study.

(3) ***Require the Sanitation District to implement CEC Science Advisory Panel monitoring requirements for water recycling activities***

The State Board has convened the CEC Science Advisory Panel. The purpose of the Panel is to develop guidance for establishing monitoring programs to assess potential CEC threats from water recycling activities. In June 2010, the Panel completed its final report entitled "Monitoring Strategies for Chemicals of Emerging Concern in Recycled Water."[160] The Panel recommended a screening approach to prioritize chemicals for CEC monitoring. Specifically

- Four indicator compounds were prioritized based on their toxicological relevance for groundwater recharge projects: NDMA, 17beta-estadiol, caffeine, and triclosan.
- Four additional CECs were identified as viable performance indicator compounds (N,N-Diethyl-meta-toluamide (DEET), gemfibrozil, iopromide, and sucralose), along with certain surrogate parameters (e.g., ammonia, dissolved organic carbon, conductivity).

Once the State Board has concluded its review, the Panel recommendations may be converted into specific monitoring requirements for recycled water projects. We request the Regional Board include a provision that allows those requirements to be incorporated into the Sanitation District's Final Order.

(4) ***Incorporate a reopener in the Final Order that would allow changes in CEC monitoring requirements based on the findings of the Emerging Constituents Workgroup***

In response to requests by the Santa Ana Regional Water Quality Control Board for targeted water quality monitoring of water sources used for groundwater recharge, the Santa Ana Watershed Project Authority (SAWPA) convened an Emerging Constituents Workgroup (EC Workgroup) that is charged with defining goals of a CEC monitoring program for local and imported surface waters, and recycled/reclaimed water. In January 2008, a Cooperative Agreement went into effect through a Resolution adopted by the Santa Ana Regional Water Board[161] authorizing a coordinated CEC study effort including both drinking water and wastewater agencies. In December 2009, the EC Workgroup submitted a workplan[162] to the

[160] State Water Resources Control Board. Monitoring Strategies for Chemicals of Emerging Concern in Recycled Water: Recommendations of a Science Advisory Panel. Sacramento, CA, June 25, 2010 can be accessed at: http://www.sccwrp.org/ResearchAreas/Contaminants/ContaminantsOfEmergingConcern/RecycledWaterAdvisoryPanel.aspx

[161] Resolution No. R8-2008-0019 – Cooperative Agreement to Protect Water Quality and Encourage the Conjunctive Uses of Imported Water in the Santa Ana River Basin.

[162] Phase II Report of the Emerging Constituents Workgroup. 2009. A Proposed Work Plan to Characterize Select EC Concentrations in Surface Waters, Imported Waters & Recycled Waters Recharging Groundwaters of the Santa Ana River Watershed.

Santa Ana Regional Water Board that lays out a CEC monitoring plan for 2010-11. The eleven CECs identified in the workplan for monitoring are acetaminophen, bisphenol A, caffeine, carbamazepine, DEET, diuron, ethynylestradiol, gemfibrozil, ibuprofen, sulfamethoxazole, and TCEP. The monitoring results from the samples collected during the first half of 2010 were submitted to the EC Workgroup in July 2010, and will be included in an Annual Report at the end of December 2010. The EC Workgroup has provided input to the Recycled Water Policy's CEC Science Advisory Panel. The EC Workgroup is preparing a report summarizing the 2010 monitoring results, developing a communications strategy, and developing the next phase of a CEC characterization study that integrates input from the CEC Science Advisory Panel, additional water quality data, and new CEC policies enacted by the State Board and the California Department of Public Health (CDPH).

(5) ***Coordinate CEC monitoring efforts with other Regional Boards***

We further urge the Regional Board to coordinate with other Regional Water Boards on CEC monitoring requirements that may be imposed for recycled water and/or groundwater recharge efforts. The Los Angeles Regional Water Quality Control Board is currently embarking on efforts to develop salt and nutrient management plans for groundwater basins within its region. This is in response to requirements prescribed in the State Board's Recycled Water Policy. The Recycled Water Policy requires that recycled water groundwater recharge projects include a monitoring program for CECs. It is possible that the Los Angeles Regional Water Board may extend CEC monitoring to imported water sources in a manner similar to that requested by the Santa Ana Regional Water Board. There is a strong need for consistent and uniform guidance with regards to CEC monitoring.

(6) ***Include a permit reopener that would apply the same types of CEC-monitoring requirements on the Sanitation District as are imposed on downstream users of Delta water.***

As monitoring requirements are placed on various recycled water and/or groundwater recharge efforts, there is a critical need to establish the sources, fate and transport, and other characteristics of CECs in the environment to further advance the science involving these chemicals. Accordingly, we request that the Regional Board include a permit reopener that would ensure that any CEC monitoring requirements for downstream users of Delta water be also included within the final discharge requirements of the Final Order.

(7) ***Include representative CEC monitoring that are indicated in the draft and upcoming final Groundwater Recharge Reuse Regulation into the monitoring program requirements.***

CDPH has included its guidance on CEC monitoring for groundwater recharge projects in its Draft Groundwater Recharge Reuse Regulations[163] (August 5, 2008 update). CEC monitoring is required for projects using recharge of recycled municipal wastewater. This draft regulation recommends that recycled water projects analyze for representative compounds within broad

[163] CDPH's draft. 2008. Groundwater Recharge Reuse Regulations can be accessed at http://ww.cdph.ca.gov/healthinfo/environhealth/water/Pages/Waterrecycling.aspx

chemical categories (hormones, industrial chemicals, pharmaceuticals, personal care products, etc.). Examples of chemicals within each of the broad categories are included in the draft regulation, although a specific list of CECs for monitoring is recommended to be determined on a project-specific basis. We request that the Regional Board include provisions for representative CEC monitoring that are indicated in the draft and upcoming final Groundwater Recharge Reuse Regulation into the monitoring program requirements contained within the Sanitation District's Waste Discharge Requirements.

(8) ***Require the Sanitation District to conduct a focused public education and outreach campaign on pharmaceutical disposal and a source control study***

The Sanitation District currently sponsors a website at www.dontflushyourmeds.com that provides certain information on pharmaceutical disposal. Based on a review of programs listed on the website, it appears that some actions have been taken to address CEC source control within the Discharger's service area. However, more can certainly be done, and we would request that the Regional Board include a provision in the Final Order that would require the Sanitation District to conduct a focused public education campaign on pharmaceutical disposal and an expanded source control study to minimize concentrations of CECs in their influent.

There is precedent for an expanded approach to source control, as the occurrence of CECs (and in particular, PPCPs) has received significant media attention and is an important issue for the public. Several wastewater agencies in California have taken a proactive approach to educate their communities on proper disposal practices for unused pharmaceuticals. One notable example is the "No Drugs Down the Drain" program which was developed in 2005 by the Los Angeles County Sanitation Districts (LACSD), City of Los Angeles, and Orange County Sanitation District (OCSD); and later expanded to include the County of Los Angeles and the Cities of Riverside and San Diego. This program, endorsed by the California Pharmacists Association, was designed to alert residents of improper disposal practices and present alternative options. Program elements include bilingual educational postcards delivered to residents, permanent and mobile hazardous waste collection events, and other public outreach initiatives. A website at www.nodrugsdownthedrain.org was launched in 2005 to provide further information on pharmaceutical disposal options. The National Association of Clean Water Agencies (NACWA) selected LACSD, City of Los Angeles, and OCSD to receive the 2008 National Environmental Achievement Award in Public Information and Education – Educational Programming for their collaborative work on the "No Drugs Down the Drain" program.

(9) ***Require the Sanitation District to submit a CEC adaptive monitoring strategy***

Lastly, we request that the Regional Board include a provision in the Final Order that requires the Sanitation District to submit a CEC adaptive monitoring strategy to address and account for anticipated changes in the state of scientific knowledge and statewide regulatory guidance involving CECs. The science surrounding CECs will continue to grow. For example, one of the difficulties faced by agencies with regards to monitoring of CECs has been the lack of standardized laboratory analytical methods. A Water Research Foundation project entitled "Evaluation of Analytical Methods for EDCs and PPCPs via Inter-laboratory Comparison" is underway to evaluate current methodologies commonly used for the analysis of EDCs and PPCPs, with the goal of providing guidelines to utilities on optimizing data quality. This project,

led by the Southern Nevada Water Authority, is expected to be completed in 2011. Further studies investigating health effects of CECs are anticipated in the future. Finally, regulatory guidance with regards to CECs will also continue to evolve, particularly in terms of recycled water interests.

VI. Temperature

A. The Regional Board should not grant an exemption from the Thermal Plan because the Discharge Creates a High Temperature Zone That Potentially Impairs State and Federally Listed Species

The Sanitation District is creating harmful thermal conditions for aquatic species, including the Delta smelt, Chinook salmon and steelhead, which are protected under the state and/or federal ESA. Those thermal conditions are likely having sublethal to lethal effects, under existing discharge levels. Diatom dominated assemblages may also be affected as water temperatures in the area of the diffuser may be elevated so significantly that the ability of diatoms to utilize nitrate (NO_3) is inhibited, thereby suppressing the productivity of the base of the food-web.

The Sanitation District requested an expanded exception from the Thermal Plan. The Regional Board may grant such an exception only if the discharger establishes that the Plan's requirements are:

> …more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on the body of water into which the discharge is made….[164]

The Sanitation District cannot justify an exception under such a standard. The Water Agencies therefore urge the Regional Board to deny the Sanitation District's request for an exception for both existing discharges and those proposed under the Tentative Order.

B. Delta smelt appear to be experiencing lethal temperatures under current conditions.

The Sanitation District barely acknowledges that Delta smelt exist in and around the wastewater diffuser. In its Thermal Plan Exception Justification, the Sanitation District states, "…the vast majority of the Delta smelt population is not anticipated to migrate past the SRCSD discharge at Freeport."[165] Even though the Sanitation District tentatively acknowledges that some Delta smelt do utilize the area around the diffuser, no analysis of the effect of the discharge on those smelt is provided. This is unacceptable.

Delta smelt are listed as threatened under the ESA. Section 9 of the federal ESA explicitly prohibits the "taking" of listed species, a prohibition that includes activities that, "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such

[164] 40 C.F.R 125.70.

[165] SRCSD. 2010. Thermal Plan Exception Justification for the Sacramento Regional Wastewater Treatment Plant, July 2010, p. 22.

conduct."[166] Delta smelt are also protected under the California ESA ("CESA"), which also unequivocally prohibits unauthorized taking of protected species.[167]

The Sanitation District discharges into the federally designated critical habitat of the Delta smelt. The critical habitat designation for Delta smelt encompasses all water and all submerged lands below the ordinary high water line and the entire water column bounded by and contained in areas that include the entire legal Delta.[168] This definition includes all of the Sacramento River up to the confluence with the American River, which is upstream of the Sanitation District's discharge diffuser. [169]

As the Sanitation District fails to include Delta smelt in its Thermal Plan Exception Justification document, the exact nature and magnitude of the thermal effect of its discharge on Delta smelt is unknowable at this time. However, several facts suggest that Delta smelt in the near-field zone, where the effluent is not fully mixed, are already experiencing sublethal to lethal thermal effects.

The section of the Sacramento River into which the Sanitation District discharges is inhabited by Delta smelt. As the Water Agencies explained in their prior comments, Delta smelt inhabit the area of the Sacramento River up to and above the Sanitation District's outfall from December through June.[170] This year's United States Fish and Wildlife Service beach seine surveys also identified Delta smelt at Garcia Bend and at Clarksburg, which are approximately three miles upstream and downstream of the Treatment Plant, respectively.[171] The fact that Delta smelt have been found upstream and downstream of the diffuser suggests that Delta smelt are passing through the discharge area multiple times and may also reside for periods of time near the diffuser. Since Delta smelt are in the river near the Treatment Plant from December through June, it is also likely that multiple life stages are present throughout the year, including spawning adults, juvenile smelt, and possibly even eggs.

Adult smelt are weak swimmers (USFWS 2008).[172] Smelt at the early life stages are particularly weak swimmers. Larval and early juvenile smelt are likely dispersed similar to neutrally buoyant particles, and could be transported back and forth through the discharge by the tides.

Temperatures above 25°C (77°F) are fatal to Delta smelt (Bennett 2005; Swanson 1998).[173] The Sacramento River at Freeport is already approaching fatal temperatures in late spring and early

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[166] 50 CFR 17.3.

[167] Cal. Fish & Game Code, §2080.

[168] 59 Fed. Reg. 65,256.

[169] *Id.*

[170] Water Agencies Comments on Aquatic Life and Wildlife Preservation Issues Concerning SRWTP NPDES permit renewal, June 2010, pp. 24-26.

[171] *Id*.

[172] United States Fish and Wildlife Service. 2008, Final Biological Opinion for the Long-Term Operational Criteria and Plan ("OCAP") of the Central Valley Project and the State Water Project.

[173] Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. *San Francisco Estuary and Watershed Science* [internet] 3(2) http:repositories.cdlib.org/jmie/sfews/vol3/iss2/art1; Swanson, C., T. Reid, P.S. Young, and J. Cech, Jr. 1998. Swimming Performance of Delta Smelt; Maximum

summer, particularly in the hotter years. In May and June, the average Sacramento River temperature at Freeport is 63.3°F and 67.4°F, respectively.[174] The average effluent temperatures being discharged into the river in May and June ranged between 72°F to 77°F.[175] In May and June, the maximum river temperatures are 74°F and 75.5°F, respectively.[176] The maximum effluent temperatures being discharged in the river in May and June is 79.45°F, which is above the lethal temperature threshold for smelt[177] Therefore, in the near-field, where the effluent is not fully mixed, there is a high likelihood that Delta smelt would be subject to a sublethal to lethal thermal condition (Thompson and Baldrige 2010).[178]

Even if near-field river temperatures are not immediately fatal, temperatures near fatal would also be expected to cause harm. The thermal stress may heighten susceptibility to predation. Increasing the susceptibility of Delta smelt to predation is particularly problematic as the outfall is a predator hot spot. The outfall in the Sacramento River is a known location for striped bass and largemouth bass, as evidenced by the numerous fishing boats that congregate near the outfall. The elevated temperatures and other favorable conditions, like feeding and the flow refuge, created by the discharge actually attract these piscivorous species (USFWF 2010; Thompson and Baldrige 2010).[179] The conditions created by the diffuser could affect Delta smelt survival, as the United States Fish and Wildlife Service observed that striped bass are the primary predator of juvenile and adult Delta smelt given their spatial overlap in pelagic habitats.[180]

As the Sanitation District has provided no analysis of the effect of its discharge on Delta smelt, including potentially adverse effects on Delta smelt critical habitat, the Regional Board cannot grant any exception to the Thermal Plan at this time.

C. Chinook salmon and steelhead are experiencing potentially lethal and sublethal temperatures under current conditions.

Delta smelt are not the only species that are likely impaired by the Sanitation District's thermal plume. Several runs of Chinook salmon and steelhead also appear acutely and chronically affected, thereby further increasing the magnitude of the District's effect on state and federally listed species.

Performance, and Behavioral and Kinematic Limitations on Swimming at Submaximal Velocities. *J. Experimental Biology* 201:333-345.

[174] SRCSD Thermal Plan Exception Justification, Appendix A, Table 1.

[175] Compilation of SRCSD Effluent and Receiving Water Concentration Data, Preliminary Data Set, July 13, 2010.

[176] SRCSD, Thermal Plan Exception Justification, Appendix A, Table 1.

[177] *Id.*

[178] Thompson, Rosie, PhD, and Jean Baldrige, 2010, Review of the Sacramento Regional Wastewater Treatment Plant, Impact of Tentative Order and Thermal Exception in Delta Smelt, Tentative Order and Thermal on Delta Smelt.

[179] *Id.*;United States and Wildlife Service, Comments on the NPDES Permit Renewal Aquatic Toxicity Issues Paper (CVWQCB), June 15, 2010, p. 3.

[180]United States Fish and Wildlife Service. 2008, Final Biological Opinion for the Long-Term Operational Criteria and Plan ("OCAP") of the Central Valley Project and the State Water Project, p.183.

Based on the Cramer (2010)[181] review of passage studies through the larger region of the Delta, any incremental increase in temperature above 18°C in a local area, such as that affected by the Sanitation District's plume, would cause an incremental increase in mortality of smolts. Temperatures in the Sacramento River at Hood are frequently in this range during May and June, when passage of Chinook smolts through this area is at its peak. Thus, available data on juvenile Chinook salmon behavior indicate that it is likely some portion of fish passing Freeport are exposed to harmful thermal effects as they migrate through the stretch of river dominated by the Sanitation District's thermal discharge. At times, such exposure would have a substantial adverse effect.

The Sanitation District discharges into the Sacramento River, which is the main conduit for fall-run Chinook salmon, winter-run Chinook salmon, spring-run Chinook salmon, and steelhead juveniles migrating to the ocean, and for returning adults migrating to their spawning grounds in the upper-tributaries of the Sacramento River. The Sanitation District discharges into the Sacramento River which is designated critical habitat for winter-run Chinook salmon, spring-run Chinook salmon and steelhead, which are federally listed.[182] The Sacramento River critical habitat is important to most life stages of salmonids, but particularly as a migration corridor.[183] To the extent the Sanitation District's thermal plume is decreasing the rate of survival and therefore ability of salmonids to migrate, the Sanitation District is contributing to the adverse modification of critical habitat.

The majority of Chinook salmon juveniles (fall-run and spring-run) will pass through the Delta as smolts from mid-March to mid-June, with peak abundance between mid-April to mid-May. Juvenile steelhead generally migrate during the same period (Cramer 2010).[184]

Only a fraction of the Chinook salmon juveniles remain in the Sacramento Basin through the summer, principally in the mainstem Sacramento River above Red Bluff and in the coolest portion of tributaries. Fish that over-summer, plus late fall-run and winter-run juveniles that emerge as fry during the summer, begin gradually migrating down the Sacramento River in autumn as temperatures drop, and may be delivered all of the way to the Delta as early as November and December (USFWS 2007).[185]

The timing at which sub-yearling smolts enter the ocean corresponds to the close of the season during which temperatures in freshwater remain suitable for their growth and survival. The

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[181] Cramer, 2010, Impact of Sacramento Regional Wastewater Treatment Plant Effluent Discharges on Salmon, pp. 5-6.

[182] 70 Fed. Reg. 37,160 (September 19, 1999; 70 Fed. Reg. 37,160 (June 28, 2005; 59 Fed. Reg. 440 (January 4, 1994); 70 Fed. Reg. 52,488 (September 2, 2005); 63 Fed. Reg. 13, 347 (March 19, 1998); 71 Fed. Reg. 834 (March 19, 1998).

[183] *Id*

[184] Cramer, 2010, Impact of Sacramento Regional Wastewater Treatment Plant Effluent Discharges on Salmon, pp. 2-4.

[185] U.S Fish and Wildlife Service (USFWS). 2007. Abundance and Survival of Juvenile Chinook Salmon in the Sacramento-San Joaquin Estuary. 2001-2005 Annual Progress Report. U.S Fish and Wildlife Service Stockton, California. 148 pages.

optimum temperature range for growth of juvenile salmon typically ranges from 10°C-16°C.[186] They begin to die from heat exposure at temperatures near 24°C, with 18°C being a threshold where survival generally begins to decline.[187] Chronic effects on salmonid species can occur at temperatures as low as 12.8°C (55°F).[188]

The distance fish must migrate through these temperatures will determine the duration of exposure to adverse circumstances, and will therefore influence mortality. The rate that juveniles move changes with time of day, channel velocity, and physical readiness for ocean entry (smolting) (Horn and Blake, 2004).[189] A combination of these factors are likely to prolong fish exposure to conditions in a local area such as the Sanitations District's discharge plume, which extends several hundred feet downstream. Chinook salmon passing Freeport, depending on the circumstances they encounter (*i.e*., tidal, diurnal, physiological state) may be exposed to the Sanitation District's thermal plume for a number of minutes or hours (Cramer, 2010).[190]

Even if fish are not exposed to the thermal plume long enough to be fatal, the temperatures in the plume are often in the range expected to cause sublethal effects on migrating salmonids. The significant impact of a brief encounter with a thermal plume within the sublethal temperature range is: 1.) greater susceptibility to predation, resulting from fish exhibiting a startle response when encountering the thermal plume, and 2.) a period of elevated stress levels which diminish the ability to avoid predators and increase susceptibility to disease and contaminant effects.

Quigley and Hinch (2006)[191] conducted a study in which they manipulated thermal conditions of small streams to simulate conditions that would be expected to result from thermal discharges and observed the startle response of juvenile Chinook salmon in the wild. They found that fish acclimated to high water temperatures displayed behaviors "indicative of stress and avoidance," including "very rapid" movement and "erratic swimming" in response to increases in temperatures. Such rapid and erratic movements are characterized as a "startle response," which may increase the risk of predation as they are likely to attract the attention of nearby predators.

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[186] Baker, P.F and J.E. Morhardt. 2001. Survival of Chinook salmon smolts in the Sacramento-San Joaquin delta and Pacific Ocean. Contributions to the Biology of Central Valley Salmonids. *Fish Bulletin* 179(s): 163-182; Newman, K.B. 2003. Modeling paired release-recovery data in the presence of survival and capture heterogeneity with application to marked juvenile salmon. *Statistical modeling* 3:157-177.; U.S Fish and Wildlife Service (USFWS). 2007. Abundance and Survival of Juvenile Chinook Salmon in the Sacramento- San Joaquin Estuary. 2001-2005. Annual Progress Report. U.S. Fish and Wildlife Service Stockton, California. 148 pages.

[187] *Id.*

[188] Zaugg, W.S., and H.H.Wagner. 1973. Gill ATPase activity related to parr-smolt transformation and migration in steelhead trout (Salmo gairdneri): Influence of photoperiod and temperature. *Comp. Biochem. Physiol*. 45B: 955-965.; Adams, B.L., W.S. Zaugg, and L.R. McLain. 1973. Temperature effect on parr-smolt transformation in steelhead trout (Salmo gairdneri) as measured by gill sodiumpotassium stimulated adenosine triphosphatase. *Comp. Biochem. Physiol.* 44A:1333-1339.

[189] Horn, M.J. and A. Blake. 2004. Acoustic tracking of juvenile chinook salmon movement in the vicinity of the Delta Cross Channel. 2001 study results. Prepared for Technical Service Center, Denver, Colorado as Technical Memorandum No. 8220-04-04, pp. 45-49 and 56-57.

[190] Cramer, 2010, Impact of Sacramento Regional Wastewater Treatment Plant Effluent Discharges on Salmon, pp. 6-8.

[191] Quigley, J.T., and S.G. Hinch. 2006. Effects of rapid experimental temperature increases on acute physiological stress and behaviour of stream dwelling juvenile Chinook salmon. *Journal of Thermal Biology*. 31: 429-441.

Sylvester (1972) demonstrated that brief exposure to sub-lethal temperatures of 17°C, 22°C or 27°C for durations as short as 60 seconds could place salmonids at higher risk for predation, depending on acclimation temperature. [192] Moreover, as mentioned above, the Sanitation District's outfall is a favorite of fisherman as it is known to attract significant numbers of large mouth and striped bass, which suggests that migrating salmon are particularly vulnerable to predation near the outfall.

Coutant (1973) reported that a minimum exposure time, varying by temperature, is required before exposed fish exhibit adverse effects from thermal stress.[193] Those fish exposed to elevated temperatures within the thermal plume for a sufficient duration will likely have poorer overall health, symptoms may include advanced aging and skin deterioration, elevated levels of heat shock proteins, hypercotisolemia, and acute thermal shock (Quigley, J.T., and S.G. Hinch, 2006.)[194] In addition, the stress response evident from elevated levels of cortisol (*i.e.*, hypercortisolemia) can be delayed by 30 minutes or longer,[195] leaving the fish vulnerable to predation even after they have left the vicinity of the thermal plume. Thus, exposure to the thermal plume would be expected to reduce the probability of survival of juvenile salmonids migrating past the Sanitation District's diffuser.

The Sanitation District's thermal plume is also likely contributing to chronic effects in migrating Chinook salmon. Chronic temperature effects are associated with reduced migratory fitness, increased vulnerability to predators, increased vulnerability to disease and contaminants, and reduced swimming performance. Water temperatures in excess of 12.8°C have been found to interfere with the formation and efficiency of ATPase in steelhead, impacting migratory behavior and seawater survival (Zaugg, W.S., and H. H. Wagner, 1973).[196] A State of California (1988) review of the relevant literature concluded that, "Seaward migratory behavior of steelhead trout and coho salmon has been found to be inhibited in juvenile fish at temperatures greater than 54°F [12.2°C]."[197] In some cases, prolonged exposure to elevated temperatures may result in smolt-to-par reversion requiring, "…additional time to fresh or brackish water to adapt to higher

[192] Sylvester, J.R. 1972. Effect of thermal stress on predator avoidance in sockeye salmon. J. Fish. Res. Bd. Canada. 29: 601-603.U.S. Fish and Wildlife Service (USFWS). 2007.

[193] Coutant, C.C. 1973. Effect of thermal shock on vulnerability of juvenile salmonids to predation. *J. Fish. Res. Bd. Canada*. 30: 765-973.

[194] Quigley, J.T., and S.G. Hinch. 2006. Effects of rapid experimental temperature increases on acute physiological stress and behaviour of stream dwelling juvenile Chinook salmon. *Journal of Thermal Biology*. 31: 429-441.

[195] *Id*. at p. 437, citing, Donaldson, E.M., U.M. Fagerlund, and J.R. McBride. 1984. Aspects of the endocrine stress response to pollutants in salmonids. In: Cairns, V.W., P.V. Hodson, and J.O. Nriagu (Eds.), *Contaminant Effects on Fisheries*. Wiley, New York, New York. p.213-221.

[196] Zaugg, W.S., and H.H.Wagner. 1973. Gill ATPase activity related to parr-smolt transformation and migration in steelhead trout (Salmo gairdneri): Influence of photoperiod and temperature. *Comp. Biochem. Physiol*. 45B: 955-965.; Adams, B.L., W.S. Zaugg, and L.R. McLain. 1973. Temperature effect on parr-smolt transformation in steelhead trout (Salmo gairdneri) as measured by gill sodiumpotassium stimulated adenosine triphosphatase. *Comp. Biochem. Physiol.* 44A:1333-1339.

[197] State of California. 1988. Water Temperature Effects on Chinook Salmon (*Oncorhynchus tshawytscha*) With Emphasis on the Sacramento River: A Literature Review. 49 pages.

salinities, thus lengthening residency in the lower reaches of rivers or estuaries and increasing predation risk." (Marine, K.R. and J.J. Cech, Jr., 2004)[198]

Chronic effects also include increased susceptibility to disease. A 1988 study of the relevant literature concluded that:

> …most of the important diseases afflicting Chinook salmon increase in virulence as temperatures increase. Water temperatures greater than 56°F favor bacteria causing columnaris and furnunculosis, while temperatures greater than 65°F favor the protozoan causing ichthyophtiriosis (or ich). A common fungus infecting fish, Saprolegnia parasitica, occurs over a wide range of temperatures but developed most rapidly at higher temperatures (State of California, 1988).[199]

Temperatures in the Sacramento River during the period of peak salmonid migration (*i.e.,* mid-April to mid-May) regularly reach levels expected to cause chronic effects, inhibiting migratory fitness, particularly in low-flow or unusually warm years (Cramer, 2010).[200]

The Sanitation District concludes that since its thermal plume concentrates in the middle of the river, there are cooler passage zones on either edge of the river that the Chinook salmon can utilize for safe passage.[201] This assumption that passage zones exist, particularly on the eastern bank of the river, is unsupported by the Sanitation District's modeling. The Sanitation District's dye studies show that even after the diffuser was modified in 2007, the effluent continues to accumulate on the eastern bank of the river in higher concentrations than in other areas of the mixing zone.[202] This is particularly important in considering the thermal effects on Chinook salmon and steelhead, because the eastern bank is on the outer bend of the river, which is exactly where the salmon would be expected to congregate.[203]

D. The Sanitation District's thermal plume may be suppressing nitrate uptake by diatoms.

Temperature is also a concern for diatoms, which are important to the food web. In systems like the Bay-Delta where ammonium inhibition of diatom growth is a concern, elevated temperatures may further exacerbate the inhibitory effect. Lomas and Glibert (1999a) studied the interactions between temperature and the inhibitory effect of ammonium on nitrate uptake by several diatom

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[198] Marine, K.R. and J.J. Cech, Jr. 2004. Effects of high water temperature on growth, smoltification, and predator avoidance in juvenile Sacramento River chinook salmon. *N. Am. J. of Fish. Mgmt*. 24:198–210.

[199] State of California. 1988. Water Temperature Effects on Chinook Salmon (*Oncorhynchus tshawytscha*) With Emphasis on the Sacramento River: A Literature Review, p. 6.

[200] Cramer, 2010, Impact of Sacramento Regional Wastewater Treatment Plant Effluent Discharges on Salmon.

[201] Robertson-Bryan, Inc. 2010. Thermal Plan Exception Justification for the Sacramento Regional Wastewater Treatment Plant. Prepared for Sacramento Regional County Sanitation District, p. 32

[202] Cramer, 2010, Impact of Sacramento Regional Wastewater Treatment Plant Effluent Discharges on Salmon.

[203] Horn, M.J. and A. Blake. 2004. Acoustic tracking of juvenile chinook salmon movement in the vicinity of the Delta Cross Channel. 2001 study results. Prepared for Technical Service Center, Denver, Colorado as Technical Memorandum No. 8220-04-04.

and phytoplankton assemblages.[204] For each species, they observed that the nitrate uptake rate was less inhibited by ammonium at lower temperatures and more inhibited at higher temperatures. They found similar results in laboratory experiments evaluating the same interaction between temperature and ammonium inhibition of nitrate uptake by diatoms in the marine environment.

A suppression of primary production in the near-field mixing zone may adversely affect sensitive species, like Delta smelt, that inhabit the area. As the near-field mixing zone has elevated ammonium concentrations and elevated water temperatures, the Sanitation District must evaluate the thermal effect of its discharge on primary production.

E. There Is No Basis For An Exception To The Thermal Plan.

The Sanitation District has not provided information to the Regional Board establishing that the Thermal Plan is "more stringent than necessary" to protect the species. The Sanitation District has also failed to show that its operations under the proposed exception to the Thermal Plan would not create conditions adverse to protected and otherwise important aquatic species, now and in the future. The Sanitation District provided no analysis of the effect of its thermal discharge on Delta smelt and green sturgeon, and the analysis it completed for salmonid species is inadequate. The Regional Board should therefore deny the Sanitation District's request for an exception from the Thermal Plan.

To provide a sound scientific basis for Regional Board decision-making, the Sanitation District must complete an analysis that: 1.) identifies daily river temperatures (including average and maximum temperatures) at 60 ft, 175ft, 700ft and 1000ft downstream of the diffuser; 2.) evaluates the effects of those temperatures on Delta smelt, salmonids and diatoms under operations consistent with the Thermal Plan and under the operations proposed in the requested exception; 3.) includes further dye studies, as the 2007 dye study did not capture the peak of the flood tide; and 4.) evaluates effluent mixing in the near-field (particularly as it relates to the eastern bank of the river).

VII. Salinity

The Regional Board properly found that discharge of salinity, in the form of electrical conductivity (EC), total dissolved solids (TDS), and chloride, is of regional concern and could impact the beneficial uses both locally and in farther reaches of the Delta (p. F-90). We commend the Regional Board on the inclusion in the Tentative Order of a limit on effluent salinity and a requirement for a salinity minimization plan. We offer the following comments to clarify and strengthen these terms.

[204] Lomas, M.W. and P.M. Glibert. 1999. Temperature regulation of nitrate uptake: A novel hypothesis about nitrate uptake and reduction in cool-water diatoms. Limnol Oceanogr 44: 556-572.

A. Limits on Effluent Salinity Are Needed to Protect the Delta Salinity Objective at Emmaton

State Board Water Right Decision 1641 (D1641) imposes numeric salinity objectives for the Delta. For the protection of agricultural beneficial uses, D1641 imposes limits on electrical conductivity in the Sacramento River at Emmaton.

The Tentative Order states on page F-50, "Based on the relatively low reported salinity, the discharge does not have reasonable potential to cause or contribute to an in-stream excursion of water quality objectives for salinity." This statement is incorrect. While the discharge may not by itself *cause* an exceedance of salinity objectives, it does increase Sacramento River salinity over the background level and hence *contributes* to the in-stream salinity and to potential exceedance of salinity objectives. The Sacramento River is, on average, the source of about 40% of the salinity at Emmaton, and at times the source of 95% of the total salinity, as shown in Figure 4. While seawater tends to be the largest source of salinity at Emmaton at times when salinity objectives are exceeded, the Sacramento River provides a steady source of salinity at all times, and an increase in that source increases the likelihood that an objective will be exceeded.

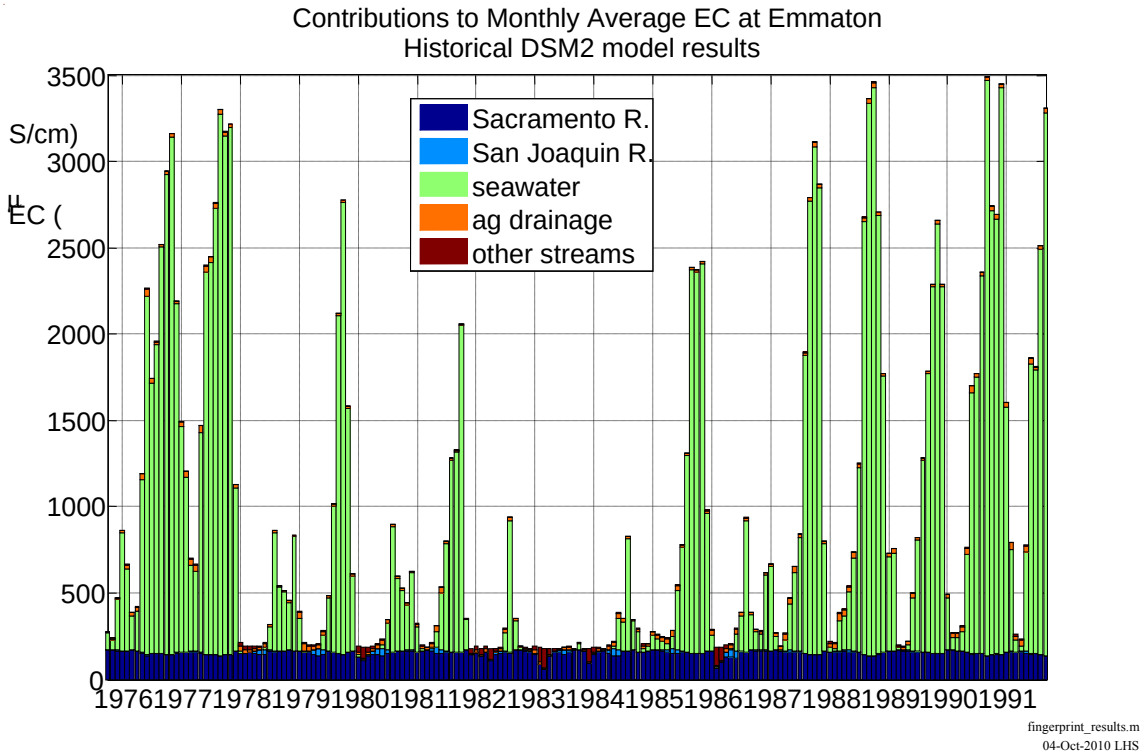

Figure 4. Monthly average electrical conductivity in the Sacramento River at Emmaton, with the contributions from the Sacramento River, San Joaquin River, seawater, agricultural drainage, and other streams (including the Mokelumne River, Cosumnes River, and the Yolo Bypass) adding up to the total electrical conductivity.

B. Limits on Effluent Salinity Are Needed to Protect Delta Salinity Objectives at Contra Costa Canal at Pumping Plant #1

For the protection of municipal and industrial beneficial uses, D1641 requires that salinity measured at Contra Costa Canal at Pumping Plant #1 must not exceed 250 mg/L chlorides and must not exceed 150 mg/L chlorides for 155 to 240 days per year, with the required number of days depending on water year type. The flow at that measuring point is a mixture of water from the Sacramento, San Joaquin, Mokelumne, and Cosumnes Rivers, with the Sacramento River accounting for 70% of the total flow on average, as shown in Figure 5.

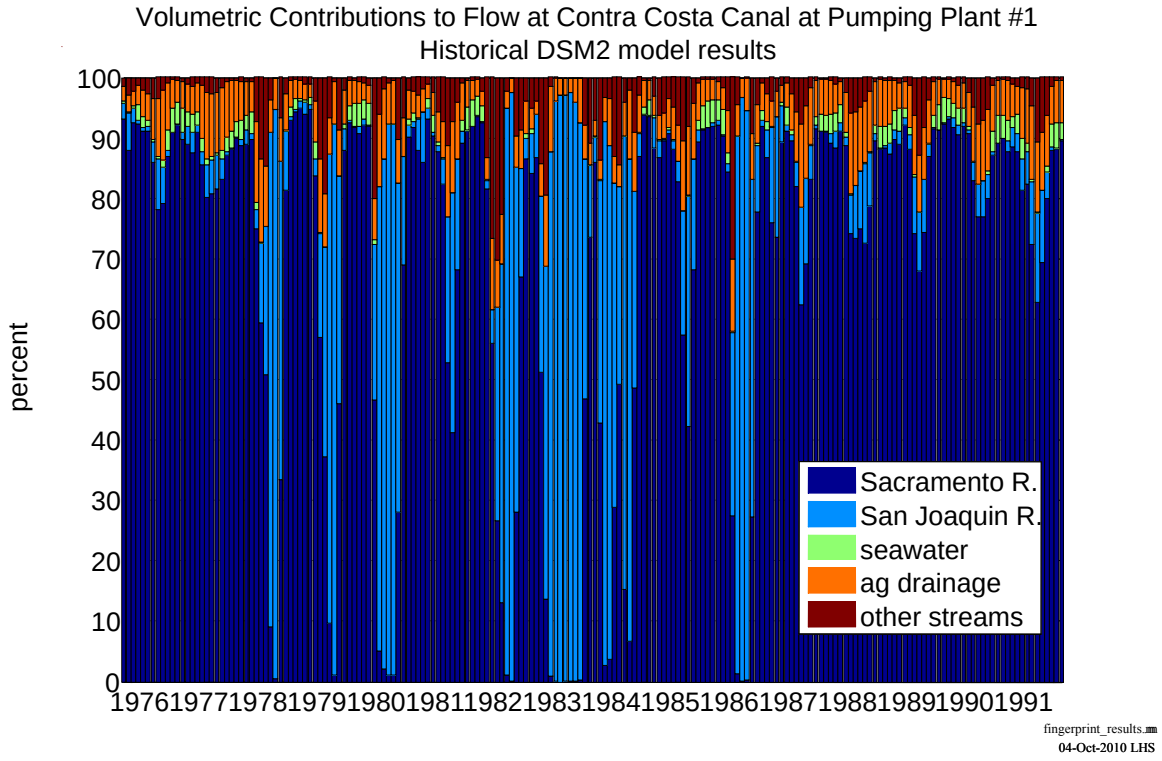

Figure 5. Composition of monthly average flow at Contra Costa at Pumping Plant #1, with the contributions by percent volume from the Sacramento River, San Joaquin River, seawater, agricultural drainage, and other streams (including the Mokelumne River, Cosumnes River, and the Yolo Bypass) adding up to 100%.

The contribution of salt from the Sacramento River at the Contra Costa Canal at Pumping Plant #1 measuring point, shown in Figure 6, is on average approximately 30% of the total salinity. The persistent, incremental contribution from the continuous discharge of Treatment Plant effluent to the total salinity of the Sacramento River should be limited to prevent contributions to exceedances of the objective measured at Contra Costa Canal at Pumping Plant #1.

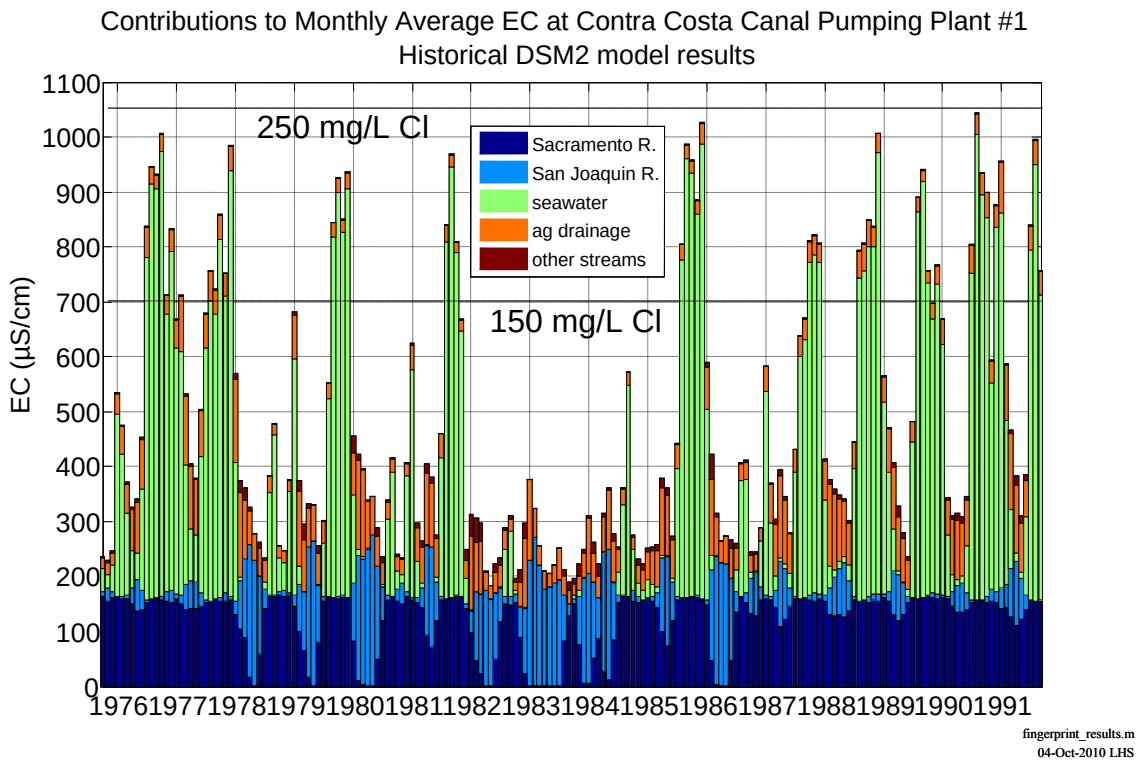

Figure 6. Monthly average electrical conductivity at Contra Costa Pumping Plant #1, with the contributions from the Sacramento River, San Joaquin River, seawater, agricultural drainage, and other streams (including the Mokelumne River, Cosumnes River, and the Yolo Bypass) adding up to the total electrical conductivity. The 150 mg/L and 250 mg/L chlorides lines, which are D1641 water quality standards for the protection of municipal and industrial beneficial uses of Delta water, are marked.

C. Effluent Limits for Salinity Should Meet the Requirements for 303(d)-Listed Constituents

The northwestern portion, the southern portion, the western portion, and the export area of the Delta are listed as impaired for electrical conductivity (also representing salinity, bromide and chloride concentrations) in the Clean Water Act 303(d) list. The discussion of Water Quality Listed Segments on page 7 of the Tentative Order should include salinity.

As discussed in section IV A (1), above, 303(d)-listed constituents must be included in the reasonable potential alternative ("RPA") as having the potential to cause an impact. Salinity limits must be given as a maximum salt load (40 CFR 122.45(f)) and as weekly and monthly average concentrations (40 CFR 122.45 (d)(2)), in addition to the proposed annual average concentration limit.

D. The Annual Average Effluent Electrical Conductivity Limit Should be Stricter

Currently, the annual average effluent electrical conductivity (EC) is 764 µmhos/cm (p. F-49). The Tentative Order sets a limit on effluent EC of 840 µmhos/cm as a calendar annual average (paragraph IV.A.1.j), which is higher than the existing average effluent salinity level. Setting the

effluent pollutant concentration limit as the 99.9th percentile value of the historical annual average effluent EC (p. F-50) allows effluent concentrations to increase above historical average levels, leading to potential further degradation of water quality rather than water quality improvement.

E. A Salt Load Limitation Is Necessary to Meet the Regional Board's Region-Wide Goals

On page F-50, the Tentative Order states that "since the discharge is to the Sacramento-San Joaquin Delta, an additional concern is the salt contribution to Delta waters. Allowing the Discharger to increase its current salt loading may be contrary to the Region-wide effort to address salinity in the Central Valley." However, the Tentative Order limits the salinity discharge only by means of an annual average effluent EC limitation of 840 µmhos/cm. This concentration limit does not limit the salt load discharged, as discharges are currently less than the permitted maximum of 181 MGD and will increase. The Regional Board should address its Region-wide effort to reduce salinity by setting an annual salinity load limit consistent with current conditions, as was done for the University of California, Davis, wastewater treatment plant permit, and then requiring a certain percentage decrease in allowable salt load each year, following the approach applied by the Regional Board for the Grassland Bypass Project. Setting a well-defined decreasing annual salt load limitation will ensure the effectiveness of the required Evaluation and Minimization Plan for Salinity.

F. Effluent Salinity Limits Are Needed to Control Taste and Odor

The Policy for Application of Water Quality Objectives contained in the Basin Plan states on page IV-17.00 that "[t]o evaluate compliance with the narrative water quality objectives, the Regional Water Board considers, on a case-by-case basis, direct evidence of beneficial use impacts, all material and relevant information submitted by the discharger and other interested parties, and relevant numerical criteria and guidelines developed and/or published by other agencies and organizations." Effluent limitations for salinity should be set to meet the Basin Plan narrative objective for control of tastes and odors.[205]

G. Effluent Limits for Chloride and TDS Are Also Required

The Tentative Order sets effluent limits only for electrical conductivity. While electrical conductivity is often used to represent salinity, some salinity objectives, such as those for Title 22 constituents and D1641 Rock Slough salinity, are set in terms of total dissolved solids (TDS) and chloride. Further, a physical salt load calculation requires salinity measurements in terms of chloride or TDS. The Final Order should set mass-based limits for chloride and TDS, as salt load and weekly and monthly average concentration limits.

[205] As CCWD has described in previous submittals, CCWD has a Board-adopted salinity delivery goal of 65 mg/L chlorides, to control taste. CCWD has made substantial investments in its water diversion infrastructure to enable it meet this goal of providing high quality water to its customers. CCWD therefore believes the narrative objective for control of tastes and odors should be used to ensure that the salinity load from the Treatment Plant does not impact its ability to continue meeting its salinity delivery goal.

H. Requirements for the Salinity Evaluation and Minimization Plan Should Be Clarified

The language describing the requirement for a Salinity Evaluation and Minimization Plan varies throughout the document. The first sentence of paragraph VI.C.3.b on page 29 of the Tentative Order and the first sentence of the last paragraph on page F-50 of the Fact Sheet should be made to conform to paragraph VII.B.3.a on page F-113 of the Fact Sheet, which states that a Salinity Evaluation and Minimization Plan is required "to ensure adequate measures are developed and implemented by the Discharger to reduce the discharge of salinity to Sacramento River." This change is needed so that it is clear that the goal is not only to identify but also to implement measures that will reduce, and not merely "address" or "control", the salinity of the effluent discharged into the Sacramento River from the wastewater treatment plant.

I. The Salinity Evaluation and Minimization Plan Should Identify Specific Effective and Implementable Source Control Measures

We request that the Salinity Evaluation and Minimization Plan be made available for public review and comment prior to adoption. We expect that it will contain source control measures, such as those identified in the process of preparing the December 2005 "Joint Study to Identify Projects of Mutual Benefit to SRCSD and Water Agencies". Potential measures include the following projects:

- Using reverse osmosis to remove salts from the processing wastewater from the Bell-Carter Olive plant in Corning would reduce the salt load to the Sacramento River by almost 5,000 tons per year.
- In Reclamation District 1500, in Sutter Basin north of Knights Landing, highly saline connate groundwater is upwelling into the agricultural drainage system; a drainage control project could remove up to 58,000 tons of salt per year from the river.
- A ban on or an educational program aimed at reducing the use of residential water softeners in the Sanitation District's service area could reduce the salt load to the Treatment Plant by at least 10,000 tons a year.

A combination of these or similar projects could acceptably decrease the Treatment Plant's contribution to Delta salinity. The projects identified in the Salinity Plan must be both effective and feasible, since the implementation of such projects is vital to reducing effluent salinity levels.

VIII. Antidegradation Policy Mandates Nutrient Removal and Tertiary Filtration While Prohibiting A Toxic Mixing Zone and Ten More Years of Degradation To Critical Habitat And The Largest Single Source of Fresh Water Supply In California

A. The Tentative Order Properly Determines That Nutrient Removal And Tertiary Filtration Are Best Practicable Treatment Or Control Required By Antidegradation Policy

The Regional Board's Tentative Order determines that nutrient removal (nitrification and denitrification) and tertiary filtration are Best Practicable Treatment or Control ("BPTC") that the Sanitation District must incorporate into the Treatment Plant in order "to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained."[206] The Regional Board's Tentative Order cites at least 14 different reasons supporting the determination that the Sanitation District "must implement BPTC" and that "BPTC for this facility includes implementation of nitrification, denitrification, and the equivalent of Title 22 filtration with ultraviolet light or chlorine disinfection treatment."[207] The Water Agencies agree with and support the Regional Board's determination.[208] Although that determination is more than adequately supported by the evidence referred to in the Tentative Order, the Water Agencies submit the following, additional evidence that further supports the Regional Board's determination.[209]

B. Antidegradation Policy Mandates Best Practicable Treatment Or Control Of The Sanitation District's Discharge In Order To Prevent Pollution And To Assure The Highest Water Quality For Maximum Benefit Of The People

The Antidegradation Analysis for the Treatment Plant's NPDES permit is governed by both state and federal regulations. The state's Antidegradation Policy is contained in State Board

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[206] Tentative Order at F-56, F-91 (citing SWRCB Res. No. 68-16.)

[207] *Id.* at F-91 to -92.

[208] The Water Agencies also submit that Antidegradation Policy requires without limitation the following additional revisions to the Tentative Order: (1) Adding effluent limitations to prevent additive toxicity for Cu, Cd, Zn, Pb (all of which are additive), organophosphate (OP) pesticides (diazinon and chlorpyrifos are additive, and Cu is additive with OP pesticides as an acetylcholinesterase inhibitor in salmon) and pyrethroid pesticides, which are additive and, therefore, are subject to the additive toxicity provisions of the Implementation Policy for Application of Water Quality Objectives in the Basin Plan; (2) Adding effluent limitations for metals based on the hardness of ambient water upstream from the point of discharge, as required by the California Toxics Rule and federal Clean Water Act regulations (i.e., 40 C.F.R. § 131.38(c)(4)), instead of basing effluent limitations on hardness of the effluent, itself, or of downstream receiving waters below the point of discharge; (3) Deleting the mixing zone for chronic toxicity under the aquatic life criteria and requiring reductions in mass loading of aquatic toxicants, because the Sacramento River and Delta are designated as impaired for unknown toxicity under section 303(d) of the federal Clean Water Act, so that the Treatment Plant's continued discharge of known toxicants unreasonably degrades beneficial uses and exceeds applicable water quality standards in violation of the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays and Estuaries and Basin Plan.

[209] The Water Agencies submitted additional evidence in their June 1, 2010, written comments on the Regional Board's April 28, 2010, Issue Paper re Aquatic Life and Wildlife Preservation and in their February 1, 2010, written comments on the Regional Board's December 14, 2009, Issue Paper re Drinking Water Supply and Public Health

Resolution No. 68-16, adopted on October 24, 1968. Resolution No. 68-16 applies to both ground and surface waters within California, and requires that existing water quality be maintained unless it is demonstrated that the benefits associated with the proposed water quality degradation outweigh the detriments associated with the degradation. The Federal Antidegradation Policy became effective on November 28, 1975, and is set forth in Title 40, section 131.12 of the Code of Federal Regulations.[210] Federal Antidegradation Policy requires states to adopt policies and implementation practices consistent with the following requirements:

> (1) Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
>
> (2) Where the quality of the waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the State shall assure water quality adequate to protect existing uses fully. Further, the State shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.
>
> (3) Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.[211]

The EPA has explained that the preceding Antidegradation Policy provision is referred to as "Tier I," which applies to all waters and prohibits water quality degradation below that necessary to maintain existing uses that have actually occurred since November 28, 1975.[212]

The Antidegradation Policy provision at 40 C.F.R. section 131.12(a)(2) is referred to as "Tier II," which applies to waters where the quality exceeds that necessary to support the propagation of fish, shellfish, and wildlife, and recreation in or out of the water.[213] Tier II water quality may not be lowered below that necessary to protect such uses, and cannot be lowered at all unless the state finds that lower quality "is necessary to accommodate important economic or social development in the area in which the waters are located," the state satisfies "all

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[210] 40 C.F.R. § 131.12.

[211] 40 C.F.R. § 131.12(a)(1)-(3).

[212] EPA *Water Quality Standards Handbook: Second Edition* (*Water Quality Handbook*), § 4.4. The *Water Quality Handbook* was originally published in 1994, but certain provisions, including Chapter 4, were updated in July, 2007. The original version is available in .pdf form, and the updated versions are available in .html form, at http://www.epa.gov/waterscience/standards/handbook/. This comment letter refers to the updated version.

[213] *Id.* at § 4.5.

intergovernmental coordination and public participation provisions," and the state assures implementation of "the highest statutory and regulatory requirements for point sources, including new source performance standards, and best management practices for nonpoint source pollutants…." (*Id*.)

Although State Board Res. No. 68-16 predates the federal Antidegradation Policy, the resolution satisfies the requirement that the state adopt a policy that is at least as stringent as the federal policy. (State Board, *Federal Antidegradation Policy Memorandum*, October 7, 1987, at p. 2; Central Valley Regional Water Quality Control Board, *Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin River Basins* (Fourth Ed., revised Sept. 2009), p. IV-8.000.)

The State Board has established an administrative procedure for determining compliance with Antidegradation Policy—Administrative Procedure Update (APU) 90-04.[214] APU 90-04 provides that the Regional Board "must consider the need to include a finding that specifies that water quality degradation is permissible when balanced against benefit to the public of the activity in question [and that this] determination as to whether a finding is needed must be made when issuing, reissuing, amending, or revising an NPDES permit."[215] An Antidegradation Policy compliance finding may only be avoided in two instances: (1) when "the proposed discharge is prohibited under either State or federal policies"; or (2) if there is "no reason to believe that existing water quality will be reduced due to the proposed action."[216]

(1) ***The Regional Board Should Reject The Sanitation District's Proposal To Use An Improper Baseline In Applying Antidegradation Policy To The Treatment Plant's Discharge***

(a) Antidegradation Policy Requires A Proper Baseline

The Antidegradation Policy analysis supporting the Final Order must utilize the proper baseline water quality. The State Board, in its APU, set forth the analytical approach one must follow to establish the Antidegradation baseline:

> The baseline quality of the receiving water determines the level of water quality protection. Baseline quality is defined as the best quality of the receiving water that has existed since 1968 when considering Resolution No. 68-16, or since 1975 under the federal policy, unless subsequent lowering was due to regulatory action consistent with State and federal antidegradation policies. If poorer water quality was permitted, the most recent water quality resulting from permitted action is the baseline water quality to be considered in any antidegradation analysis. Baseline quality is pollutant specific, not waterbody specific. Baseline quality should be determined for each constituent in the discharge which is likely to degrade water

[214] State Board Administrative Procedure Update (APU) 90-04, (July 1, 1990).

[215] *Id.* at p. 1.

[216] *Id.* at p. 2.

> quality. The baseline water quality should be representative of the water body, accounting for temporal and spatial variability.[217]

This approach is essential to achieving the objective of the 1972 Federal Water Pollution Control Act ("Clean Water Act"), which is:

> to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. In order to achieve this objective it is hereby declared that . . . it is the national goal that the discharge of pollutants into the navigable waters be eliminated . . . .[218]

Consistent with that statutory objective, guidance from EPA Region IX targets "Issuance/Re-issuance/Modification of NPDES permits" that threaten "[i]ncreases in the discharge of pollutants from point sources due to … Municipal growth."[219] The EPA Region IX guidance warns that:

> Repeated or multiple small changes in water quality can result in significant water quality degradation. To prevent such cumulative adverse impacts, a baseline of water quality must be established for each potentially affected water body.[220]

That warning highlights the need to enforce Antidegradation Policy by setting a baseline that forces the Sanitation District to stop the degradation problems caused by its discharge of secondarily treated sewage into the Sacramento River and Delta.

(b) The Sanitation District Urges Use Of An Improper Baseline And Other Analytical Approaches That Fail To Lawfully Apply Antidegradation Policy To The Treatment Plant's Discharge

The Sanitation District has asked the Regional Board to renew an NPDES permit that was issued ten years ago and which expired five years ago.[221] The old NPDES permit allowed an average dry weather flow (ADWF) discharge of up to 181 mgd, although the Treatment Plant's discharge has never reached that level and the Regional Board has determined that the current discharge is 141 mgd ADWF.[222]

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[217] *Id.* at p.4.

[218] 33 U.S.C. § 1251(a)(1).

[219] EPA Region IX, Guidance on Implementing the Antidegradation Provisions of 40 CFR 131.12, at pp. 2-3 (June 3, 1987.)

[220] *Id.* at p. 6.

[221] See February 1, 2005, Sanitation District letter to Regional Board requesting NPDES Permit Renewal for Sacramento Regional Wastewater Treatment Plant (SRWTP), NPDES Permit No. CA0077682 (citing Regional Board Order No. 5-00-188.)

[222] See Regional Board April 28, 2010, Issue Paper re Aquatic Life and Wildlife Preservation at p. 1 (stating current flows average 141 mgd); Regional Board December 14, 2009, Issue Paper re Drinking Water Supply and Public Health at p. 1 (stating current flows average 141 mgd).

With respect to Antidegradation Policy compliance, the Sanitation District's position is set forth in the May 20, 2009, report titled "Antidegradation Analysis for Proposed Discharge Modification for the Sacramento Regional Wastewater Treatment Plant" ("Sac Regional Antidegradation Report"). There, the Sanitation District defines the "project" subjected to Antidegradation Policy compliance review as "increasing the permitted discharge of secondary treated effluent to the Sacramento River from the currently permitted 181 mgd (ADWF) to 218 (ADWF) consistent with the application filed by SRCSD (SRCSD, 2005a)." (Sac Regional Antidegradation Report at p. ES-2.) The Sanitation District has since withdrawn its 218 mgd permit request and asked the Regional Board to reapprove the decade-old year 2000 NPDES permit at the 181 mgd discharge level.[223] Thus, the Sanitation District has asked the Regional Board to rely upon an Antidegradation Analysis that uses a 181 mgd "discharge" level. The Sanitation District's request must be denied.

First, the request if granted would set the "discharge" level far above any that ever has occurred. As a result, the request if granted would obfuscate the purposes underlying federal and state law by averting a full assessment of the entire Treatment Plant discharge, up to 181 mgd, under Antidegradation Policy.

To the extent that expansion in flow over current ADWF would cause or contribute to violations of receiving water standards, any such expansion also would be inconsistent with U.S. EPA regulations and Ninth Circuit precedent.[224] New connections to the sewer system that would cause or contribute to such violations likewise would be inconsistent with these controlling authorities. This underscores the need for Sanitation District to control and reduce ammonia/um discharges in the interim period while permanent nutrient removal facilities are constructed.

Second, and irrespective of the discharge level assumed in the Antidegradation Analysis, the Sanitation District ignores the requirements that the Antidegradation Analysis be conducted on a pollutant specific basis, and that the baseline quality for each pollutant be "defined as the best quality of the receiving water that has existed since 1968 when considering Resolution No. 68-16, or since 1975 under the federal policy, unless subsequent lowering was due to regulatory action consistent with State and federal antidegradation policies."[225] For many pollutants of particular interest to the health of the Sacramento River, the Bay-Delta and the Water Agencies, the Sanitation District's failure to adequately consider those requirements has incredible significance. For example, the Regional Board has not previously regulated the Sanitation District's discharge of ammonia/um, nitrate, or nitrite. Thus, the baselines for those pollutants must be either 1968 or 1975. The data plainly show that the Sanitation District has degraded the quality of the Sacramento River, and Bay-Delta by discharging ammonia/um, nitrate, and nitrite, using either a 1968 or 1975 baseline. In fact, the Sanitation District has caused water quality degradation consistently since the Treatment Plant began operations in 1983. Figure 7 shows the increase in ammonium concentration in the Sacramento River near the confluence with the San Joaquin River beginning when the Treatment Plant came on line in 1983.

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[223] See June 11, 2010, letter from Sanitation to Regional Board withdrawing 218 mgd discharge request in favor of 181 mgd discharge limit because "much has changed" since 2005 permit request.

[224] See 40 C.F.R. § 122.4; *Friends of Pinto Creek v. U.S. E.P.A* (9th Cir. 2007) 504 F.3d 1007, 1011.

[225] APU 90-004 at p. 4.

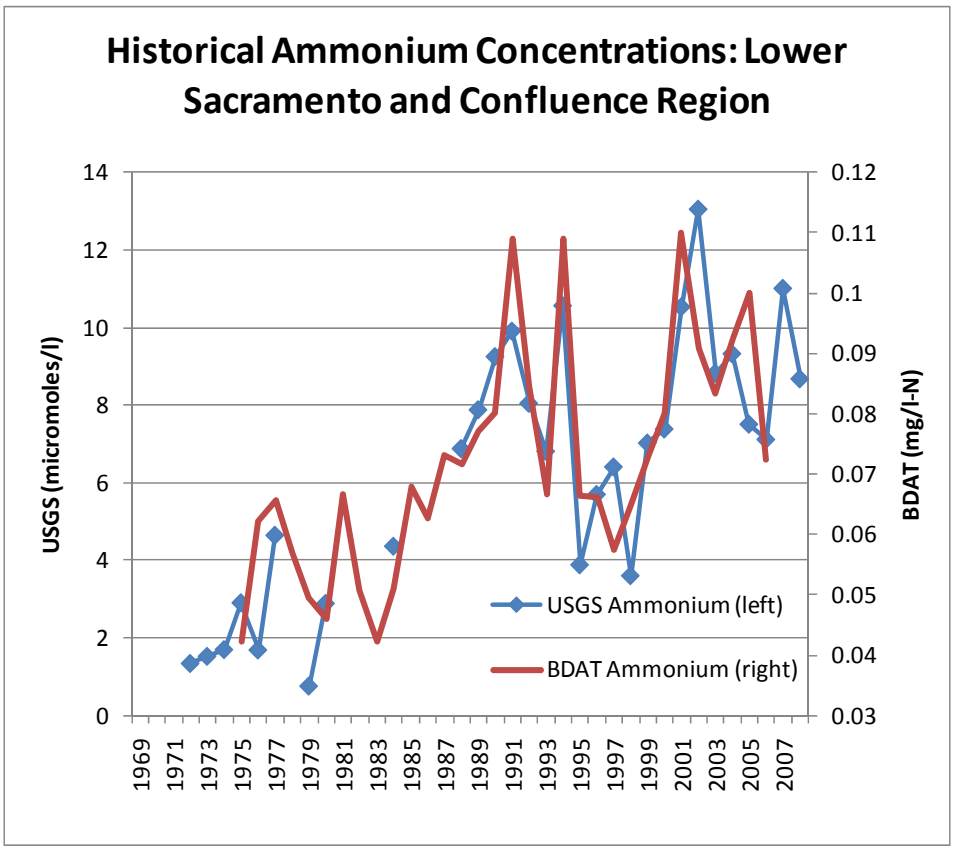

Figure 7 Ammonium concentration in the lower Sacramento River and confluence region. Left axis and blue line is ammonium data collected by U.S. Geological Survey in µmoles L^{-1}. Right axis and red line is ammonium data collected by the Department of Water Resources Environmental Monitoring Program in mg L^{-1}.

Additional data in the record demonstrate that the Sanitation District has also caused consistent degradation through its discharge of other pollutants, including pathogens.

(2) *Antidegradation Policy Requires Maintenance And Restoration Of High Quality Waters Except Under "Extraordinary" Circumstances That Do Not Exist Here*

The Sanitation District and the Tentative Order both seem to assume that the baseline is now-existing water quality that is better than the water quality defined by the numeric or narrative water quality objectives applicable to the receiving waters in the Sacramento River and Delta. That assumption is wrong. With respect to ammonia/um, aquatic toxicity, DO, temperature, pathogens and other pollutant impacts detailed in these comments and elsewhere in the administrative record, now-existing water quality is less than the quality defined by water quality objectives in the Regional Board's Basin Plan. Under Antidegradation Policy, that means the Sanitation District's new NPDES permit must prescribe effluent limits that will maintain or *improve* receiving water quality to a level that achieves the Basin Plan objectives.

The Antidegradation Policy analysis for the Treatment Plant's Final Order must examine the significance of the daily, weekly, monthly and annual increase in the mass emission of all

pollutants discharged by the Treatment Plant and assess how the discharge affects baseline water quality. Some published reports indicate that the Treatment Plant, which was not brought online until 1983, contributes as much as 90 percent of the ammonia and ammonium that makes its way into the Delta.[226] This discharge has contributed to the deterioration of water quality in the Delta, and harms beneficial uses even at the current 141 mgd ADWF discharge level.

Also, regardless of which baseline is employed for the Antidegradation Analysis, when the baseline water quality for one or more pollutants in the discharge exceeds all applicable water quality objectives, the Regional Board may not permit a discharge that will reduce baseline water quality, unless all of the following conditions are satisfied:

> a. The proposed action is necessary to accommodate important economic or social development in the area. …
> b. The reduction in water quality is consistent with maximum public benefit.
> c. The reduction in water quality will not unreasonably affect actual or potential beneficial uses.
> d. Water quality will not fall below water quality objectives prescribed in the Basin Plan.[227]

The Sanitation District's discharge does not satisfy any of these conditions. In assessing an increase in discharge to high quality waters that exceed all applicable water quality objectives, "[t]he severity and extent of water quality reduction should be weighed when evaluating the [economic] benefits required to compensate for that degradation."[228] Moreover, with respect to high quality waters, the Antidegradation Policy specifies that lowering water quality where "necessary" to accommodate important economic or social development:

> is intended to provide relief only in a few extraordinary circumstances where the economic and social need for the activity clearly outweighs the benefit of maintaining water quality above that required for "fishable/swimmable" water, and the two cannot both be achieved.[229]

The Antidegradation Policy mandates that in such circumstances:

> The burden of demonstration on the individual proposing such activity will be very high.[230]

In determining whether continuing the Sanitation District's secondary treatment approach is "*necessary* to accommodate important economic or social development" and is "consistent with *maximum public benefit*," the Regional Board is to consider:

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[226] Jassby, 2008, *supra*.

[227] APU 90-004 at pp. 4-5.

[228] APU 90-004 at p. 5.

[229] *Id.* at p. 7 (emphasis added).

[230] *Id.* (emphasis added).

a. "Past, present and probable beneficial uses of the water."
b. "Economic and social costs, tangible and intangible, of the proposed discharge compared to the benefits."
c. "The environmental aspects of the proposed discharge."
d. "The implementation of feasible alternative control measures which might reduce, eliminate, or compensate for negative impacts of the proposed action."[231]

As explained below, and throughout the Water Agencies' Comments, there are no extraordinary circumstances that could justify a Final Order that does anything less than require BPTC to assure that the high quality waters in the Sacramento River and Delta are not polluted.

C. Nitrification/Denitrification And Tertiary Filtration Are Required BPTC

The State's Antidegradation Policy mandates that:

> any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control [BPTC] of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.[232]

Because the Treatment Plant is degrading receiving water quality, the Regional Board properly found that the Sanitation District is required to implement BPTC, which in this case consists of the addition of nitrification/denitrification, and Title 22 or equivalent filtration and disinfection.[233]

(1) *Nitrification/Denitrification is Necessary in response to significant water quality degradation*

As the Regional Board correctly concluded and as described in these comments, ammonia/um removal is necessary and BPTC in response to significant water quality degradation to aquatic life uses, including acute and chronic toxicity, depletion of dissolved oxygen, production of harmful nitrosamines, and detrimental impacts to the Bay-Delta food web.[234] As we have documented in these and prior comments, ammonia/um discharged from the Treatment Plant is significantly degrading aquatic life beneficial uses due to changes in the nutrient balance, which have adversely affected the entire aquatic food web of the Bay-Delta, resulting in conditions

[231] APU 90-004 at p. 5 (emphasis added.)

[232] State Board, Resolution 68-16 (Oct. 24, 1968).

[233] Tentative Order, p. F-91.

[234] *Id.* at p. F-92.

more favorable to non-native and invasive species and less favorable to native species, particularly the state and federally listed Delta smelt.[235]

The Regional Board correctly found that denitrification is necessary and BPTC for removal of nitrate. Ammonia/um removal alone by nitrification would not reduce total nitrogen loads but would significantly increase nitrate-nitrogen loading in the Treatment Plant's effluent. As our previous comments explained and has explained in these comments above, total nitrogen, including ammonia/um and nitrate removal is necessary to avoid water quality degradation and adverse impacts on aquatic life caused by degraded N:P ratios. In addition, ammonia/um removal by nitrification but without imposing denitrification would exacerbate existing nuisance conditions from algal growth in the reservoirs, conveyance systems, and treatment plants, including those owned and operated by or for the benefit of the Water Agencies. Ammonia removal without denitrification would also increase the potential for developing eutrophic conditions in the Delta and more frequent *Microcystis* outbreaks and consequent public health impacts. Denitrification would reduce overall levels of nitrogen, improving water quality by restoring proper N:P ratios and reducing the potential for nuisance conditions and toxic algae blooms.

(2) *Tertiary Filtration Is Necessary for protection of human health and to avoid water quality degradation*

The Regional Board also correctly found that Title 22 or equivalent filtration and disinfection, or "tertiary filtration" as used herein, is necessary and BPTC. Tertiary filtration is necessary for the protection of human health and to avoid water quality degradation due to the discharge of pathogens, particularly the protozoa *Giardia* and *Cryptosporidium*. As we have noted in these comments, the Treatment Plant's discharge of *Giardia* and *Cryptosporidium* pose an unacceptable public health risk for recreational and agricultural irrigation uses and a demonstrated impairment of the Sacramento River's municipal drinking water designated use, requiring enhanced levels of treatment under the Surface Water Treatment Rule. Removing pathogens from the Treatment Plant effluent is necessary to restore and protect existing designated uses in the Sacramento River and Bay-Delta as well as for downstream drinking water uses. Downstream drinking water treatment plants rely on multiple barriers to ensure public health protection. Controlling sources of contamination is the first barrier.

As pointed out in the Tentative Order, there are ancillary water quality benefits to providing tertiary filtration in that other constituent concentrations will be reduced. This is particularly true where filtration is provided by membrane technology. Microfiltration is membrane filtration, which is the filtration technology proposed by the Sanitation District.[236] As described in our comments below, microfiltration has been independently recommended as the preferred filtration

[235] The Water Agencies submit that the food web impacts from the discharge of ammonia/um alone justify ammonia/um removal as necessary and BPTC, and this water quality impact should be specifically listed among the factors shown on pages F-91 and F-92.

[236] Carollo Engineers 2010a. Memo from Elisa Garvey to Bob Seyfried, Vyomini Pandya, "Modification of Flow basis for treatment train costs as previously presented in the 'Advanced Treatment Alternatives for the Sacramento Regional Wastewater Treatment Plant' (Carollo, March 2009) based on an average dry weather flow (ADWF) of 181 mgd", (August 19, 2009). .

technology for the Treatment Plant by Trussell Technologies, an engineering firm retained by the Water Agencies.

Microfiltration is a low pressure technology that removes small particles from water based on size exclusion (>0.1 to 0.01µm) and can be useful for wastewater reclamation and reuse.[237] Dissolved components are removed more effectively by desalination with high pressure membranes such as nanofiltration membranes (0.01µm- 0.001 µm) and reverse osmosis membranes (< 0.0001µm).[238] However, microfiltration can be used for the removal of dissolved metals, carbon species, and nutrients, particularly if the target compounds can be converted to small particles or colloids prior to filtration.[239] To optimize removal of dissolved components, various metal salts or oxidants can be added to cause flocculation, precipitation, or colloid formation, depending on the nature of the raw water and the components targeted for removal. Transforming dissolved components to less soluble forms allows the membranes to remove formerly dissolved components, but can also leads to membrane fouling. The particle size of transformed components sometimes determines whether membrane filtration will be sustainable.[240]

In addition, providing tertiary treatment will result in an effluent quality that is suitable for reuse. In 2009 the Sanitation District produced less than 1 mgd of recycled water.[241] The Sanitation District has a goal of increasing water recycling by 30 to 40 mgd by 2024.[242] If the Regional Board requires the Sanitation District to treat the entire effluent flow to tertiary levels, the Sanitation District will have an incentive to provide their treated effluent to meet non-potable water demands in the Sacramento region. This would result in less effluent being discharged to the Sacramento River, and would further protect the beneficial uses of the Sacramento River and Bay-Delta due to the decreased load of all constituents in the discharge.

(3) *Granting An Exception To The Thermal Plan Conflicts With Antidegradation Policy And Temperature Control May Be Necessary*

As described in our comments, Sacramento River ambient water temperatures already reach near fatal levels for protected species in the vicinity of the Treatment Plant's point of discharge. The thermal impacts from the Treatment Plant's discharge are likely having a lethal to sublethal effect on Delta smelt, Chinook salmon, and steelhead—effects that will be greater at the

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[237] Wintgens, M. et al. 2005. The role of membrane processes in municipal wastewater reclamation and reuse. *Desalination* 178: 1-11; Gomez et al. 2007. A comparative study of tertiary wastewater treatment by physico-chemical-UV process and macrofiltration–ultrafiltration technologies. *Desalination* 202: 369-370.

[238] Crittenden, Trussell, et al. 2005. Water Treatment - Principles and Design (2d Ed). John Wiley & Sons.

[239] Jana, S. et al. 2010. Preparation and characterization of low-cost ceramic microfiltration membranes for the removal of chromate from aqueous solutions. *Applied Clay Science* 47: 317–324; Meyn, T. et al. 2008. Significance of flocculation for NOM removal by coagulation–ceramic membrane microfiltration. *Water Science & Technology: Water Supply* 8.6; Koch, J. and VonGottberg, A. 2009. MBR Effectively Removes Phosphorous. *Pollution Engineering* June 2009.

[240] Kimura, K. et al. 2008. Irreversible membrane fouling in microfiltration membranes filtering coagulated surface water. *Journal of Membrane Science* 320: 356–362.

[241] SRCSD. 2009. State of the District Report.

[242] See http://www.srcsd.com/water-recycling-environemnt.php.

permitted flow and under the expanded Thermal Plan exception proposed in the Tentative Order. These thermal impacts are a degradation of water quality and impairment of aquatic life uses in the Sacramento River. However, the Tentative Order's antidegradation discussion does not note these significant impacts or require the Treatment Plant to implement temperature control.

The Sanitation District investigated compliance with the Thermal Plan and concluded that facility modifications or new facilities coupled with operations modifications would be necessary to cool the plant's effluent.[243] Specifically, the Sanitation District's consultant identified installation of evaporative cooling units or construction of a second outfall diffuser as modifications that could lower effluent temperatures.[244] The consultant noted two facilities that have recently installed cooling units – the City of Roseville's Dry Creek Wastewater Treatment Plant and the City of Placerville's Hangtown Creek Water Reclamation Facility – and based on those facilities, estimated the cost for installing cooling units at the Treatment Plant at $121 million.[245]

The Sanitation District's investigation confirms that at least two control technologies are available to avoid degradation of water quality due to thermal impacts. That Sanitation District's assessment of thermal impacts on Delta smelt, salmonids, green sturgeon and other aquatic resources fails to show that these species are protected from harm. It would be inconsistent with Antidegradation Policy to grant an exception to the Thermal Plan. Upon further assessment, it may be necessary for the Regional Board to require temperature control as BPTC. The Sanitation District has provided insufficient information to permit further comment on the specific thermal control method that should be imposed.

(4) *Nitrification/Denitrification and Tertiary Filtration Are Required BPTC For Other Existing Wastewater Treatment Plants That Discharge To The Sacramento River And Delta*

The large number of wastewater treatment plants providing advanced treatment (tertiary filtration and nitrification/denitrification) surrounding the Treatment Plant establishes a standard of BPTC. The Regional Board has required nitrification/denitrification and tertiary filtration plus disinfection for most wastewater treatment plants in the Central Valley as illustrated in Table 6. (A spreadsheet summarizing the major permit requirements for these wastewater plants is provided in Attachment 2.) Nitrification/denitrification has been required by other dischargers to control water quality degradation due to discharge of ammonia/um and nitrates to protect aquatic life and other beneficial uses. The requirement to filter and disinfect wastewater to remove pathogens is due to the use of the receiving waters for municipal water supply, and/or body contact recreation, and/or irrigation of food crops. In many cases, the Regional Board has specifically found nitrification/denitrification and tertiary filtration to be BPTC for these existing plants. The beneficial uses the Regional Board has previously found mandated BPTC in other

[243] Robertson-Bryan, Thermal Plan Exception Justification for the Sacramento Regional Wastewater Treatment Plant, July 2010, p. 42.

[244] *Id.*

[245] *Id.* at pp. 42-43.

plants are the same beneficial uses that are designated for the Sacramento River downstream of the Sanitation District's discharge.

Table 6. Treatment Requirements for Central Valley Wastewater Treatment Plants.

Discharger	Permitted Average Dry Weather Flow, mgd	Treatment Requirements	
		Nitrification Denitrification	Tertiary Filtration
Sacramento (tentative)	181	✓	✓
Stockton	55	✓	✓
Turlock	20	✓	✓
Roseville - Dry Creek	18	✓	✓
Manteca	17.5	✓	✓
Tracy	16	✓	✓
Roseville - Pleasant Grove	15	✓	✓
Vacaville	15	✓	✓
Woodland	10.4	✓	✓
Lodi	8.5	✓	✓
Davis	7.5	✓	✓
Mountain House	5.4	✓	✓
Olivehurst	5.1	✓	✓
Brentwood	5.0	✓	✓
Linda County Water District	5.0	✓	✓
Galt (tentative)	4.5	✓	✓
El Dorado Irrigation District – El Dorado Hills	4.0	✓	✓
El Dorado Irrigation District – Deer Creek	3.6	✓	✓
Grass Valley	2.78	✓	✓
Placerville	2.3	✓	✓
Placer County Sewer Maintenance District	2.18	✓	✓
Auburn	1.67	✓	✓
Live Oak (tentative)	1.4	✓	✓
Willows	1.2	✓	✓
Rio Vista – Northwest	1.0	✓	✓

With respect to the tertiary filtration requirements for other dischargers listed in Table 6, it is noted that in most of the permits, but not all, the requirement to filter and disinfect the wastewater is based on the plant having less than 20:1 dilution in the receiving water. The Sanitation District also has less than 20:1 dilution. The existing permit and Tentative Order for the Sanitation District allow wastewater to be discharged to the Sacramento River when the river

to effluent flow ratio is 14:1. In emergency situations the permitted river to effluent flow ratio is as low as 9:1.

In addition, wastewater treatment plants around the country and state are employing reverse-osmosis (RO), or even RO-plus. Clearly, micro or nano filtration can be considered BPTC for wastewater discharges of impairing pollutants into critically sensitive ecological areas containing listed species that are already suffering serious degradation.

D. Nitrification/Denitrification and Tertiary Filtration Can Be Implemented At Significantly Lower Costs Than Have Been Estimated By the Sanitation District

The Tentative Order cites a total compliance cost for the required BPTC of nitrification/denitrification and tertiary filtration of $2.066 billion.[246] The $2.066 billion cost estimate was developed by the Sanitation District's engineering consultant, Carollo, and is detailed in an August 19, 2010 Memorandum as one of four advanced treatment trains investigated.[247] The $2.066 billion estimate corresponds to "Treatment Train C", which consists of nitrifying trickling filters, fluidized bed reactors, microfiltration, and UV disinfection.[248] The Sanitation District's consultant estimates the nitrification/denitrification component will cost $783 million.[249] The cost for the filtration and disinfection component is the difference – $1.283 billion.[250]

Given the high estimated compliance costs, the Regional Board retained PG Environmental, LLC to review the reasonableness of the Sanitation District's proposed treatment trains and their associated costs. PG Environmental concluded that significant costs savings could be achieved by replacing the proposed microfiltration with granular filtration, for a total compliance cost of $1.346 billion.[251]

The Water Agencies have retained Trussell Technologies, Inc to review the Tentative Order and the Sanitation District's cost and engineering documents to provide another expert opinion of the reasonableness of the proposed treatment trains and costs. Trussell Technologies was also retained to look at ways of accelerating the compliance schedule and means of reducing ammonia loading to the Bay-Delta in the near term. Trussell Technologies based their analyses upon a process train with the greatest probability of being able to achieve the targeted ammonia

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[246] Tentative Order, p. F-93.

[247] Carollo Engineers 2010a, *supra*. See also Carollo Engineers 2010b. Memo from Elisa Garvey to Bob Seyfried, Vyomini Pandya, "Clarification of base construction costs and construction cost factors as presented in the 'Advanced Treatment Alternatives for the Sacramento Regional Wastewater Treatment Plant', (Carollo Engineers, March 2009)", (August 25, 2010).

[248] *Id.*

[249] *Id.*, Table 1 (from Treatment Train B).

[250] In 2003, for the Sanitation District's 218-mgd 2020 Master Plan, the Sanitation District's consultant estimated implementation of filtration and ozone or UV disinfection at considerably lower costs of only $214 to $244 million. See Carollo Engineers 2003, *supra*, p. 4-15.

[251] PG Environmental. 2010. Memo to Kathleen Harder, Regional Board, "Technical Review of Estimated Costs for Propsed Changes to the Sacramento Regional Wastewater Treatment Plant" (August 18, 2010).

reduction, provide improved pathogen inactivation and removal, consistently achieve Title 22 requirements for unrestricted reuse, and oxidize many constituents of emerging concern.[252]

(1) *Nitrification/Denitrification Process and Costs*

While many process alternatives for nitrification/denitrification may be available, Trussell Technologies, Inc. previously recommended in an engineering study commissioned for the Water Agencies, and still recommends, the Modified Ludzack-Ettinger (MLE) process.[253] This recommendation was developed in a study Trussell Technologies performed with the assistance of Civil Engineering Professor David Stensel, University of Washington, as the study's Technical Advisor. The study assumed a goal of reducing ammonia in the Treatment Plant effluent to 1 mg L^{-1}, based on the existing conditions reported in the Sanitation District's Master Plan 2020 (design average dry weather flow of 154 mgd, influent ammonia concentration of 22 mg L^{-1} N). The 1 mg L^{-1} effluent ammonia goal represents a reasonably low permit limit for the study's purpose of developing conservative estimates of feasibility and costs for ammonia/nitrogen removal.

The study initially examined seven potential treatment alternatives. The two most viable alternatives were selected for further study—nitrifying biofilters and converting to the MLE process. The MLE process provides both ammonia removal and nitrogen removal, thus meeting BPTC, and has the added benefit of reducing some biological oxygen demand. Conceptual designs for both options were developed and construction costs estimated. The conversion to MLE process would involve constructing a retrofit of the existing High Purity Oxygen Activated Sludge (HPOAS) process to anoxic conditions, aeration units, blower and power building, pump station, lime storage and feeding facility, and rail spur at a capital cost of $432.3 million, or about 1.6 cents per pound removed. Detailed estimates of operation and maintenance costs were beyond the scope of the study, but the study noted that the MLE options would increase power costs and increase costs due to required lime addition, but would also reduce sludge production by approximately 25 percent.

Because the previous Trussell Technologies study was based on a design flow of 154 mgd, the cost estimates have been conservatively adjusted for the proposed maximum permit flow of 181 mgd plus a peaking factor of 1.33, consistent with the peaking factor previously used by the Sanitation District's consultant.[254] As shown in Table 7, Trussell Technologies estimates the nitrification/denitrification with an MLE process would cost $663.2 million, or *$120 million less* than the estimate by the Sanitation District.[255]

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[252] Trussell Technologies, Inc. 2010b. Letter to Adam Kear, Metropolitan Water District, "Summary of Preliminary Findings in Response to the Tentative SRCSD NPDES Permit" (October 1, 2010).

[253] Trussell Technologies, Inc. 2010a. Ammonia Removal Cost Alternatives for the Sacramento Regional Wastewater Treatment Plant (May 31, 2010).

[254] Trussell 2010b, p.3 (citing Carollo 2005).

[255] *Id.*

(2) *Tertiary Filtration and Disinfection Process and Costs*

While the consultant retained by the Regional Board, PG Environmental, concluded that granular filtration would be an appropriate and cost-saving filtration process, Trussell Technologies has concluded that membrane filtration is a more appropriate filtration choice for tertiary treatment at the Treatment Plant. Trussell Technologies has concluded that granular media filters are not the best alternative for this application because they would require pretreatment and significant chemical addition.[256]

Although Trussell Technologies agrees with the Sanitation District's process choice, it believes the Sanitation District's estimated costs for membrane filtration are overly conservative, based on much smaller plants constructed during the past 10 years. Based upon larger capacity membrane projects, Trussell Technologies determined that a more competitive cost for installed membranes is between $1/gal (86 mgd being installed at the Orange County Water District's Groundwater Replenishment System) and $2/gal (30 mgd under construction at Clark County Water Reclamation District), or less than half the cost used by the Sanitation District's engineering firms in their cost estimates.

For disinfection, Trussell Technologies agrees with PG Environmental's recommendation to replace the UV system with an ozone system, but not to also include hydrogen peroxide. Ozone is a very effective disinfection system with well documented costs and provides ancillary benefits in reducing other constituents of concern, such as many EDCs. Ozone alone has been shown to have excellent destruction of estrogen and pharmaceuticals.[257]

The membrane filtration and ozone cost estimate was estimated based upon a recently awarded large wastewater construction project for Clark County Water Reclamation District, which is more comparable in size than projects previously used for points of reference. Other large projects (e.g. Orange County Water District's Groundwater Replenishment System) were also used as a reference point to verify the CCWRD membrane costs. As shown in Table 7**,** the estimated project cost for microfiltration and ozone is $510 million, and the total estimated costs for the full BPTC treatment train described above is $1,173 million. *This is nearly a 50% reduction from the Sanitation District's estimated cost of $2.066 billion*.

[256] *Id.* at p. 2.

[257] Trussell, Shane. Personal communication.

Table 7. Cost Breakdown for MLE, Microfiltration and Ozone Process Train. [1,2]

Process	**Value, $million**[3]	**Notes**[4]
MLE From Trussell (31 May 2010)	$ 663.2	The estimated cost of the MLE process includes pump stations. ADWF cost scaled up from 154 mgd to 241 mgd. Calculated as Cost = 154 mgd cost x $(241/154)^{0.91}$ (Gates and Scarpa, 1979)
MF and Ozone[5] From CCWRD ozone membrane plant under construction.	$ 509.8	Calculated as Cost = 30 mgd cost x $(241/30)^{0.91}$ (Gates and Scarpa, 1979)
Total	$ 1,173.0	October Sacramento ENR CCI 9518

Notes:
1. Costs are based on an ADMMF of 241 mgd [181 mgd ADWF x 1.33 PF from Carollo (2005)].
2. Total capital costs include all other project costs.
3. All costs are reported in October 2010 dollars ENR CCI 9518, calculated as the average of the ENR CCI 20 Cities (8921) and ENR CCI San Francisco (10,115).
4. ADWF – average dry weather flow; ADMMF – average daily maximum month flow.

E. Measures Are Available To Reduce Compliance Time Frames And Reduce Ammonia/um Loading In The Near Term

The Tentative Order includes a schedule for compliance with the final effluent limitations, which would not have the final limitations implemented for 10 years. Given the severe degradation of water quality and impairment of beneficial uses that will be caused by the discharges during that period, Trussell Technologies examined opportunities to reduce the implementation schedule for BPTC facilities, as well as interim measures that could reduce the extent of degradation and impairment in the intervening years.

With respect to the overall BPTC implementation schedule, measures are available that could reduce both schedule and cost. Specifically, alternative project delivery systems such as Construction Manager at-risk (CM at-risk), or Design-Build; and alternative project approaches such as phased or modular construction can be employed. These have not been considered in the Sanitation District's schedule estimates. CM at-risk is an appropriate method to use for a project of this size and it has been used successfully on other large projects.[258] Design-Build is a project delivery method that the Sanitation District is very familiar with – the Sanitation District has

[258] *Id.* at p. 1.

legislative authority to use the Design Build method[259] and they have successfully used it on other projects such as the Biosolids Recycling Facility located at the Treatment plant.[260]

Phased or modular approaches to project construction may not expedite the overall schedule, but either alternative has the potential to achieve water quality improvements at much earlier milestones in the project schedule, and should also be considered.[261]

Because the proposed BPTC implementation schedule is long, even if accelerated as discussed above, significant water quality degradation in violation of the Antidegradation Policy would continue for years. Therefore, the Regional Board should consider the availability of interim measures designed to improve the effluent quality prior to project completion. Trussell Technologies investigated such measures.[262] Trussell Technologies did not consider interim measures that required the Sanitation District to construct package or capital facilities that would later need to be abandoned or demolished for construction of an ultimate solution. Interim treatment alternatives considered would enhance the Sanitation District's ability to comply with ultimate permit objectives. Two such measures were identified, which can be implemented with minimal impact to the overall project duration or cost, as potential interim measures:

- **Sidestream treatment**: The centrate or filtrate generated from the dewatering processes that remove water from anaerobically digested solids prior to disposal typically has a high ammonia/um concentration ~1,000 mg/L. Designing and constructing a biological treatment system for this sidestream can be performed in the near term because the project is manageable in size with an estimated hydraulic capacity of less than 1 mgd. Additionally, due to the high ammonia/um concentration in this stream, biological oxidation of the ammonia/um in this stream could reduce the mass ammonia/um loading to the Sacramento River by *10 to 30%*.
- **Reclaimed water:** The expanded use of the Sanitation District's recycled water program could also offset ammonia/um discharges to the Sacramento River in the short-term. The Sanitation District has completed the design for its Phase II Water Recycling Program (WRP) expansion project and it is feasible that this project could be constructed and operational within 12 to 24 months.[263] The Sanitation District's South Sacramento County Ag. & Habitat Lands Recycled Water Project is a long-term recycled water project that could dramatically increase the quantity of recycled water delivered by the Sanitation District. This project should also be pursued with urgency. With the addition of Phase II WRP capacity, the Sanitation District could distribute 3,750 acre-ft/year (3.34 mgd) of recycled water, reducing the ammonia/um discharge by 1 to 3%.

Another interim strategy that may hold some promise of reducing the significant adverse impacts of ammonia/um discharge on the aquatic food web is to increase onsite effluent storage during

[259] Gov. Code, § 5956.

[260] Trussell 2010a, p. 2.; Robles, R 2010. "California's First Design-Build Biosolids Thermal Dryer," Presentation to CWEA Biolsolids Specialty Workshop (January 27 2010).

[261] *Id.*

[262] *Id.* at p. 4.

[263] SRCSD 2010. "SRCSD Water Recycling Program." Presentation, June 24, 2010.

certain, critical times. As described elsewhere, food limitation has been identified as a strong contributing factor to the pelagic organism decline. One possible strategy to provide a small measure of relief during the interim period when the Sanitation District is implementing BPTC is to hold back some effluent for a period of time to relieve the ammonium inhibition of phytoplankton bloom formation in Suisun Bay. This strategy does not replace the need for full, year round nitrification/denitrifcation. It does not restore the N:P ratios that are driving species composition elsewhere in the Delta and at other times of the year and may only reduce ammonium inhibition for a short period of time. If pursued, this strategy should be implemented in close coordination with the fish agencies to target a time before clam biomass is too great and when target fish species are located in Suisun Bay.

Using the three criteria that must be met in order for primary productivity to be unimpaired by ammonium as determined by Dugdale *et al* (2010),[264] Dr. Dugdale calculated the ammonium load from the Treatment Plant and the flow rate that are necessary at current discharge rates and concentrations for primary productivity to be unimpaired by ammonium in Suisun Bay. At the current discharge of 140 mgd and effluent ammonium concentration of 24 mg L^{-1}, if the Treatment Plant held back 89 million gallons per day for one week (624 million gallons total), this would reduce the ammonium loading to Suisun Bay to below the Loading Criterion of 0.49 mmol d^{-1}. Holding back the effluent would need to occur when river flow rates exceed 10,500 cfs in order to get ammonium concentrations in Suisun Bay below the Inhibition Criterion of 4 µmol L^{-1} and when river flow rates are less than 42,000 cfs to prevent washout. This assumes an ammonium loss rate of 75% between the diffuser and Suisun Bay.[265] Meeting the three criteria for one week may give the phytoplankton in Suisun Bay a chance to initiate a bloom.

As noted in the Tentative Order, the Treatment Plant currently has five Emergency Storage Basins with a total capacity of 302 million gallons.[266] Given the very large site area available, constructing additional storage basins appears feasible. However, the Water Agencies have not investigated the engineering feasibility of constructing new storage basins and possibly repurposing the existing basins to achieve the required additional retention storage. This measure is suggested merely as a concept that deserves much more study to determine if it is feasible to implement and operate effectively.

It is stressed that the three interim measures described in these comments are not a long term solution, but merely potential strategies to give the Delta's food web a little bit of relief from the

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[264] Inhibition Criterion: ammonium must be less than 4 µmol L^{-1} to prevent inhibition of nitrate uptake (Wilkerson *et al* 2006).

Loading Criterion: ammonium loading to Suisun Bay must be less than 0.49 mmol d^{-1}. Based on Wilkerson *et al* 2006, a value of 0.49 mmol d^{-1} was determined to be the maximum ammonium loading to Suisun Bay that will not overwhelm the ability of the phytoplankton to assimilate and control the ammonium environment in the Bay and prevent the reduction of ammonium concentrations to bloom forming levels (<4 µmol L^{-1}).

Washout Criterion: Flows must be less than 42,000 cfs. The washout point occurs when river flow divided by basin volume exceeds the phytoplankton growth rate of $vNH_4 = 0.1\ d^{-1}$. ($vNH_4 = 0.1\ d^{-1}$ is the mean vNH_4 for phytoplankton in Suisun Bay from Wilkerson *et al* 2006).

[265] Foe *et al*, 2010, *supra*.

[266] Tentative Order, p. F-15.

Sanitation District's discharges until the Sanitation District can install full nitrification/denitrification facilities.

F. Socioeconomic Analysis Mandates That The Treatment Plant Implement BPTC

The EPA has prescribed guidance for states to apply in assessing whether the economic impacts of preventing water quality degradation are so large as to justify the lowering of water quality (where all applicable water quality objectives still would be met). That guidance is set forth in the EPA's March 1995 Interim Economic Guidance for Water Quality Standards Workbook ("EPA Economic Guidance").[267]

As stated in the EPA Economic Guidance:

> The antidegradation policy allows States to lower water quality in high-quality waters only if it is necessary to accommodate important economic and social development. The use of the term "important" communicates a general sense of the level of economic and social development. This provision is intended to permit degradation of high-quality water bodies in *only a few extraordinary cases where the benefits of the economic and social development unquestionably outweigh the costs of lowered water quality*.[268]

To satisfy the requirement of accommodating important economic and social development, the EPA Economic Guidance notes that economic impacts must demonstrate:

> [T]hat the polluting entity, whether public or private, would face *substantial financial impacts* due to the costs of the necessary pollution controls (substantial impacts or would interfere with development).[269]

The 1995 EPA economic guidance document recommends a multi-step process for assessing whether pollution control (treatment) economic impacts are substantial. For public entities (such as POTWs), the multi-step process to assess whether impacts are "substantial" includes:

- Estimating capital and operation and maintenance costs of the pollution controls.
- Identifying the area and number of households affected by the increased cost of pollution control and calculating annual pollution control costs per household.
- Performing a primary economic test by dividing the annual pollution control cost per household by the median household income to develop a screening value. (If the screening value is less than 1 percent of the median household income, the economic cost is presumed to not represent an unreasonable economic hardship.)
- Performing a secondary economic test by evaluating (1) community bond ratings, (2) net debt as a percentage of market value of taxable property, (3) the unemployment rate, (4)

[267] U.S. EPA. 1995. Interim Economic Guidance for Water Quality Standards Workbook (EPA-823-B-95-002).

[268] *Id.* at pp. 1-3, -4, emphasis added.

[269] *Id.* at p. 1-5.

median household income, (5) property tax revenue as a percent of full market value of taxable property, and (6) property tax collection rate.

- Comparing the results from the primary and secondary tests with EPA's "Substantial Impacts Matrix" to determine if the economic impacts are substantial.[270]

If the tests indicate that economic impacts may be substantial, a series of additional steps may be appropriate to determine if the impacts are widespread. These steps include assessing how the pollution control costs would affect such factors as median household income, the community unemployment rate, overall net debt as a percent of full market value of taxable property, tax revenues, development opportunities, and relocation of businesses resulting from the increased costs.[271]

The Water Agencies retained Entrix, Inc. to analyze the BPTC compliance costs under the EPA Guidance, as well with a regional economic model, "IMPLAN." Entrix analyzed the following scenarios and costs:[272]

- Nitrification/Denitrification as Recommended by Trussell Technologies:

  Process: MLE Process
  Capital Cost: $663.2 million

- Full BPTC as Recommended by Trussell Technologies:

  Process: MLE Process + Microfiltration + Ozone
  Capital Cost: $1,173.0 million

- Full BPTC as Recommended by PG Environmental:

  Process: Nitrifying Trickling Filters + Fluidized Bed Reactors + Filtration + Ozone
  Capital Cost: $1,346.0 million

O&M costs were based on the costs reported by the Sanitation District's consultant, Carollo, in its August 19, 2010 memo to determine a ratio of O&M costs to capital costs. Specifically, the Nitrification/Denitrification scenario assumes O&M costs are 4.0% of capital costs; the full BPTC scenarios assume 3.70%. Capital costs were annualized assuming a 30-year amortization period and a 5 percent interest rate.[273]

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[270] *Id.* at pp. 2-1 to 2-13.

[271] *Id.* at pp. 4-1 to 4-7.

[272] Entrix 2010. Technical Memoranda by Paul, Duane and Steve Pavich, "Economic Analysis of the Advanced Treatment Trains in the Tentative NPDES Permit. October 8, 2010.

[273] The amortization period used Carollo Engineers and PG Environmental analyses is 20 years; however, a 30-year amortization period is commonly used by municipalities in debt financing and was also used by the Sanitation District in its 2010 technical memorandum detailing project cost and benefits. The Sanitation District can issue bonds of up to 40 years (Health & Safety Code, § 4788) and the average term of bonds actually issued by the

For each scenario, Entrix first determined the impact on sewer fees, allocating annual costs based on formulas established by the Sanitation District in its May 20, 2009 Antidegradation Analysis.[274] Specifically, costs were allocated among four distinct ratepayer groups: (1) current residential; (2) current non-residential; (3) future residential; and (4) future non-residential. The allocation of costs across these ratepayer groups is 70 percent to current users (30 percent to future users) and 80 percent of costs to residential users (20 percent to non-residential users).

The results of Entrix analyses are presented below, which conclude that none of the scenarios represents a substantial socioeconomic impact that could justify lowered water quality.

(1) ***The Cost For Nitrification/Denitrification Is Reasonable***

Table 8 presents the impacts on sewer rates for Nitrification/Denitrification as recommended by Trussell Technologies. As shown, the sewer rate for current residential users would increase by an estimated $9.39 per month (or $112.68 per year), which is in addition to charges for collection and conveyance of wastewater. The total sewer fee would vary based on provider of collection and conveyance services. On a monthly basis, total sewer fees would range between $34.33 and $45.29, and between $411.96 and $543.48 annually.

Table 8. Sewer Rate Impacts (Nitrification/Denitrification Alternative).

	Sewer Fee (Treatment and Disposal)			Total Sewer Fee	
Contributing Agency	Existing Monthly Rate	Monthly Increase [2]	Sewer Fee (Collection and Conveyance)	Monthly	Annual
Sacramento Area Sewer District	$19.75	$9.39	$15.00	$44.14	$529.68
City of Sacramento			$11.10	$40.24	$482.88
City of West Sacramento			$5.19	$34.33	$411.96
City of Folsom			$16.15	$45.29	$543.48

The EPA Economic Guidance employs a screening test to ascertain whether the ratio of total annual pollution control costs per household (including both existing costs and those which ascribed to the proposed project) over the median household income exceeds a threshold value. If the ratio is less than 0.01 (1.0 percent of median household income), the project is not expected to impose a substantial economic hardship, or as stated by the Guidelines, that "the community can clearly pay for the project." If the cost exceeds 2.0 percent of median household income, the project may place an unreasonable financial burden on ratepayers. Mid-range impacts are expected when the ratio falls between 1.0 and 2.0 percent. It is assumed that ratios well below 1.0 percent indicate that dischargers will be able to pay for the pollution control project without substantial economic impacts. Readings above 1.0 percent may be used as an indication that a Secondary Test should be applied.

Sanitation District since 2000 is 27 years, ranging from 8 to 36 years (see http://www.srcsd.com/pdf/Debt-Composition-SRCSD.pdf.)

[274] Larry Walker Associates. 2009. "Antidegradation Analysis for Proposed Discharge Modifications for the Sacramento Regional Wastewater Treatment Plant, Administrative Draft", May 20, 2009.

Applying the EPA Economic Guidance results in a finding that the Nitrfication/Denitrification alternative would not impose a substantial economic hardship on the community and that the community can clearly pay for the project. Based on the assumptions previously outlined, the Nitrification/Denitrification alternative has an annualized cost of $69.7 million, the current residential share of the project is $39.0 million, and the number of existing households in the region is 477,804 ESD.[275] Because the EPA Economic Guidance focuses on the local households' ability to pay for the project, only current residential costs are considered. The total annualized pollution control cost per household for this scenario is $112.68. This value must be added to the baseline costs of $417 per year (within the Sanitation District's service area), resulting in a total annual cost of $524.83 per household. According to data from the U.S. Census Bureau, the median annual household income for Sacramento County in 2008 was $56,882. This value was adjusted to 2009 levels using CPI to be consistent with project costs, which are estimated in 2009 dollars; the 2009 figure is $56,706. Dividing $529.68 by $56,706 results in a preliminary "screener" value of 0.93 percent, which is below the threshold value of 1.0 percent up to which a "community can clearly pay for the project." With project costs spread out over a growing number of households, the preliminary screener value would be lower still. Because the preliminary screener value is less than 1.0, there is no need to implement the secondary test in the EPA Economic Guidance.

(2) *The Cost For Full BPTC Is Reasonable*

Table 9 and Table 10 present the impacts on sewer rates for full BPTC (nitrification, denitrification and filtration) as recommended by Trussell Technologies and PG Environmental, respectively. As shown, the Sanitation District's sewer rate for current residential users would increase by an estimated $16.13 to $22.18 per month. The total sewer fee would vary based on provider of collection and conveyance services. On a monthly basis, total sewer fees would range between $41.07 and $58.08, and between $492.89 and $696.96 annually.

Table 9. Sewer Rate Impacts of Full BPTC - Trussell Technologies Assumptions.

	Sewer Fee (Treatment and Disposal)		Sewer Fee (Collection and Conveyance)	Total Sewer Fee	
Contributing Agency	Existing Monthly Rate	Monthly Increase [2]		Monthly	Annual
Sacramento Area Sewer District	$19.75	$16.13	$15.00	$50.88	$610.61
City of Sacramento			$11.10	$46.98	$563.81
City of West Sacramento			$5.19	$41.07	$492.89
City of Folsom			$16.15	$52.03	$624.41

[275] LWA 2009, p. 6-10.

Table 10. Sewer Rate Impacts of Full BPTC - PG Environmental Assumptions.

Contributing Agency	Sewer Fee (Treatment and Disposal)		Sewer Fee (Collection and Conveyance)	Total Sewer Fee	
	Existing Monthly Rate	Monthly Increase [2]		Monthly	Annual
Sacramento Area Sewer District	$19.75	$22.18	$15.00	$56.93	$683.16
City of Sacramento			$11.10	$53.03	$636.36
City of West Sacramento			$5.19	$47.12	$565.44
City of Folsom			$16.15	$58.08	$696.96

Applying the EPA Economic Guidance as previously described for the total annual cost of $119.7 million to $164.6 million for the Trussell and PG Environmental BPTC scenarios, respectively (current residential allocation of $67.0 to $92.2 million) results in preliminary screener scores just above the threshold of 1.0%. The preliminary screener score for BPTC as recommended by Trussell Technologies is 1.08%, the score for BPTC as recommended by PG Environmental is 1.2%. Where the preliminary screener score falls above 1.0 percent, the EPA Economic Guidance calls for a second test to determine if "substantial" economic impacts would be incurred in order to avoid lowering water quality.

The secondary test established by EPA focuses on the community's ability to obtain financing and the socioeconomic health of the community. Six indicators are used to develop a composite score for the community: (1) bond rating, (2) overall net debt as a percent of full market value of taxable property, (3) unemployment rate, (4) median household income, (5) property tax revenue as a percent of full market value of taxable property, and (6) property tax collection rate. The application of these indicators to Sacramento County is presented below.

- Bond Rating: The bond rating in Sacramento County as rated by Moody's is A3. Bond ratings above Baa (Moody's) are considered "strong" and receive a rating of 3 for this indicator.
- Overall Net Debt as a Percent of Full Market Value of Taxable Property: Overall net debt (repaid by property taxes) in Sacramento County in Fiscal Year 2009 was $1.4 billion. The full market value of taxable property in the county is unknown; however, a conservative estimate can be obtained using the total assessed value of taxable property, which was $138.7 billion in Sacramento County in 2009. Based on these values, this parameter is estimated at 1.02 percent. Values below 2 percent are considered "strong" and receive a rating of 3 for this indicator.
- Unemployment Rate: This parameter considers the unemployment in the affected community to the national rate. In 2009, the average annual unemployment rate in Sacramento County was 11.3 percent compared to 9.3 percent for the U.S. The unemployment rating in the county is more than 1 percent above the national average. This indicator is considered "weak" and receives a rating of 1.
- Median Household Income: This parameter considers the median household income in the affected community relative to the income levels in the state it is located in. Using

census data (adjusted to 2010 levels), the median household income in Sacramento County is $58,039 compared to $62,258 in California. The median household income level in the county is within 10 percent of the state level. Therefore, this indicator is considered "mid-range" and receives a rating of 2.

- Property Tax Revenue as a Percent of Full Market Value of Taxable Property: This parameter is excluded from the analysis because property taxes in California are subject to a statutory limit per Proposition 13. The EPA Economic Guidance states that there is no appropriate substitute in these cases, and that this indicator should be dropped and the other five factors are assigned equal weights.
- Property Tax Collection Rate: The property tax collection rate in Sacramento County is 96.2 percent. The collection rate falls between 94-98 percent, which is considered "mid-range" and receives a rating of 2.

The total composite score for all five applicable indicators is 11 and the average is 2.2. The average score (2.2) is the secondary score under the EPA Economic Guidance.

To determine whether a community would incur substantial economic impacts, both the preliminary screener value and secondary score are considered in the "assessment of substantial impacts matrix" shown as Table 11 and Figure 8. For BPTC, the preliminary screener value is 1.1 to 1.2 percent and the secondary score is 2.2.

The EPA Economic Guidance has provisions if both the screener value and secondary score are borderline, which is the case here, and indicates that the community should move into the category closest to it. Here, the preliminary screener value is close to being less than 1 percent and the secondary score is close to being greater than 2.5 (particularly if full market value of property is considered). As a result, the project would fall into the able to pay category indicating, that the impact is not likely to be substantial. This is particularly true for the BPTC using the process and cost assumptions recommended by Trussell Technologies.

Table 11. Impact Scoring Matrix for Pollution Control Costs (EPA Guidelines).

	Municipal Preliminary Screening Score		
Secondary Score	Less than 1.0%	1.0% - 2.0%	More than 2.0%
Less than 1.5	?	X	X
1.5 – 2.5	✓	?	X
Greater than 2.5	✓	✓	?

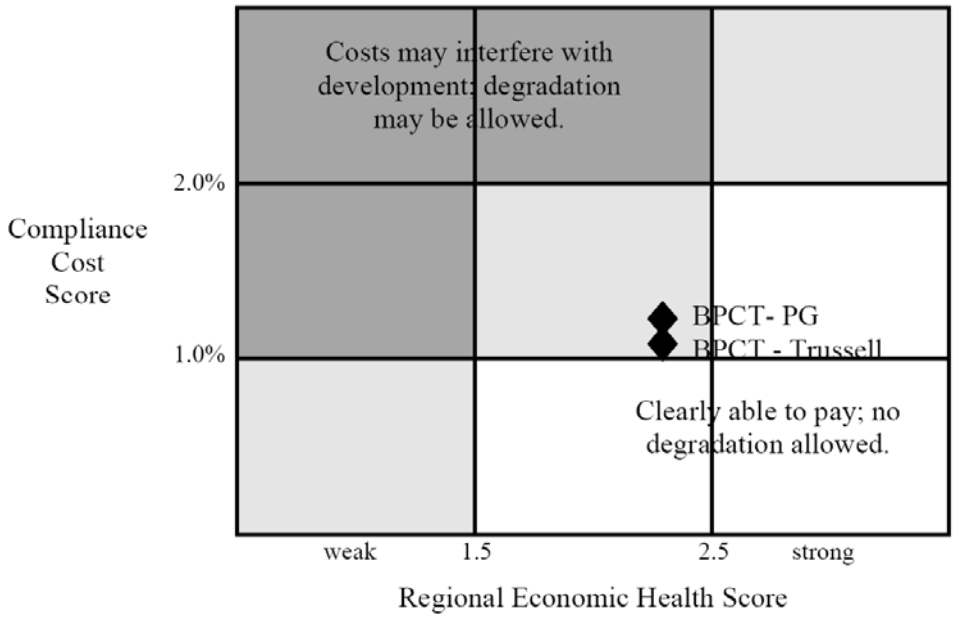

Figure 8. Impact Scoring Matrix for Pollution Control Costs (EPA Guidelines).

(3) *Regional Economic Impacts Of BPTC Are Minimal*

As presented above, the EPA Economic Guidance suggests that implementation of BPTC would not result in substantial economic impacts on households in the Sanitation District's service area. Entrix also considers the regional economic effects of proposed changes in sewer rates under the more conservative PG Environmental assumptions using the IMPLAN model, which takes into account the ripple effects in the local economy from reductions in household spending patterns.

The regional economic analysis is intended to demonstrate how the local economy would be affected by projected changes in sewer rates with BPTC implemented. This analysis captures the monetary flows throughout the local economy in response to increases in sewer rates, which would reduce the amount of disposable personal income (DPI) available to local households.

This analysis utilizes a framework similar to that used in the 2009 LWA Antidegradation Analysis. The analysis was conducted using IMPLAN, an economic modeling program commonly used to conduct regional economic analyses. The economic model was constructed using the zip code-level data associated with the Sanitation District's service area – in total, 53 zip codes comprise the study area in the economic model.

In order to conduct the regional analysis, project costs were allocated across household income classes as shown in Table 12, which represent inputs to the IMPLAN model. The focus of the analysis is on impacts on current residential ratepayers, who are most likely to be affected by reductions in disposable income.

Table 12. Project Cost Allocation Across Household Income Classes (Full BPTC - PG)

Household Income Class	Average Annual Household Income	Disposable Household Income	Number of Households	% of Total	Project Cost Allocation				
					Current Residential	Current Non-Residential	Future Residential	Future Non-Residential	Total
< 10K	$8,453	$8,299	44,274	8.5%	$7,841,598	$1,960,400	$3,360,685	$840,171	$14,002,854
10-15K	$21,133	$21,213	31,428	6.0%	$5,566,296	$1,391,574	$2,385,555	$596,389	$9,939,815
15-25K	$33,803	$30,433	63,260	12.2%	$11,204,348	$2,801,087	$4,801,863	$1,200,466	$20,007,764
25-35K	$50,683	$43,997	67,357	12.9%	$11,929,970	$2,982,493	$5,112,844	$1,278,211	$21,303,519
35-50K	$71,804	$63,894	88,930	17.1%	$15,750,851	$3,937,713	$6,750,365	$1,687,591	$28,126,520
50-75K	$118,222	$100,068	105,573	20.3%	$18,698,620	$4,674,655	$8,013,694	$2,003,424	$33,390,393
75-100K	$151,991	$124,122	56,318	10.8%	$9,974,842	$2,493,711	$4,274,932	$1,068,733	$17,812,218
100-150K	$211,032	$164,364	44,021	8.5%	$7,796,805	$1,949,201	$3,341,488	$835,372	$13,922,866
150K+	$337,654	$247,754	19,139	3.7%	$3,389,839	$847,460	$1,452,788	$363,197	$6,053,284
Total	$95,654	--	520,302	100.0%	$92,153,170	$23,038,292	$39,494,216	$9,873,554	$164,559,232

The results of the regional economic analysis cover both the scenario where only current residential ratepayers would be affected, as well as the scenario where the total cost of the project would affect household income levels. The results of the regional economic analyses are presented in Table 13.

Table 13. Regional Economic Effects of the Full BPTC - PG Environmental.

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	- 447.4	- $19,669,299	- $34,675,118	- $56,612,177
Indirect Effect	- 112.8	- $6,265,708	- $10,193,903	- $17,089,721
Induced Effect	- 120.3	- $5,516,381	- $9,612,401	- $15,815,989
Total Effect	- 680.5	- $31,451,388	- $54,481,422	- $89,517,887

Implementation of BPTC is expected to result in the following impacts in the Sanitation District's service area: loss of about 681 jobs and reduction in annual labor income, value added and economic output of $31.5 million, 54.5 million, and $89.5 million, respectively.

These regional economic impacts of implementing BPTC must be considered in the context of the size of the local economy and current economic conditions. In total, the local economy covering the Sanitation District's service area supports approximately $108.0 billion in economic output, $46.7 billion in labor income, and $67.7 billion in value added on an annual basis. Further, the local employment base totals 830,130 jobs. Estimated job losses anticipated with implementation of BPTC account for less than 0.1 percent of the local employment base, which can be considered a negligible impact on overall economic conditions in the study area regardless of which scenario is used.

(4) *The Sanitation District Must Consider The Socioeconomic Impacts It Is Causing to the Areas Served By SWP and CVP Water*

The socioeconomic cost of maintaining baseline water quality is not the sole cost consideration that the Sanitation District must assess for the Regional Board in order to justify allowing its Treatment Plant discharges to continue to degrade water quality in the River and Bay-Delta. Antidegradation Policy also requires the Sanitation District to assess the broader environmental and socioeconomic harm caused when secondary treated wastewater is discharged directly into the heart of California's water supply system. Those discharges affect fresh drinking water for more than 25 million Californians in two thirds of the State's households and irrigation water that is used to sustain orchards, vineyards and other crops on 2 million acres of prime farmland.

Direct and indirect ammonia/um impacts, impacts from other toxic pollutants (including additive toxicity impacts from copper, pesticides, etc.), temperature impacts, dissolved oxygen impacts and other water quality impacts of the Sanitation District's discharge are contributing to the decline of Delta smelt and other state and federally protected fish species whose decline has caused dramatic reductions in SWP and CVP water availability. The Sanitation District has failed to consider, no less even mention, the socioeconomic impact arising from reduced SWP and CVP water availability.

There are no published reports of which the Water Agencies are aware that consider the specific socioeconomic impacts the Sanitation District is causing to the areas served by SWP and CVP water. However, there is a report that considers the overall socioeconomic impacts from reduced water availability in 2009.[276] In that report, economists from U.C. Davis and the University of the Pacific concluded that in 2009, as a result of a relatively dry hydrology and water supply restrictions imposed on the SWP and CVP under the federal Endangered Species Act, in the San Joaquin Valley as many as 7,434 jobs, more than $278 million in income, and more than $368 million in overall economic output were lost. The economists were able to estimate, that the ESA-based restrictions alone caused the San Joaquin Valley to lose as many as 3,000 jobs, more than $111 million in income, and more than $318 million in overall economic output.[277]

As discussed in detail in these comments, the Sanitation District's discharge is harming the very aquatic species the intended protection of which caused the losses identified by the economists from U.C. Davis and the University of the Pacific. And, while the full extent of those impacts may not be attributable solely to the Sanitation District, the research and data demonstrate that the Sanitation District's discharges are quite clearly harming aquatic species and contributing significantly to the pelagic organism decline in the Delta. However, the Sanitation District has not considered how its operations have and may continue to redirect regulation to the SWP and

[276] Michael J., et al. 2009. A Retrospective Estimate of the Economic Impacts of Reduced Water Supplies to the San Joaquin Valley in 2009 (September 28, 2010) (U.O.P-U.C. Davis Report), Table 11 at p. 14.

[277] Those impacts do not begin to cover the full breadth and depth of socioeconomic costs because reduced SWP and CVP water availability harms more than the San Joaquin Valley. Ongoing SWP and CVP water delivery reductions arising from listed species regulations harm family households and businesses from the San Francisco Bay Area to San Diego every year. (See, e.g., California Department of Water Resources, 2009 State Water Project Delivery Reliability Report, Table 6.3-6.4 [projecting reduction in long-term average annual SWP water delivery reliability to 60 percent of contract Table A amounts).

CVP and thus cause socioeconomic impacts to the areas they serve. That consideration must be part of the Sanitation District's analysis of the socioeconomic cost of maintaining baseline water quality and must be considered fully by the Regional Board before it could grant any exception to the Sanitation District from BPTC based on an analysis of the economic impacts of the upgrades.

IX. The proposal in the Tentative Order to require nutrient removal and filtration is consistent with California's fundamental water policy

The Tentative Order's proposal to require the Sanitation District to install full nutrient removal and microfiltration also squares with long held California water policies set by the State Board, the State Constitution, and the State Supreme Court to protect state water resources. Additional requirements urged by the Water Agencies in these comments likewise are supported by these fundamental principles of California law.

Indeed, the State Board decided almost 40 years ago in the "Delta Water Rights Decision" that specifically protecting the Delta from pollution through the use of "stringent controls" was a "prime objective." As the State Board held:

> Recent state and regional board activity in the regulation of waste discharges demonstrates an intent to protect the Delta environment with stringent controls on waste discharges at the earliest reasonable date. Waste discharges will be managed and where possible reused with a view toward achieving these prime objectives. No one has a right to pollute the waters of the state regardless of the quality of water that may flow in the particular streams.[278]

The requirement to insist upon full nutrient removal and filtration are also consistent with California's most fundamental declaration of water policy in Article X of the State Constitution to protect the full beneficial uses of our state's waters:

> It is hereby declared that because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare.[279]

Requiring the Sanitation District to stop its continued pollution of the Bay-Delta is also consistent with the California Supreme Court's holding that pollution of a water supply effects an invasion of a legal right. In *Wright v. Best* (1942) 19 Cal.2d 368, the Court held that an appropriator of water:

[278] State Board Decision 1379 at p. 40 (1971.)

[279] Cal. Const., Art. X, § 2.

> is entitled to have the water at his point of diversion preserved in its natural state of purity and any use which corrupts the water so as to essentially impair its usefulness for the purposes to which he originally devoted it, is an invasion of his rights. Any material deterioration of the quality of the stream by . . . others without superior rights entitles him to both injunctive and legal relief.[280]

The Sanitation District's continued use of developed SWP and CVP storage releases to dilute its wastewater would violate these principles established by the California Legislature, the State Board, and the State Supreme Court and would directly harm the Water Agencies' legal rights and interests in the stored and released water. Indeed, the Sanitation District's continued use of SWP and CVP reservoir releases to dilute, transport and dispose of the Sanitation District's wastewater is precisely the unreasonable waste of water that the State Constitution declared should be prevented. That unreasonable use and waste of SWP and CVP stored water will be addressed, at least in part, by the Regional Board approving the Tentative Permit's proposal to require nutrient removal and filtration, as well as the others terms and conditions set forth in the Tentative Permit or as requested in these comments.

X. Compliance Issue

A. The Tentative Order Contains An Improper Compliance Schedule

The current Tentative Order contains a compliance schedule which would allow the Sanitation District to discharge large and increasing amounts of ammonia/um into the Sacramento River for the next 10 years.[281] This compliance schedule violates the CWA, the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan), and the Water Quliaty Control Plan for the Bay-Delta by allowing the Sanitation District to discharge ammonia/um in excess of the current water quality standards. The compliance schedule should be removed from the permit and placed into a stand-alone Cease and Desist Order and time schedule order.[282] That approach is needed particularly since the Sanitation District plans on increasing the adverse effect it is having on the Bay-Delta and has no plan to minimize or mitigate those effects. Issuance of a Cease and Desist Order is consistent with the approach the Regional Board took in the permitting for the Stockton Publicly Owned Treatment Works (POTW).[283] The Final Order must be structured in this manner in order to comply with law, and also so that the Regional Board does not abuse its discretion.

It is well established under the federal CWA and the Regional Board's Basin Plan that compliance schedules are not appropriate to implement older water quality standards such as the DO and narrative toxicity standards, upon which the proposed ammonia limits in the Tentative

[280] *Wright v. Best*, 19 Cal.2d at 378.

[281] Tentative Order, p. 33-34.

[282] See Cal. Wat. Code §§ 13303, 13308.

[283] See Regional Board Order No. R5-2002-0083.

Order are based.[284] The proposed compliance schedule is not lawful under these principles given that the relevant standards have not changed since the 1970s and have not been relaxed.[285]

The Tentative Order documents state that the proposed ammonia limits for the Sanitation District's POTW are "newly interpreted," and therefore subject to an exception to the prohibition against compliance schedules for older standards.[286] The Tentative Order's reliance on this exception is not well founded for three reasons. First, it violates U.S. EPA regulations and the federal CWA, which contains no such exception. Second, the ammonia limits are driven in part by the DO standard which characteristically is interpreted to prevent consumption of oxygen related to nutrients such as ammonia. In other words, there is nothing new about regulating the causes of oxygen depletion and DO exceedances. Rather, this is common and traditional California Water Board practice, and cannot be used to avoid the prohibition for using compliance schedules to enforce old water quality standards.

Finally, the Tentative Order does not constitute a new interpretation of the narrative toxicity objective. The narrative toxicity objective routinely has been interpreted by the Regional Board to require ammonia limits, nitrification, and denitrification, and the Basin Plan explicitly states that all material and relevant information shall be considered in evaluating compliance with the objective.[287] That was exactly the situation in the City of Stockton permit proceeding which resulted in a Cease and Desist Order for the ammonia limits based on the narrative toxicity objective.[288] In addition to the Stockton permitting matter, the Regional Board has interpreted the narrative toxicity standard to require ammonia limits, nitrification, and denitrification many times during this past decade.[289] While we understand that compliance schedules were issued for some of these permits, these permits establish a body of prior interpretation of the narrative toxicity standard that renders further reliance on compliance schedules including that proposed for the Sanitation District improper.

The facts and circumstances surrounding the Sanitation District's Treatment Plant also point towards a stand-alone order, rather than a compliance schedule, to address the immanent non-compliance with the proposed ammonia limits. The Sanitation District has had years to address ammonia in its discharge, but has done little or nothing while a number of small treatment plants have moved forward with nutrient removal. This is particularly troubling in light of the fact that

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[284] 33 U.S.C. § 1131(b); 40 CFR 122.44(a)(1); Basin Plan III-2.00. The current edition of the Basin Plan allows for compliance schedules "not to exceed 10 years after the adoption of applicable objectives or criteria," but only in the case where, "water quality objectives and water quality criteria [are] *adopted after the effective date of this amendment to the Basin Plan*." Basin Plan III-2.00. (emphasis added).

[285] See e.g., Regional Board Order No. R5-2002-0083,10.7 (imposing a cease and desist order on the Stockton POTW instead of a compliance schedule within the NPDES permit itself, where ammonia limits were based on the narrative toxicity standard which had been relaxed, but not otherwise changed, since 1975).

[286] See e.g., State Board Order WQ 2001-06, pg. 53-55.

[287] Basin Plan III-8.01.

[288] Order No. R5-2002-0083,10.7; Order No. R5-2002-0084, CDO.

[289] See e.g., Order, No. R5-2008-0053 (City of Placerville, Hangtown Creek Water Reclamation Facility), No. R5-2007-0132 (City of Davis Wastewater Treatment Plant), No. R5-2004-0094 (Olivehurst Public Utility District Wastewater Treatment Facility), No. R5-2003-0031 (City of Woodland Water Pollution Control Facility).

the Sanitation District's 1994 Master Plan for the Treatment Plant was based on nutrient removal.[290] Before implementing that Master Plan, the Sanitation District took advantage of a change in standards to revise it to eliminate nutrient removal.[291] In addition, the Sanitation District on a regular basis has violated the narrative toxicity standard on which the ammonia limits are partially based. These violations provided another impetus for the Sanitation District to move forward with nutrient removal; but it did not.

The Regional Board would be well served as a matter of policy by issuing a stand-alone Cease and Desist Order to enforce the ammonia limits. Doing so creates a much greater likelihood that full nutrient removal will be achieved in the shortest practicable time. Extending to the Sanitation District what it may argue constitutes a permit shield, makes no sense under the dire circumstances created by almost three decades of unabated and increasing ammonia discharges, and the associated degradation.

B. An Opportunity for Public Comment Should Occur Before Adoption of a Pollution Prevention Plan

The Tentative Order calls for the Sanitation District to submit and implement a Pollution Prevention Plan within 1 year of adoption of the Final Order.[292] The Pollution Prevention Plan is a crucial part of the permit, essentially acting as the standard to which the Sanitation District will be held in the time between the adoption of this permit and their achieving full compliance.[293] During the intervening years, the Sanitation District has a duty to achieve the final effluent limitations in as short a time as possible and reduce their current ammonia output as much as possible.

As such, this critical Plan and its implementation will directly impact the Sacramento River and Bay-Delta, as well as the designated and interested parties involved in this proceeding. The Water Agencies therefore request that the Regional Board include in the Final Order "an opportunity for comment at a public proceeding with regard to that plan" as authorized by Water Code section 13263.3(e) before approval and adoption of the Plan. The proposed Pollution Prevention Plan should include the Interim Measures plan as outlined in Section II, above. To stay within the one year period to adopt and implement the Plan, the Sanitation District should submit its proposed Plan not more than 60 days after a final permit is approved. As the Regional Board has recognized, there are many complex and controversial permitting issues for this facility. By allowing an opportunity for public comment on the Pollution Prevention Plan at a public proceeding in the Final Order, the Regional Board will assure that the public's interests are fully and fairly protected.

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[290] SRCSD, 1994 Master Plan Update.

[291] State Board Res. No. 94-87 (rescinding the Inland Surface Waters Plan).

[292] Tentative Order, p. 35, F-115.

[293] As described elsewhere in these comments, the Water Agencies maintain a 10-year compliance date is excessive and in violation of the state and federal antidegradation policy.

XI. The Water Agencies Fully Support the Following Provisions in the Tentative Order and Request that they be Adopted in the Final Order

1. The Water Agencies strongly support the Tentative Order's requirement that the Sanitation District update its Treatment Plant to incorporate ammonia removal through nitrification as BPTC and for the protection of beneficial uses. The Tentative Permit provides sufficient support for this determination; however, additional support is provided in the Water Agencies comments, attachments and references.

2. The Water Agencies strongly support the Tentative Order's requirement that the Sanitation District update its Treatment Plant to incorporate nitrate removal through denitrification as BPTC and for the protection of beneficial uses. The Tentative Permit provides sufficient support for this determination; however, additional support is provided in the Water Agencies comments, attachments and references

3. The Water Agencies strongly support the Tentative Order's requirement that the Sanitation District update its Treatment Plant to incorporate pathogen removal through tertiary filtration as BPTC and for the protection of beneficial uses. The Tentative Permit provides sufficient support for this determination; however, additional support is provided in the Water Agencies comments, attachments and references.

4. The Water Agencies strongly support the Tentative Order's determination that a mixing zone for acute aquatic life criteria should not be granted. The Tentative Permit provides sufficient support for this determination; however, additional support is provided in the Water Agencies comments, attachments and references.

5. The Water Agencies strongly support the Tentative Order's determination that a mixing zone for ammonia/um should not be granted. The Tentative Order provides sufficient support for this determination; however, additional support is provided in the Water Agencies comments, attachments and references.

6. The Water Agencies support the pathogen monitoring requirements in the Tentative Order.

7. The Water Agencies support the Regional Board's proposal to require effluent (Tables E-3a and E-3b), and receiving water (Table E-6b) monitoring that includes certain CECs. See e.g., Table E-3b, n.8 and Table E-6b, n.6 (referring to chemicals classified as "Other Constituents of Concern").

8. The Water Agencies support the requirement in Attachment I to conduct an "Effluent and Receiving Water Characterization Study."

9. We commend the Regional Board on the inclusion in the Tentative Order of an effluent limit on salinity and a requirement for a salinity minimization plan.

A. The Water Agencies Request that the Following Changes to the Tentative Order be Adopted in the Final Order

(1) *Nutrients*

1. The Final Order should require that nutrient removal be incorporated in the shortest practicable time with milestones enforceable through a Cease and Desist Order.

2. The Regional Board should issue a Cease and Desist Order and require the Treatment Plant to submit a plan within 60 days that would propose as part of the Pollution Prevention Plan a set of Interim Measures to reduce the mass of total ammonia/um and nitrogen loadings in the effluent each year until full nitrification and denitrification facilities are completed. The Interim Measures plan should be made available to the public for review and comment prior to implementation.

3. The Tentative Order sets an interim maximum daily effluent limit for ammonia/um at 45 mg L^{-1}, allowing a doubling of ammonium discharges into the Sacramento River and Bay-Delta over the next ten years. The Final Order needs to set interim average monthly, average weekly, and maximum daily effluent limits for ammonium concentration and load that, at a minimum, do not allow an increase over current discharge levels.

4. The Tentative Order does not set any effluent limits for total nitrogen. The Final Order needs to set average monthly, average weekly and maximum daily effluent limits for total nitrogen that, at a minimum, do not allow any increase over current discharge levels during the interim period and correspond to decreased nitrogen loading once full nitrification/denitrification facilities are operational.

5. The Tentative Order does not set any effluent limits for total phosphorus. The Final Order needs to set average monthly, average weekly and maximum daily effluent limits for total phosphorus that do not allow any increase over current discharge levels.

6. Table E-3a in the Monitoring and Reporting Program should be expanded to include total phosphorus monitoring of the effluent at least monthly. Table E-6b needs to include monitoring for nutrients (ammonia/um, nitrite, nitrate, total kjeldahl nitrogen and total phosphorus) in the receiving water at least monthly. And, Table I-1 needs to specify criterion quantitation limits for ammonia/um, total phosphorus, nitrate, nitrite, and total kjeldahl nitrogen no higher than 10 μg L^{-1} to detect environmentally relevant concentrations.

7. The Tentative Order allows an increase in the allowable pH range from 6.0 -7.5 as a 1-hour average to a range of 6.5 - 8.5 as an instantaneous minimum and maximum. No increase in pH should be allowed in the Final Order.

(2) *Pathogens*

8. The Final Order should require that tertiary filtration be incorporated in the shortest practicable time with milestones enforceable through a Cease and Desist Order.

9. The Regional Board should require the Sanitation District to cooperate with the DWR MWQI Program in a planned pathogen study in the vicinity of the discharge in 2011 and provide effluent samples and the data collected by the Sanitation District as part of its routine monitoring program.

(3) *Toxicity*

10. The Final Order should not allow a mixing zone for chronic aquatic life criteria.

11. The Tentative Permit should explicitly acknowledge that the Sanitation District's wastewater is discharged into a waterbody listed on the CWA 303(d) list for Chlorpyrifos, DDT, Diazinon, Exotic Species, Group A Pesticides, Mercury, Polychlorinated byphenyls (PCBs) and unknown toxicity. The Final Order needs to set effluent limits including mass limits for ALL listed constituents.

12. The Final Order should include a finding that the Basin Plan requires the consideration of additive toxicity. This finding is relevant to conducting the Reasonable Potential Analysis, determining effluent limits, and in the Anti-degradation analysis. Metals such as Cu, Cd, Zn and Pb are known to be additive. Pyrethroids are additive. Cu, as an acetylcholinesterase inhibitor in salmon, should also be considered additive with the OP pesticides.

13. The Tentative Order relies on a reasonable potential analysis for hardness-dependent metals that uses incorrect statistical multipliers as required by Federal regulations, 40 CFR § 122.44(d)(1)(ii). The Final Order needs to establish effluent limitations for metals based on the hardness of the ambient upstream receiving water hardness as required by Federal Regulations, the California Toxics Rule (CTR, 40 CFR 131.38(c)(4)). The Tentative Order likely underestimated the toxic effect of metals during the RPA and additional effluent limits are likely required for constituents such as copper, lead, zinc, and aluminum. Effluent limits should also be considered for pesticides and TDS.

14. The monitoring and special studies plan should describe a WET testing program that is designed to maximize the ability to identify toxicants, and to answer the questions that are implicitly raised in the permit.

a. No manipulation of the effluent to control for ammonia or pH should be allowed;

b. The upstream ambient river water should be used as the dilution water;

c. The fish for acute testing should be as young as possible, consistent with the lower range given in the acute methods;

d. TIE manipulations to address ammonia toxicity need to be carefully designed since controlling or eliminating ammonia will alter or eliminate other potential toxicants as well, such as metals, surfactants and certain types of organics;

e. Rainbow trout testing should be added to the suite of test species; however, fathead minnow testing should not be removed from the chronic tests. Both fish species should be used in chronic testing;

f. The use of *Hyallella* should augment the list of species tested, and not be a replacement for *Ceriodaphnia*;

g. The approach to algal testing needs to be re-examined in light of the known algal toxicity to ammonium and the indication that a second toxicant is likely present.

15. Concurrent chemistry analysis should be required during all chronic and TIE testing.

16. The toxicity effluent limit should reflect the worst case dilution scenario. If the permit is not modified to incorporate an enforceable chronic WET limit equivalent to the worst case instream waste concentration (IWC), as the proposed toxicity policy requires, the 6 TUs in the proposed permit should change from being a trigger to being an enforceable effluent limit.

(4) ***Emerging Contaminants***

17. The Regional Board has appropriately included NDMA as one of its priority pollutants to be monitored for in the Sanitation District's Waste Discharge Requirements. N-Nitrosomorpholine (NMOR) is a nitrosamine that is commonly found in wastewater effluent, and should also be included in Tables E-3b and E-6b of "Other Constituents of Concern" to be monitored.

18. The Final Order should require the Sanitation District to cooperate and participate in studies to advance the state of knowledge of CECs in California's water systems, particularly in a planned follow-up study to the National Water Research Institute funded study of the occurrence, fate and transport of PPCPs in three California watersheds.

19. The Final Order should require the Sanitation District to implement CEC Science Advisory Panel monitoring requirements for water recycling activities.

20. The Final Order should include reopeners that would allow increases in CEC monitoring requirements based on the findings of the Emerging Constituents Workgroup and that would apply the same types of CEC-monitoring requirements on the Sanitation District as are imposed on downstream user of Delta water.

21. The Final Order should include representative CEC monitoring that is indicated in the draft and upcoming final Groundwater Recharge Reuse Regulation into the monitoring program requirements.

22. The Final Order should require the Sanitation District to conduct a focused public education and outreach campaign on pharmaceutical disposal and a source control study.

23. The Final Order should require the Sanitation District to submit a CEC adaptive monitoring strategy to address and account for anticipated changes in the state of scientific knowledge and statewide regulatory guidance involving CECs.

(5) ***Temperature***

24. The Tentative Order grants the Sanitation District's request for an expanded exception to the Thermal Plan. The Sanitation District has not shown that the Thermal Plan is more protective than necessary to protect and propagate ESA listed fish species and other aquatic organisms utilizing the reach of the Sacramento River affected by its discharge. The Final Order should therefore reject the Sanitation District's request for an exception to the Thermal Plan.

(6) ***Salinity***

25. The Final Order should be modified to set a limit of annual average effluent electrical conductivity no greater than 595 μmhos cm^{-1} to avoid increasing the salt load.

26. The Regional Board should address its Region-wide effort to reduce salinity by setting an annual salinity load limit consistent with current conditions, as was done for the University of California, Davis, wastewater treatment plant permit, and then requiring a certain percentage decrease in allowable salt load each year, following the approach applied by the Regional Board for the Grassland Bypass Project.

27. The Final Order should set mass-based limits for chloride and TDS, as salt load and weekly and monthly average concentration limits.

28. The Final Order should specify that the Salinity Evaluation and Minimization Plan identify specific effective and implementable source control measures.

(7) ***Antidegradation Policy***

29. The Regional Board should reject the Sanitation District's proposal to use an improper baseline in applying Antidegradation Policy to the Treatment Plant's discharge.

30. Nitrification/denitrification and tertiary filtration can be implemented at significantly lower costs than have been estimated by the Sanitation District.

31. Measures are available to reduce compliance time frames to implement BPTC. The Final Order should require that the Sanitation District consider alternative project approaches such as Construction Manager at-risk, Design-Build, and phased or modular construction and require that BPTC be implemented in the shortest practicable time with milestones enforceable through a Cease and Desist Order.

(8) ***Additional Changes Requested***

32. The Water Agencies request that the Final Order include a requirement to immediately notify downstream drinking water agencies if there are spills of untreated or partially treated wastewater from the Sanitation District's facilities into the Sacramento River and Bay-Delta waters. Attachment 3 is contact information for the agencies that should be notified.

33. The Tentative Order requires that Self-Monitoring Reports be submitted in hard copy until the State Water Board's California Integrated Water Quality System Program Web site is available. The Final Order should require that Self-Monitoring Reports be submitted in excel spreadsheets (or equivalent data format) and made available to the public upon adoption of the Final Order.

34. The Tentative Order requires that the Sanitation District conduct five Special Studies and to submit workplans and time schedules within 90-days from adoption of the Final Order (*see* Tentative Order at pp. 25-29). The Water Agencies request that draft workplans be prepared within 60-days of permit adoption and be released for public review and comment before approval by the Regional Board.

XII. Tentative NPDES Permitting Options

A. The Regional Board Cannot Adopt the Tentative NPDES Permitting Options Until Further Regional Board Staff Analysis is Complete

Separate and apart from the requirements set forth in the Tentative Permit, the Regional Board's staff has provided a "brief description" of certain "permitting options." The Water Agencies submit that the brief description of options is not a sufficient basis for revising the tentative permit at the Regional Board's December 8-10 hearing. Those options are not simply alternative means to achieve the discharge cleanup and beneficial use protection requirements identified by

Regional Board staff in the proposed permit findings and Fact Sheet. Rather, they are diametrically opposed to those goals and objectives, and would allow the Treatment Plant's ongoing discharge to continue harming the largest single source of fresh water supply in California.

The Regional Board's staff has not presented an adequate description of the alternative permitting options and has not provided a justification for these alternative outcomes, which would do little or nothing to alleviate the ongoing harm caused by the POTW's ongoing discharge. There are no findings or fact sheet to support the "options," nor any logic connecting them to protection of beneficial uses and compliance with federal and state anti-degradation policy.

Under these circumstances, staff would be required to revise substantially and to reissue the permit and the permit documents before the briefly described options may be considered for adoption. Staff is required to furnish the Regional Board with "findings to bridge the analytic gap between the raw evidence and ultimate decision or order." *See Topanga Ass 'n for a Scenic Cmty.* v. *County ofLos Angeles,* 11 Cal. 3d 506, 514 (1975). It is staffs burden to document "the analytic route the administrative agency traveled from evidence to action." *id.* While we do not believe that a lawful "analytic route" could be developed to support these alternative permitting options, it is plain that no attempt to develop one has been made to date and that, therefore, these options are not appropriate for adoption and are not proposed for adoption.

Absent a record for the alternative permitting options, it is not possible for the Water Agencies to respond meaningfully to them. Nor would it be fair for staff to impose on the Water Agencies a burden of trying to respond fully to these inchoate options. They lack definition and explication and are not presented as bona fide alternatives that the Regional Board may appropriately adopt in December.

Resort to these permitting options would be such a fundamental and major change as to "require a renewed public notice and comment period." *Hughey et al.* v. *Gwinnett Cnty. et al., 609* S.E.2nd 324, 329 (Georgia Supreme Court overturning NPDES permit for 40 MGD county wastewater discharge into municipal drinking water source on ground that challengers lacked full and fair opportunity to present evidence supporting claim that permit changes were significant enough to require a renewed public notice and comment period).

Finally, if the Regional Board were inclined to adopt any of these alternative permitting options, the December 8-10 hearing date would have to be continued. That is because much more record development, including formal evidentiary proceedings, would be necessary in that event.

B. Dilution Alternatives –Dilution for Acute and Chronic Life Criteria Should Not Be Allowed in the Final Order

A chronic mixing zone allowance for aquatic life criteria should not be permitted for several reasons, all of which are described in greater detail in the toxicity discussion, above.

1. The 303(d) listing for the Sacramento-San Joaquin Delta includes: Chlorpyrifos, DDT, Diazinon, Exotic Species, Group A Pesticides, Mercury, Polychlorinated byphenyls (PCBs) and unknown toxicity. By definition, an allowance for chronic mixing means

that chronic water quality objectives will be exceeded within the mixing zone. An allowance for a chronic mixing zone within the Sacramento River, which is 303(d) listed for unknown toxicity, does not meet the Basin Plan requirements for additional treatment to meet water quality objectives in the limited segment of the river.

2. The Sacramento River at Freeport is within the designated critical habitat for 5 federally-listed fish species including winter- and spring-run Chinook salmon *(Oncorhynchus tshawytscha),* steelhead (0. mykiss), Delta smelt *(Hypomesus transpacificus)* and green sturgeon *(Acipenser medirostris).*

3. The zone of passage is unacceptably small near the bottom of the river. The Tentative Order states that the chronic aquatic life mixing zone is 400 feet wide and extends 350 feet downstream of the diffuser. The Tentative Order also describes the river as 600 feet across at the surface and 400 feet across at the bottom. In addition, in a Regional Board requested review of the Sanitation District's mixing zone modeling, Tetra Tech discovered some discrepancies between model and dye study results that were never addressed and that may have serious implications for fish passage.

4. The proposed mixing zone is larger than a zone of initial dilution. Non-motile (planktonic drifters like Delta smelt larvae) and sessile organisms could be present in the mixing zone long enough to encounter acutely toxic conditions. The Tentative Order does not show that aquatic life passes through the mixing zone fast enough to prevent toxicity as required by the TSD which in turn is required by the Basin Plan.

5. The Sanitation District's discharge does not satisfy all of the requirements of a mixing zone specified in Section 1.4.2.2 of the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays. In fact, the discharge does all of the following: causes acutely toxic conditions to aquatic life, restricts the passage of aquatic life, adversely impacts biologically sensitive habitats, and dominates the receiving water body or overlaps a different mixing zone.

6. A particular volume of river water may move back and forth, past the discharge point many times due to tidal action, each time receiving an additional load of wastewater. Flow reversals and multi-dosing of pollutants are not discussed in the Tentative Order's mixing zones.

7. The granting of a mixing zone is an unreasonable use of water when proper treatment of the waste stream can be accomplished to meet end-of-pipe limitations. Also contrary to the California Constitution, a mixing zone does not *serve the beneficial use;* to the contrary, beneficial uses are degraded within the mixing zone.

C. Dilution Alternatives –The California Department of Public Health Should be Consulted Regarding the Allowance of Dilution for Human Carcinogen Criteria

The area around the discharge is known as a popular fishing location. In addition, numerous agricultural pumps exist within the three mile long mixing zone for human carcinogens. The Department of Public Health should be consulted regarding the public health risk of human contact, consumption of fish exposed to contaminants, and irrigation of crops for human

consumption within the mixing zone to the constituents of concern. At a minimum, the Sanitation District should be required to post signage along the entire length of the mixing zone in multiple languages warning the public that human health criteria are exceeded in this length of the river.

D. Disinfection Alternative 1 is Not Protective of Beneficial Uses and Should Not be Adopted

The Water Agencies concur with the Regional Board that any increased risk of illness and infection from exposure to the Sanitation District's discharge is an unacceptable impairment of the beneficial uses of the Sacramento River. The existing level of disinfection is not currently protecting the drinking water beneficial use of the Sacramento River, as demonstrated previously with the analysis of the *Cryptosporidium* data, and should not be considered as an alternative to providing tertiary filtration.

The Regional Board correctly determines that, "[g]iven the very high level of public contact with the receiving water, the use of the receiving water for irrigation which can result in human contact with pathogens, and the extensive use of Delta water as private and public water supplies, any increased risk of illness and infection from exposure to the wastewater is an impact to the Sacramento River's beneficial use." The risk to public health demands that the Sanitation District install tertiary filtration.

E. Ammonia Removal Alternatives 1 and 2 are Not Protective of Beneficial Uses and Should Not be Adopted

As described earlier, the ammonia/um limits presented in the dilution and ammonia removal alternatives in Table 3 of the Tentative NPDES Permitting Options document are not protective of aquatic life beneficial uses in the Sacramento River and Bay-Delta and should not be adopted. Modeling done by Dr. Dugdale and his colleagues confirms that the alternative permitting options – as well as the proposal to *increase* the discharge during an interim period – would not adequately protect beneficial uses of the water. The modeling finds that

- At the proposed increased interim discharge rate of 47 mg L^{-1} and the proposed alternative permit level of 13 mg L^{-1}, the ammonium loadings at those concentrations would inhibit phytoplankton nitrate uptake and prevent phytoplankton blooms. In contrast, at expected River flow rates, the nutrient removal and reduced discharge concentration of 2.2. mg L^{-1} would allow nitrate uptake by phytoplankton in Suisun Bay, encouraging phytoplankton blooms.

- Further, even assuming dilution were appropriate, the modeling shows there is insufficient River flow to dilute the ammonium down from the higher concentrations of 47 mg L^{-1} or 13 mg L^{-1}, and still protect the phytoplankton. Indeed, even if the requisite flows could be achieved, the modeling establishes the flow rates would be so high that it would "washout" the phytoplankton and prevent the blooms.

Of the five dilution and ammonia removal alternatives included in the Tentative NPDES Permitting Options, only the effluent limits in the Tentative Order of 1.8 and 2.2 mg L^{-1} (AMEL

and MDEL, respectively) can meet all the criteria needed for bloom formation in Suisun Bay to not be inhibited by ammonium.

Further, as described earlier in these comments, ammonia removal alternatives 1 and 2 are not protective of beneficial uses and should not be adopted due to ammonia toxicity, ammonium impacts on the phytoplankton community composition and food web, low dissolved oxygen conditions in the Sacramento River, the generation of harmful nitrosamine by-products and nitrosamine precursors, and stimulating nuisance algal growth in the Bay-Delta and in water supply systems.

F. Nitrate Removal Alternative 1 – Effluent Limits for Nitrate based on Primary MCL Needs Further Analysis and Modeling

As described earlier, it is the N:P ratios and the form of N that drive community composition throughout the food web. And, it is the total load of N and P (and other micronutrients) that determines the amount of biomass produced. If N:P are near the "Redfield" ratio, but the amount of each is too high, we risk pushing the system too far in the opposite extreme, producing too much phytoplankton and possibly creating eutrophic conditions and hypoxia. Both the nutrient ratios and the nutrient loads of the discharge need to be considered in the context of what is already in the River and Bay-Delta and in relation to the total phosphorus load in the discharge and in the River and Bay-Delta. It is important to consider the organic forms of N and P in this calculation as well.

If total phosphorus concentrations and loads are maintained at current levels, both in the discharge and in the River, then reducing ammonia/um to 1.8 mg L^{-1} AMEL and 2.2 mg L^{-1} MDEL and nitrate to 10 mg L^{-1} AMEL with a reasonable MDEL might be sufficient to restore the N:P ratio in the River and Bay-Delta. However, the organic nitrogen load must also be considered. Additional modeling and analysis needs to be completed to ensure that both the nutrient ratio and the total load of nutrients are balanced under Nitrate Removal Alternative 1. This modeling and analysis can likely be done relatively rapidly with the existing monitoring data from the River and the Treatment Plant and should not delay the implementation of full nitrification and denitrification. The Water Agencies are available to assist with the analysis.

REFERENCES AND ATTACHMENTS

Attachment

1. Water Agencies' Expert Team – Curricula Vitæ.
2. Summary of Tertiary Treatment Plants in Central Valley Water Board Area that Discharge to the Delta or Upstream of the Delta.
3. Wastewater Spill Notification Emergency Contact Information.

4. Adams, B.L., W.S. Zaugg, and L.R. McLain. 1973. Temperature effect on parr-smolt transformation in steelhead trout (Salmo gairdneri) as measured by gill sodiumpotassium stimulated adenosine triphosphatase. *Comp. Biochem. Physiol.* 44A:1333-1339.
5. Anderson, L.W.J. 1999. *Egeria* invades the Sacramento-San Joaquin Delta. *Aquatic Nuisance Species Digest*. 3: 37-40
6. Aquatic Ecosystems Analysis Laboratory. 2009. Pharmaceuticals and personal care products in surface water: Occurrence, fate and transport, and effect on aquatic organisms. Report prepared for State Water Resources Control Board. October 2009.
7. Baker, P.F and J.E. Morhardt. 2001. Survival of Chinook salmon smolts in the Sacramento-San Joaquin delta and Pacific Ocean. Contributions to the Biology of Central Valley Salmonids. *Fish Bulletin* 179(s): 163-182
8. Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. San Francisco Estuary and Watershed Science [internet] 3(2) http:repositories.cdlib.org/jmie/sfews/vol3/iss2/art1
9. Berman, T and S. Chava, 1999. "Algal growth on organic compounds as nitrogen sources." *Journal of Plankton Research* 21:1423-1437.
10. Bowes, G. 1987. Aquatic plant photosynthesis: strategies that enhance carbon gain. In: R.M. Crawford, ed., *Plant life in aquatic and amphibian habitats*. Special Publication of the British Ecological Society. Blackwell Scientific. 5: 79-89.
11. California Department of Public Health. 2008. Groundwater Recharge Reuse Regulations. Draft. Can be accessed at http://ww.cdph.ca.gov/healthinfo/environhealth/water/Pages/Waterrecycling.aspx
12. California Department of Water Resources. 2009. State Water Project Delivery Reliability Report.
13. California Department of Water Resources. Monitoring data, 2008-2009, attached to, Department of Water Resources Office Memo from Sal Batmanghilich, Chief Real-time Monitoring Section to Kathleen Harder, Central Water Quality Control Board re Hood water quality station Dissolved Oxygen QA/QC data. July 22, 2010.
14. Carollo Engineers 2010b. Memo from Elisa Garvey to Bob Seyfried, Vyomini Pandya, "Clarification of base construction costs and construction cost factors as presented in the 'Advanced Treatment Alternatives for the Sacramento Regional Wastewater Treatment Plant', (Carollo Engineers, March 2009)", (August 25, 2010).
15. Carollo Engineers, Task 600 Technical Memorandum No. 4 Evaluation of Effluent Disinfection Alternatives. Interim Copy. March 2003.

REFERENCES AND ATTACHMENTS

16. Carollo Engineers. 2010a. Memo from Elisa Garvey to Bob Seyfried, Vyomini Pandya, "Modification of Flow basis for treatment train costs as previously presented in the 'Advanced Treatment Alternatives for the Sacramento Regional Wastewater Treatment Plant' (Carollo, March 2009)", (August 19, 2009).
17. Central Valley Regional Board Order No. R5-2002-0083
18. Central Valley Regional Board Order No. R5-2002-0084.
19. Central Valley Regional Board Order No. R5-2003-0031 (City of Woodland Water Pollution Control Facility)
20. Central Valley Regional Board Order No. R5-2004-0094 (Olivehurst Public Utility District Wastewater Treatment Facility)
21. Central Valley Regional Board Order No. R5-2007-0132 (City of Davis Wastewater Treatment Plant)
22. Central Valley Regional Board Order, No. R5-2008-0053 (City of Placerville, Hangtown Creek Water Reclamation Facility)
23. Central Valley Regional Board. 1995 (as amended). Water Quality Control Plan (Basin Plan) For The Sacramento River And San Joaquin River Basins Basin Plan.
24. Central Valley Regional Board. 2010. Data file provided by Kathy Harder entitled "Compilation of SRCSD Effluent and Receiving Water Concentration Data," dated July 13, 2010.
25. Central Valley Regional Water Quality Control Board Resolution 2007-0161. Water Boards Actions to Protect Beneficial Uses of the San Francisco Bay/Sacramento-San Joaquin Delta
26. Cloern, J.E. 1999. The relative importance of light and nutrient limitation of phytoplankton growth: a simple index of coastal ecosystem sensitivity to nutrient enrichment. *Aquatic Ecology*. 33:3-16
27. Cloern, J.E., 2001. Our evolving conceptual model of the coastal eutrophication problem. *Mar. Ecol. Prog. Ser.* 210:223-253
28. Cloern, J.E., and R. Dufford. 2005. Phytoplankton community ecology: principles applied in San Francisco Bay. *Mar. Ecol. Prog. Ser.* 285:11-28.
29. Coutant, C.C. 1973. Effect of thermal shock on vulnerability of juvenile salmonids to predation. *J. Fish. Res. Bd. Canada*. 30: 765-973.
30. Cramer, Steve, Gaskill, Phil, and Vaughn, Jason. 2010. Impact of Sacramento Regional Wastewater Treatment Plant Effluent Discharges on Salmonids.

-- Crittenden, Trussell, et al. 2005. Water Treatment - Principles and Design (2d Ed). John Wiley & Sons.

31. DiGiorgio, C.L. et al. Investigation into the Sources of Nitrosamines and their Precursors in the Sacramento-San Joaquin Delta, California. California Department of Water Resources and Metropolitan Water District of Southern California. Poster developed for 2009 Gordon Research Conference.

REFERENCES AND ATTACHMENTS

32. Downing, J.A., S.B. Watson, and E. McCauley. 2001. Predicting cyanobacterial dominance in lakes. Ca. J. Fish. Aquat. Sci. 58: 1905-1908.

33. Duarte, C.M., D.J. Conley, J. Carstensen, and M. Sánchez-Camacho. 2009. Return to Neverland: Shifting Baselines Affect Eutrophication Restoration Targets. *Estuaries and Coasts*. 32:29–36.

-- Dugdale, R., A. Parker, A. Marchi, and F. Wilkerson. 2010. "Criteria for the occurrence of spring blooms in Suisun Bay." Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

34. Dugdale, R.C., F. P. Wilkerson, V. E. Hogue and A. Marchi. 2007. The role of ammonium and nitrate in spring bloom development in San Francisco Bay. *Estuarine, Coastal and Shelf Science* 73: 17-29.

35. Entrix 2010. Technical Memoranda by Paul, Duane and Steve Pavich, "Economic Analysis of the Advanced Treatment Trains in the Tentative NPDES Permit. October 8, 2010.

36. Feijoo, C., M.E. Garcia, F. Momo, and J. Tpja. 2002. Nutrient absorption by the submerged macrophyte *Egeria dense* Planch: Effect of ammonium and phosphorus availability in the water column on growth and nutrient uptake. *Limnetica* 21: 93-104.

-- Finlayson, B.J. 1983. Water hyacinth: Threat to the Delta? Outdoor California 44: 10-14.

-- Gopal, B. 1987. Aquatic plant studies. 1. Water hyacinth. Elsevier Publishing, New York.

37. Foe, Chris, A. Ballard, S. Fong.. 2010. Nutrient concentrations and biological effects in the Sacramento-San Joaquin Delta. Report prepared for the Central Valley Regional Water Quality Control Board

38. Glibert, P. 2010a. "Long-term changes in nutrient loading and stoichiometry and their relationships with changes in the food web and dominant pelagic fish species in the San Francisco Estuary, California," *Reviews in Fisheries Science.*

-- Glibert, P. 2010b. Changes in the quality and quantity of nutrients over time and the relationships with changes in phytoplankton composition. Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010

-- Glibert, P. 2010c. Nutrients and the food web of the Bay Delta. Oral Presentation to the National Academy of Sciences Committee on Sustainable Water and Environmental Management in the California Bay-Delta, Sacramento, CA. July 13, 2010.

39. Glibert, P., C.A. Heil, D. Hollander, M. Revilla, A. Hoare, J. Alexander, S. Murasko. 2004. "Evidence for dissolved organic nitrogen and phosphorous uptake during a cyanobacterial bloom in Florida Bay." *Mar. Ecol. Prog. Ser.* 280:73-83.

40. Glibert, P.M., J. Boyer, C. Heil, C. Madden, B. Sturgis, and C. Wazniak. 2010. Blooms in Lagoons: Different from those of river-dominated estuaries. In: M. Kennish and H. Paerl, eds, *Coastal Lagoons: Critical habitats of environmental change*. Taylor and Francis.

41. Gomez et al. 2007. A comparative study of tertiary wastewater treatment by physico-chemical-UV process and macrofiltration–ultrafiltration technologies. *Desalination* 202: 369-370.

REFERENCES AND ATTACHMENTS

42. Greening, H. and A.Janicki. 2006. Toward reversal of eutrophic conditions in a subtropical estuary: Water quality and seagrass response to nitrogen loading reductions in Tamp Bay, Florida, USA. *Environ. Mgt.* 38(2):163-178.

43. Guo, Y.C. et al. May 2010. Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California. National Water Research Institute: Fountain Valley, CA, The final report can be accessed at http://www.nwri-usa.org/CECs.htm.

44. Ha, J.H., T. Hidaka, and H. Tsuno. 2009. Quantification of toxic Microcystis and evaluation of its dominance ratio in blooms using real-time PCR. *Envir. Sci. Technol*. 43: 812-818

45. Harvey, H.W. 1953, Synthesis of Organic Nitrogen and Chlorophyll by Nitzschia Closterium. J. Mar.Biol. Res. Assoc. U.K. 31:477-487

46. Hessen, D.O.. 1997. Stoichiometry in food webs – Lotka revisted. *Oikos* 79: 195-200.

-- Hodgkiss, I.J. 2001. The N:P ratio revisited. In: K.C. Ho and Z.D. Wang (Eds.), Prevention and Management of Harmful Algal Blooms in the South China Sea. School of Science and Technology, Open University of Hong Kong.

47. Hodgkiss, I.J. and K.C. Ho. 1997. Are changes in N:P ratios in coastal waters the key to increased ref tide blooms?. *Hydrobiologia.* 352:141-147

48. Horn, M.J. and A. Blake. 2004. Acoustic tracking of juvenile chinook salmon movement in the vicinity of the Delta Cross Channel. 2001 study results. Prepared for Technical Service Center, Denver, Colorado as Technical Memorandum No. 8220-04-04.

49. Ibanez, C., N. Prat, C. Duran, M. Pardos, A. Munne, R. Andreu, N. Caiola, N. Cid, H. Hampel, R. Sanchez, and R. Trobajo. 2008. Changes in dissolved nutrients in the lower Ebro river: Causes and consequences. *Limnetica.* 27(1):131-142.

50. Jana, S. et al. 2010. Preparation and characterization of low-cost ceramic microfiltration membranes for the removal of chromate from aqueous solutions. *Applied Clay Science* 47: 317–324

51. Jassby, A. 2008. "Phytoplankton in the Upper San Francisco Estuary: recent biomass trends, their causes, and their trophic significance." *San Francisco Estuary and Watershed Science*. 6(1): Article 2, February 2008.

52. Jassby, A.D. and J.E. Cloern. 2000.Organic matter sources and rehabilitation of the Sacramento-San Joaquin Delta (California, USA). *Aquat. Conser: Mar. Freshw. Ecosyst.*, 10:323-352.

53. Jassby, A.D., J.E. Cloern and B.E. Cole. 2002. Annual primary production: Patterns and mechanisms of change in a nutrient-rich tidal ecosystem. *Limnol. Oceanogr.*, 47(3): 698–712.

54. Kemp, W.M., W. R. Boynton, J. E. Adolf, D. F. Boesch, W. C. Boicourt, G. Brush, J. C. Cornwell, T. R. Fisher, P. M. Glibert, J. D. Hagy, L.W. Harding, E. D. Houde, D. G. Kimmel, W. D. Miller, R. I. E. Newell, M. R. Roman, E. M. Smith, J. C. Stevenson.

Eutrophication of Chesapeake Bay: historical trends and ecological interactions. *Mar. Ecol. Prog. Ser.* 303:1–29.

-- Kendall, C. 2010a. Causes of seasonal and spatial variation in water chemistry in the Sacramento River, Delta, and Eastern San Francisco Bay and their effects on chlorophyll levels. Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA. September 27-29, 2010.

-- Kendall, C. 2010b. Use of stable isotopes for evaluating environmental conditions associated with *Microcystis* blooms in the Delta. Oral Presentation at the 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

55. Kendall, C., Silva, S.R., Young, M.B., Guerin, M., Kraus, T., and Parker, A., 2010. Stable isotope tracing of nutrient and organic matter sources and biogeochemical cycling in the Sacramento River, Delta, and Northern Bay. U.S. Geological Survey Open-File Report 2010-XX, preliminary draft for colleague review, 52 pages

56. Kimmerer, W. 2005. Long-term changes in apparent uptake of silica in the San Francisco Estuary. *Limnology and Oceanography*. 50(3):793-798

57. Kimura, K. et al. 2008. Irreversible membrane fouling in microfiltration membranes filtering coagulated surface water. *Journal of Membrane Science* 320: 356–362.

58. Koch, J. and VonGottberg, A. 2009. MBR Effectively Removes Phosphorous. *Pollution Engineering* June 2009.

59. Krasner, S. et al., "Wastewater and Algal Derived N-DBPs" (paper presented at the American WaterWorks Association's annual conference, Toronto, Canada, 2007).

60. Krasner, S. W., et al. 2009. Occurrence of Disinfection Byproducts in United States Wastewater Treatment Plan Effluents. *Environ. Sci. Technol.* 2009, 43, 8320-8325.

61. Krasner. S. et al., "Impact of Wastewater Treatment Processes on Organic Carbon, Organic Nitrogen, andDBP Precursors in Effluent Organic Matter" (paper presented at the American Water Works Association's WaterQuality Technical Conference, Denver, CO, 2006.

62. Lam, C. W. Y. and K. C. Ho. 1989. Red tides in Tolo Harbour, Hong Kong, p. 49–52. In T. Okaichi, D. M.Anderson, and T. Nemoto (eds.), Red Tides: Biology, Environmental Science and Toxicology. Elsevier, New York.

63. Larry Walker Associates. 2009a. Low dissolved oxygen prevention assessment-Administrative Draft. Prepared for SRCSD.

64. Larry Walker Associates. 2009b. "Antidegradation Analysis for Proposed Discharge Modifications for the Sacramento Regional Wastewater Treatment Plant, Administrative Draft", May 20, 2009. Prepared for SRCSD.

65. Lehman, P. W. 2000. The influence of climate on phytoplankton community biomass in San Francisco Bay Estuary. *Limnol. Oceanogr*. 45: 580–590

66. Lehman, P. W., G. Boyer, C. Hall, S. Waller and K. Gehrts. 2005. Distribution and toxicity of a new colonial *Microcystis aeruginosa* bloom in the San Francisco Bay Estuary, California. *Hydrobiologia* 541:87-99

67. Lehman, P.W., S.J. The, G.L. Boyer, M.L. Nobriga, E. Bass, and C. Hogle. 2010. Initial impacts of *Microcystis aeruginosa* blooms on the aquatic food web in the San Francisco Estuary. *Hydrobiologia* 637:229-248

-- Lindemuth, T. 2010. Linking nutrients to severe Delta eutrophication, 2009/2010 findings. Oral Presentation at the 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

68. Lomas, M.W. and P.M. Glibert. 1999a. Interactions between NH_4 and NO_3 uptake and assimilation: comparison of diatoms and dinoflagellates at several growth temperatures. Marine Biology 133:541-551

69. Lomas, M.W. and P.M. Glibert. 1999b. Temperature regulation of nitrate uptake: A novel hypothesis about nitrate uptake and reduction in cool-water diatoms. *Limnol Oceanogr* 44:556-572.

70. Ludwig, C.A. 1938. The availability of different forms of nitrogen to a green alga (Chlorella) Am.J.Bot. 25:448-458

71. MacIsaac, J.J. and R.C. Dugdale , 1969. The kinetics of nitrate and ammonium uptake by natural populations of marine phytoplankton. Deep-Sea Res. 16:45-67

72. MacIsaac, J.J. and R.C. Dugdale, 1972. Interactions of light and inorganic nitrogen controlling nitrogen uptake in the sea. Deep-Sea Res. 19:209-232.

73. Managing Contaminants of Emerging Concern in California. California CEC Workshop. Co-sponsored by the Southern California Coastal Water Research Project, California Ocean Protection Council, California Ocean Science Trust, National Water Research Institute, San Francisco Estuary Institute and the Urban Water Research Center at the University of California-Irvine. Held: April 28-89, 2009. Report published in September 2009 and is available at: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/600_CEC_wkshp2009.pdf

-- Marchi, A. 2010. "Spring 2010 phytoplankton blooms in Northern San Francisco Estuary: influences of climate and nutrients." Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA, Sept. 27-29, 2010.

74. Marine, K.R. and J.J. Cech, Jr. 2004. Effects of high water temperature on growth, smoltification, and predator avoidance in juvenile Sacramento River chinook salmon. *N. Am. J. of Fish. Mgmt*. 24:198–210.

75. McCarthy, J.J., W.R. Taylor and J.L. Taft, 1975. The dynamics of nitrogen and phosphorous cycling in the open water of the Chesapeake Way. In: T.M. Church (ed.) Marine Chemistry in the Coastal Environment. American Chemical Society Symposium Series 18. Washington D.C., pp. 664-681.

76. Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition (EPA-821-R-02-012).

77. Metropolitan Water District of Southern California. Preliminary data representation provided by MWDSC. A peer-reviewed paper will be submitted for publication in 2011.

78. Meyer, J.S., P.J. Mulholland, H.W. Paerl, and A.K. Ward. 2009. "A framework for research addressing the role of ammonia/ammonium in the Sacramento-San Joaquin Delta and the San Francisco Bay Estuary ecosystem." Report to CalFed Science Program.

79. Meyn, T. et al. 2008. Significance of flocculation for NOM removal by coagulation–ceramic membrane microfiltration. *Water Science & Technology: Water Supply* 8.6

80. Michael J., et al. 2009. Retrospective Estimate of the Economic Impacts of Reduced Water Supplies to the San Joaquin Valley in 2009 (September 28, 2010) (U.O.P-U.C. Davis Report), Table 11 at p. 14.

81. Mitch, W. and David L. Sedlak, "Factors Controlling Nitrosamine Formation during Wastewater Chlorination," in Water Science & Technology: Water Supply 2, no. 3 (2002): 191-198.

82. Mizgireuv, I. V.; Majorova, I. G.; Gorodinskaya, V. M.; Khudoley, V. V.; Revskoy, S. Y. Carcinogenic effect of N-nitrosodimethylamine on diploid and triploid zebrafish (*Danio rerio*). *Toxicol.Pathol.* 2004, *32* (5), 514–518. It is anticipated that NDMA, or a broader class of nitrosamines, may likely be the next disinfection byproduct(s) regulated by the U. S. Environmental Protection Agency.

83. Müller-Solger, A., A.D. Jassby and D.C. Müller-Navarra. 2002. Nutritional quality of food resources for zooplankton (*Daphnia*) in a tidal freshwater system (Sacramento-San Joaquin River Delta). *Limnol Oceanogr*47(5):1468-1476.

84. Najm, I. N. and S. W. Krasner, 1995. Effects of bromide and NOM on by-product formation. Jour. AWWA, 87:106-115.

85. Newman, K.B. 2003. Modeling paired release-recovery data in the presence of survival and capture heterogeneity with application to marked juvenile salmon. *Statistical modeling* 3:157-177.

86. NOAA Fisheries. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, June 4, 2009 at page 157.

87. Nobriga, M.L., F. Feyrer, R.D. Baxter, and M. Chotkowski. 2005. Fish community ecology in an altered river delta: spatial patterns in species composition, life history strategies, and biomass. *Estuaries* 28(5):776-785

88. Oh, H-M., S.J. Lee, M-H. Jang and B-D. Yoon. 2000. Microcystin production by *Microcystis aeruginosa* in a phosphorus-limited chemostat. *Appl. Envir. Microbiol*. 66: 176-179.

89. Paerl, H.W. 1988. Nuisance phytoplankton blooms in coastal, estuarine, and inland waters. *Limnol. Oceanogr*. 33(4, part 2): 823-847.

90. Paerl, H.W. 2009. Controlling Eutrophication along the Freshwater–Marine Continuum: Dual Nutrient (N and P) Reductions are Essential. *Estuaries and Coasts* 32:593–601

REFERENCES AND ATTACHMENTS

91. Parker, A.E., A.M. Marchi, J.Drexel-Davidson, R.C. Dugdale, and F.P. Wilkerson. 2010a. "Effect of ammonium and wastewater effluent on riverine phytoplankton in the Sacramento River, CA. Final Report to the State Water Resources Control Board.

-- Parker, A.E., Dugdale, R.C., Wilkerson, F., Marchi , A. 2010b. Biogeochemical Processing of anthropogenic ammonium in the Sacramento River and the northern San Francisco Estuary: consequences for Pelagic Organism Decline species. Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA. September 27-29, 2010.

92. PG Environmental. 2010. Memo to Kathleen Harder, Regional Board, "Technical Review of Estimated Costs for Propsed Changes to the Sacramento Regional Wastewater Treatment Plant" (August 18, 2010).

93. Phase II Report of the Emerging Constituents Workgroup. 2009. A Proposed Work Plan to Characterize Select EC Concentrations in Surface Waters, Imported Waters & Recycled Waters Recharging Groundwaters of the Santa Ana River Watershed.

94. Quigley, J.T., and S.G. Hinch. 2006. Effects of rapid experimental temperature increases on acute physiological stress and behaviour of stream dwelling juvenile Chinook salmon. *Journal of Thermal Biology*. 31: 429-441.

95. Rask, N., S. E. Pedersen, and M. H. Jensen. 1999. Response to lowered nutrient discharges in the coastal waters around the island of Funen, Denmark. *Hydrobiologia* 393: 69–81.

96. Reddy, K.R., J.C. Tucker, and W.F. Debusk. 1987. The role of *Egeria* in removing nitrogen and phosphorus from nutrient enriched waters. *J. Aquat. Plant Management* 25: 14-19

97. Redfield, A.C. 1934. On the proportions of organic derivatives in sea water and their relation to the composition of plankton. Reprinted from *James Johnstone Memorial Volume*, Liverpool University Press, Liverpool. 176-192.

98. Redfield, A.C. 1958. The biological control of chemical factors in the environment. Reprinted from *The American Scientist*. 46(3):205-221.

99. Resource Management Associates. 2009. Modeling the fate and transport of ammonia using DSM2-QUAL, Draft final report, October 2009. Prepared for State Water Contractors.

100. Robertson-Bryan, Inc. 2010. Thermal Plan Exception Justification for the Sacramento Regional Wastewater Treatment Plant. Prepared for Sacramento Regional County Sanitation District.

101. Robles, R 2010. "California's First Design-Build Biosolids Thermal Dryer," Presentation to CWEA Biolsolids Specialty Workshop (January 27 2010).

102. Romdhane, M.S., H.C. Eilertsen, O.K.D. Yahia, and Y.N.D. Daly. 1998. Toxic dinoflagellate blooms in Tunisian lagoons: causes and consequences for aquaculture. In: *Harmful Algae* Edited by B.Reguera, J.Blanco, M.L.Fern'andez & T.Wyatt, Xunta de Galicia and Intergovernmental Oceanographic Commission of UNESCO, pp. 80–83.

103. Ruhl, H.A. and N.B. Rybicki. 2010. Long-term reductions in anthropogenic nutrients link to improvements in Chesapeake Bay habitat. www.pnas.org/cgi/doi/10.1073/pnas.1003590107.

REFERENCES AND ATTACHMENTS

104. San Francisco Regional Water Quality Control Board. 2010, June 4. Letter from Bruce H. Wolfe to Ms. Kathy Harder at Central Valley Regional Water Quality Control Board re Comments on "Issue Paper – Aquatic life and Wildlife preservation issues – proposed NPDES permit renewal for the Sacramento Regional County Sanitation District Sacramento Regional Wastewater Treatment Plant."

105. Santa Ana Regional Water Quality Control Board Resolution No. R8-2008-0019 – Cooperative Agreement to Protect Water Quality and Encourage the Conjunctive Uses of Imported Water in the Santa Ana River Basin.

106. Schaefer, M. and M.L. Johnson. 2009. Pharmaceuticals and personal care products in the Sacramento River. Report prepared for the State Water Resources Control Board. October 2009.

107. Schindler, D. W. 1974. Eutrophication and Recovery in Experimental Lakes: Implications for Lake Management. *Science*. 184(4139):897-899

108. Seitzinger, S.P. 1991. The effect of pH of the release of phosphorus from Potomac estuary sediments: Implications for blue-green algal blooms. *Estuarine, Coastal and Shelf Science.* 33:409-418.

109. Slaughter, A. and W. Kimmerer. 2010. Abundance, composition, feeding, and reproductive rates of key copepodsspecies in the food-limited Low Salinity Zone of the San Francisco Estuary. Poster Presentation at the 6th Bienniel Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

110. SLDMWA and SWC Comments on Draft Report Titled, Nutrient Concentrations and Biological Effects in the Sacramento-San Joaquin Delta at 3 (June 14, 2010).

111. Smith, V.H. 1983. Low nitrogen to phosphorus ratios favor dominance by blue-green algae in lake phytoplankton. *Science* 221: 669-671.

Solomon, C. Gallaudet Univ, unpub. data.

112. Sommer. T, C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga and K. Souza. 2007. The Collapse of Pelagic Fishes in the Upper San Francisco Estuary. *Fisheries* 32(6):270-277.

113. Spencer, W., and G. Bowes. 1985. Limnophila and hygrophila: a review and physiological assessment of their weed potential in Florida. *J. Aquat. Plant Manage*. 23: 7-16; and

114. SRCSD 2010. "SRCSD Water Recycling Program." Presentation, June 24, 2010.

115. SRCSD SRWTP TRE Status Report, August 23, 2007.

116. SRCSD, 1994 Master Plan Update.

117. SRCSD. February 1, 2005 letter to Regional Board requesting NPDES Permit Renewal for Sacramento Regional Wastewater Treatment Plant (SRWTP), NPDES Permit No. CA0077682

118. SRCSD. June 11, 2010 letter to Regional Board.

REFERENCES AND ATTACHMENTS

119. SRCSD. 2009. State of the District Report.

120. Stahl-Delbanco, A., L.-A. Hansson and M. Gyllstrom. 2003. Recruitment of resting stages may induce blooms of *Microcystis* at low N:P ratios. *J. Plankt. Res*. 25: 1099-1106.

121. State Board Administrative Procedure Update (APU) 90-04, (July 1, 1990).

122. State Board Decision 1379 (1971).

123. State Board Order WQ 2001-06.

124. State Board Res. No. 94-87.

125. State Board, Resolution 68-16 (Oct. 24, 1968).

126. State of California. 1988. Water Temperature Effects on Chinook Salmon (*Oncorhynchus tshawytscha*) With Emphasis on the Sacramento River: A Literature Review. 49 pages.

127. State Water Resources Control Board. 2010. Draft *Policy for Whole Effluent Toxicity and Control*, State Water Resources Control Board.

128. State Water Resources Control Board. States Policy for Implementation of Toxic Standards for Inland Surface Waters, enclosed Bays and Estuaries of California (SIP)

129. State Water Resources Control Board. Monitoring Strategies for Chemicals of Emerging Concern in Recycled Water: Recommendations of a Science Advisory Panel. Sacramento, CA, June 25, 2010 can be accessed at: http://www.sccwrp.org/ResearchAreas/Contaminants/ContaminantsOfEmergingConcern/RecycledWaterAdvisoryPanel.aspx

-- Sterner, R.W. and J.J. Elser. 2002. Ecological stoichiometry: The biology of elements from molecules to the biosphere. Princeton University Press, Princeton, N.J.

130. Swanson, C., T. Reid, P.S. Young, and J. Cech, Jr. 1998. Swimming Performance of Delta Smelt; Maximum Performance, and Behavioral and Kinematic Limitations on Swimming at Submaximal Velocities. *J. Experimental Biology* 201:333-345.

131. Sylvester, J.R. 1972. Effect of thermal stress on predator avoidance in sockeye salmon. J. Fish. Res. Bd. Canada. 29: 601-603.U.S. Fish and Wildlife Service (USFWS). 2007.

132. Tetra Tech Memorandum, to Diana Messina, Central Valley Regional Water Quality Control Board, from Jonathan Butcher, Ph.D., P.H., Re: Sacramento Regional LDOPA, June 29, 2010.

133. Thompson, Rosie, PhD, and Jean Baldrige, 2010, Review of the Sacramento Regional Wastewater Treatment Plant, Impact of Tentative Order and Thermal Exception in Delta Smelt, Tentative Order and Thermal on Delta Smelt.

134. Toft, J.D., C.A. Simestad, J.R. Cordekk and L.F. Grimaldo. 2003. The effects of introduced water hyacinth on habitat structure, invertebrate assemblages and fish diets. *Estuaries* 26: 746-758.

135. Trussell Technologies, Inc. 2010a. Ammonia Removal Cost Alternatives for the Sacramento Regional Wastewater Treatment Plant (May 31, 2010).

REFERENCES AND ATTACHMENTS

136. Trussell Technologies, Inc. 2010b. Letter to Adam Kear, Metropolitan Water District, "Summary of Preliminary Findings in Response to the Tentative SRCSD NPDES Permit" (October 1, 2010).

137. U.S Fish and Wildlife Service (USFWS). 2007. Abundance and Survival of Juvenile Chinook Salmon in the Sacramento-San Joaquin Estuary. 2001-2005 Annual Progress Report. U.S Fish and Wildlife Service Stockton, California. 148 pages.

138. U.S. EPA (2007) California's 2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments Requiring TMDLs.

139. U.S. EPA Region IX, Guidance on Implementing the Antidegradation Provisions of 40 CFR 131.12 (June 3, 1987.)

140. U.S. EPA Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fourth Edition (EPA-821-R-02-013)

141. U.S. EPA *Water Quality Standards Handbook: Second Edition* (*Water Quality Handbook*), § 4.4. The *Water Quality Handbook* was originally published in 1994, but certain provisions, including Chapter 4, were updated in July, 2007. (the original version is available in .pdf form, and the updated versions are available in .html form, at http://www.epa.gov/waterscience/standards/handbook/.)

142. U.S. EPA. 1995. Interim Economic Guidance for Water Quality Standards Workbook (EPA-823-B-95-002).

143. U.S. Fish and Wildlife Service. 2010. Comment letter on CVRWQCB NPDES Permit Renewal Issues Aquatic Life and Wildlife Preservation.

144. U.S. Fish and Wildlife Service. 2008, Final Biological Opinion for the Long-Term Operational Criteria and Plan ("OCAP") of the Central Valley Project and the State Water Project.

-- van de Waal, D.B. , L.Tonk, E. van Donk, H.C.P. Matthijs, P. M. Visser and J. Huisman. 2010. Climate Change And The Impact Of C:N Stoichiometry On Toxin Production By Harmful Cyanobacteria. Oral Presentaton at the 14th International HAB Conference, Greece.

145. Van Nieuwenhuyse, E. 2007. Response of summer chlorophyll concentration to reduced total phosphorus concentration in the Rhine River (Netherlands) and the Sacramento-San Joaquin Delta (California, USA). *Can. J. Fish. Aquat. Sci.,* 64:1529-1542; and Glibert, 2010a, *supra*.

146. Werner, I. 2009. "Effects of Ammonia/um and Other Wastewater Effluent Associated Contaminants on Delta Smelt," presented at the 18-19 August 2009 Ammonia Summit.

-- Wilkerson, F., R. Dugdale, A. Marchi, and A. Parker. 2010. "Different response types of phytoplankton to changing nutrient regimes in SF Bay/Delta: Bottom up effects of ammonium and nitrate." Oral Presentation at 6th Biennial Bay-Delta Science Conference, Sacramento, CA, September 27-29, 2010.

147. Wilkerson, F.P, R.C. Dugdale, V.E. Hogue and A. Marchi. 2006. Phytoplankton blooms and nitrogen productivity in San Francisco Bay. *Estuaries and Coasts* 29(3): 401–416

148. Winder, M. and A.D. Jassby. In press. Shifts in zooplankton community structure: Implications for food web processes in the Upper San Francisco Estuary. *Estuaries and Coasts*. DOI 10.1007/s12237-010-9342-x.

149. Wintgens, M. et al. 2005. The role of membrane processes in municipal wastewater reclamation and reuse. *Desalination* 178: 1-11

150. Zaugg, W.S., and H.H.Wagner. 1973. Gill ATPase activity related to parr-smolt transformation and migration in steelhead trout (Salmo gairdneri): Influence of photoperiod and temperature. *Comp. Biochem. Physiol*. 45B: 955-965.