Attachment A

Sacramento Regional County Sanitation District (District) Comments on Issue Paper Regarding Aquatic Life and Wildlife Preservation Issues

The Sacramento Regional County Sanitation District ("SRCSD" or the "District") appreciates the opportunity to offer comments on the Central Valley Regional Water Quality Control Board's (Water Board) Issue Paper regarding Aquatic Life and Wildlife Preservation Related Issues (Issue Paper), as prepared by Water Board staff. The Issue Paper raises and discusses numerous issues associated with the renewal of the District's NPDES permit and appears to rely on information contained in documents provided by the District to the Water Board as part of the NPDES permit renewal process and on information based on research studies that are currently in progress.

The District's comments are provided under the same general topic areas as in the Issue Paper:

1. Mixing Zones and Dilution for Aquatic Life Criteria
2. Ammonia
3. Low Dissolved Oxygen
4. Thermal Conditions
5. Pyrethroid Pesticides
6. Whole Effluent Toxicity

MIXING ZONES AND DILUTION FOR AQUATIC LIFE CRITERIA

The Issue Paper raises several questions regarding the proposed mixing zone in the Sacramento River downstream of the Sacramento Regional Wastewater Treatment Plant (SRWTP) discharge. The issue paper references approaches to establishing mixing zones based on the 1995 policy used in EPA Region VIII to guide States and Tribes in that region. Specifically, the Issue Paper refers to the Region VIII document with respect to the applicability of mixing zones to acute aquatic life criteria and with respect to consideration of attraction of aquatic life to the effluent plume. The Issue paper also discusses the applicability of a mixing zone for ammonia based on conditions in the Delta.

While the District's proposed mixing zone meets the criteria proposed by Region VIII, the District urges the Regional Board to rely on the mixing zone policies established under the State Implementation Plan which was adopted by the State Water Resources Control Board in 2000[1] and has been used to establish mixing zones throughout the Central Valley and more generally in the State of California. The District has conducted a thorough effort to model the discharge and evaluate the risks in the near field and, as described in the District's Anti-degradation Analysis[2], there is no unacceptable risk to aquatic life within the District's

[1] California Environmental Protection Agency (Cal EPA). 2000. Policy of Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP). State Water Resources Control Board

[2] Larry Walker Associates, 2009. Anti-Degradation Analysis for Proposed Discharge Modification to the Sacramento Regional Wastewater Treatment Plant. DRAFT. Prepared for Sacramento Regional County Sanitation District. May 2009.

proposed mixing zone. As stated below, the proposed mixing zone for the SRCSD discharge meets all applicable State and federal requirements and guidelines and is established in a manner that is consistent with other mixing zones granted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) in other NPDES permits.

The State's mixing zone policy, as it applies to priority toxic pollutants, is contained in the state's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* ("SIP"). The specific SIP mixing zone requirements are that the mixing zone must be as small as practicable and shall not:

- Compromise the integrity of the water body
- Cause acute toxicity conditions to aquatic life passing through the mixing zone;
- Restrict the passage of aquatic life
- Adversely impact biologically sensitive or critical habitats, including, but not limited to, habitats of species listed under federal or State endangered species laws;
- Produce undesirable or nuisance aquatic life;
- Result in floating debris, oil, or scum;
- Produce objectionable color, odor, taste, or turbidity;
- Cause objectionable bottom deposits;
- Cause nuisance;
- Dominate the receiving water body or overlap a mixing zone from different outfall;
- Be located at or near any drinking water intake.

The proposed mixing zone for the Sacramento Regional Wastewater Treatment Plant (SRWTP) discharge satisfies each of these criteria.

The Issue Paper references the guidance for mixing zones that has been developed for USPEA Region VIII. First, it should be noted that California is in USEPA Region IX – not Region VIII. USEPA Region VIII covers the states of Colorado, Utah, Wyoming, North Dakota, South Dakota and Montana. Thus, the USEPA Regional VIII guidance referenced in the issue paper does not apply to California or SRCSD's discharge. The USEPA Region VIII *Mixing Zones and Dilution Policy* is a 1994 document that was developed to upgrade methods for deriving water quality-based permit limits, improve the technical defensibility of NPDES permits, and reduce risks associated with mixing zone and dilution practices in those States within its jurisdiction. The document was specifically developed to address a concern with a 1990's practice in Region VIII states to follow a simple mass balance approach that effectively provided the entire critical low flow as a dilution allowance and granted mixing zones which extended far downstream of a discharge. The guidance states that consideration of how quickly a discharge actually mixes is important in the mixing zone and dilution determination. The purpose of the Region VIII guidance was to implement a mixing zone approach that placed controls on the size and quality of effluent plumes.

On page 10 of the Region VIII guidance document, a definition of "near instantaneous and complete mixing" is provided. This condition is defined as "no more than a 10% difference in bank-to-bank concentrations within a longitudinal distance of not greater than 2 stream/river widths." The provisions of the Region VIII policy vary depending on the determination of whether a discharge is completely or incompletely mixed. For instance, the Region VIII guidance states explicitly that where a discharge mixes rapidly with a receiving water body, a dilution allowance based on the critical low flow of the receiving water may be provided. In cases where a discharge is determined to be incompletely mixed, per the Region VIII definition, the guidance is more restrictive (e.g. consideration should be given to restricting dilution credit for acute limits, etc.).

For incompletely-mixed flows, the Region VIII Guidance Document provides guidance in "Alternative Procedures for Chemical-Specific Acute Criteria in Incompletely-Mixed Situations (Appendix D),"

> *For acute chemical-specific standards in incomplete mix situations, although achieving such standards at the end-of-pipe is recommended by the Region, EPA will also approve mixing zone policies that allow a zone of initial dilution on a case-by-case basis where:*
>
> *There is evidence of rapid mixing between the discharge and receiving water based on factors such as high exit velocity of the discharge (e.g., > 10 ft per second), and*
>
> *The rationale for the discharge permit includes an evaluation of risks (such as those describe in Step 4 of the Region's model procedure) and a finding that allowing a zone of initial dilution posses no unacceptable risk.*
>
> *Where both of the above two conditions are met in a particular case, it is recommended that the zone of initial dilution (ZID) for achieving acute standards be limited as follows:*
>
> *Rivers and Streams: The ZID volume must be small. This may be implemented by applying the more stringent of the following two restrictions:*
>
> *ZID volume or flow may not exceed 10% of the chronic mixing zone volume or flow; or*
>
> *ZID length may not exceed a maximum downstream length of 100 feet.*

Flexibility regarding mixing zones for incompletely mixed discharges is also provided as outlined in the flow chart in Figure 1 of the document. Under Step 5 in Figure 1, a mixing zone and dilution credit may be allowed if there is use of a diffuser which would be applicable to the SRWTP discharge. Under Step 6, dilution may be determined by a field study. The numerous dye studies conducted to validate the District's dynamic model would certainly provide the field validation necessary to document dilution of the SRWTP discharge.

As noted above, the EPA Region VIII Guidance Document was generated to stop the practice of using a "simplified mass balance approach that effectively provides the entire critical low flow as a dilution allowance in calculating the permit limit, regardless of the rate of mixing" (p. 1 of EPA Region VIII Mixing Zones and Dilution Policy). Clearly this is not the situation or the proposal regarding the SRWTP mixing zone. The SRWTP diffuser causes "rapid mixing of effluent into the receiving water within a short distance of the discharge."[3] In addition, the District has conducted a thorough effort to model the discharge and to conduct field studies documenting dilution to evaluate the risks in the near field and, as described in the District's Anti-degradation Analysis[4], there is no unacceptable risk to aquatic life. The edge of the acute mixing zone proposed by the District is 60 feet downstream from the diffuser, which is consistent with the Region VIII guidance of not exceeding 100 feet. Further, the EPA Region VIII Guidance document acknowledges that the document serves as guidance and that States and Tribes should develop their own methods and criteria for setting up acute and chronic mixing zones.

Also, on Page 10, the Region VIII guidance specifies maximum size restrictions on mixing zones, particularly applicable to incompletely mixed discharges. For streams and rivers, mixing zones must not exceed one-half of the cross-sectional area or a length of 10 times the stream width at critical low flow, whichever is more limiting.

In evaluating the proposed SRCSD aquatic life mixing zones (an acute mixing zone extending 60 feet downstream from the diffuser and a chronic mixing zone extending 350 feet downstream) in comparison to the maximum mixing zone size restrictions cited in the Region VIII guidance, neither of those mixing zones would occupy over half of the river cross section or extend more than 6000 feet (10 times the river width) downstream. Therefore, the proposed SRCSD aquatic life mixing zones would satisfy the maximum size provisions of the Region VIII guidance.

The Issue Paper also notes that the Region VIII document recommends meeting acute or chronic water quality criteria without dilution 'where available data support a conclusion that fish or other aquatic life are attracted to the effluent plume.' While the area around the SRWTP outfall is 'known to be popular for fishing,' there is no evidence that this is a result of attraction or that it results in 'adverse effects such as acute or chronic toxicity.' The absence of evidence of fish toxicity supports a finding that adverse effects are not occurring at this location. Lacking evidence or information that adverse effects are occurring near the SRCSD diffuser, special restrictions on the proposed mixing zone are not warranted.

Examples of NPDES permits adopted by the Central Valley Water Board that have been granted acute and chronic mixing zones are shown in Table 1. In addition, acute mixing zones have recently been proposed in the San Francisco Bay Region for the Town of Yountville (Order No. R2-2010-0072) and the City of Calistoga. These NPDES permits in the Central Valley and San Francisco Bay Regions have satisfied the SIP's requirements for mixing zones.

[3] California Regional Water Quality Control Board, Central Valley Regiona. Order No. 5-00-188. NPDES No. CA0077682

[4] Larry Walker Associates, 2009. Anti-Degradation Analysis for Proposed Discharge Modification to the Sacramento Regional Wastewater Treatment Plant. DRAFT. Prepared for Sacramento Regional County Sanitation District. May 2009

TABLE 1 - REGION 5 ADOPTED MIXING ZONES[5]

Discharger	Order #	Type	Receiving Water
City of Chico, Chico Water Pollution Control Plant	R5-2010-0019	Acute, Chronic and Human Health	Sacramento River M&T Irrigation Canal
City of Yuba City, City of Yuba City Wastewater Treatment Facility	R5-2007-0134-01 (as amended by Order No. R5-2010-0007)	Acute, Chronic and Human Health	Feather River
City of Angels, City of Angels Wastewater Treatment Plant	R5-2007-0031-01 (as amended by Order No. R5-2009-0074)	Acute, Chronic and Human Health	Angels Creek
Forest Meadows Wastewater Reclamation Plant, Calaveras County Water District and Cain-Papais Trust	R5-2008-0058	Acute, Chronic and Human Health	Stanislaus River
Ironhouse Sanitary District, Wastewater Treatment Plant	R5-2008-0057	Acute, Chronic and Human Health	San Joaquin River
Town of Discovery Bay, Discovery Bay Wastewater Treatment Plant	CA0078590	Acute and Chronic	Old River
City of Portola, Wastewater Treatment Plant	NPDES No.: CA0077844 Order #: R5-2009-0093	Acute & Chronic	Middle Fork, Feather River
City of Rio Vista, Beach Wastewater Treatment Facility	R5-2008-0108	Acute, Chronic and Human Health	Sacramento River

In summary, the information provided to the Regional Water Board previously and above supports the District's proposed mixing zone as it meets the requirements of the SIP and also satisfies USEPA guidelines for mixing zones that have been used in other states.

The Issue Paper also states that "ammonia levels in the Delta are a concern due to the toxicity of ammonia and the effect ammonia can have on dissolved oxygen." With respect to the applicability of these issues at the edge of the proposed mixing zones, it should be noted that modeling results presented by the District indicate that neither toxicity nor low dissolved oxygen levels would occur at these locations..

The Issue paper also states that "removal of ammonia is both technically feasible and commonly employed by most dischargers in the Central Valley Region." While this may be

[5] Region 5 Permits can be found at: http://www.swrcb.ca.gov/centralvalley/board_decisions/adopted_orders/

true, these dischargers referred to in the Issue Paper are not similar to SRCSD. In particular, the dischargers that have been required to remove ammonia in the Central Valley typically discharge to effluent dominated water bodies where there is limited or no dilution available. In contrast, the SRWTP discharges to the Sacramento River where significant dilution is available. Furthermore, technical feasibility should not be an overriding consideration when establishing effluent limits in an NPDES permit. As indicated in [Cost Benefit analysis dated May, 2010], the costs of nitrification are significant and should not be imposed on local communities unless information exists to indicate that a commensurate environmental benefit would be achieved. Available information, as summarized below, indicates that, beyond the ammonia reduction needed to prevent low dissolved oxygen in downstream waters, further ammonia reduction is not warranted or reasonable.

AMMONIA

Ammonia is the subject of ongoing studies to understand its role in the Delta ecosystem. Several statements regarding ammonia in the Issue Paper are not supported by the body of current research as discussed in detail below. The District's detailed comments are related to the following:

- Ammonia Toxicity
- Synergistic effects
- Inhibition of Phytoplankton Primary Production
- Shift in algal communities

In brief, the Issue Paper does not recognize recent findings regarding the occurrence, or lack thereof, of ammonia-based acute and chronic toxicity as stated in the May 2010 Central Valley Regional Water Quality Control Board Draft "Nutrient Concentrations and Biological Effects in the Sacramento-San Joaquin Delta" report. With regard to potential synergistic effects, ambient percentages of effluent in the Sacramento River just below the discharge are well below the no effects threshold for "percent effluent" obtained in Inge Werner's effluent dosing experiment. The environmental relevance of exposure concentrations has received less attention than deserved in investigations of contaminants in the Delta by some researchers. Several key elements of the ammonium inhibition hypothesis researched by Dugdale and Parker (San Francisco State University) were not confirmed by the Sacramento River study in 2009. Cecile Mioni's research (University of California, Santa Cruz), including data from sampling events in October 2008 and June-August 2009, has revealed a lack of correspondence between ammonium concentrations and toxic *Microcystis* blooms. Instead, independent studies in several Pelagic Organism Decline ("POD") years (2004, 2005, 2008, 2009) have consistently indicated that other factors such as water temperature, flow and turbidity best explain *Microcystis* abundance and toxicity in the Delta.

<u>Ammonia toxicity</u>

The statement, "*[a]mmonia is extremely toxic to aquatic life at low levels*," is not placed in sufficient context with the abundant recent research that indicates that ambient ammonia concentrations in the Sacramento River - and in the whole Delta as defined by the Issue Paper - are well below 1999 USEPA chronic or acute ammonia criteria *and* are well below concentrations which are currently estimated to be acutely toxic to sensitive Delta species such as Delta smelt and the calanoid copepods *Eurytemora affinis* and *Pseudodiaptomus forbesi*. Examples from recent research are as follows:

> USEPA Criteria (1999). The Issue Paper statement "[*s*]*tudies indicate that the Delta waters rarely exceed the USEPA ammonia acute or chronic criteria*" implies that the acute criterion is sometimes exceeded in the Delta. This is not true. Also exceedances of the chronic criterion are *extraordinarily* rare. A screening of almost 12,000 samples from 80 stations throughout the upper San Francisco Bay Estuary, collected over 35 years (1974-2010)[6] resulted in *zero* exceedances of the acute criterion, and *only two* exceedances of the chronic criterion[7]. Neither of the two exceedances of the chronic criterion occurred during the POD years of 2000-2010. Margins of safety (estimated by dividing USEPA criterion values for each sample by the corresponding ambient ammonia concentration) are very large for the Delta. Over the available time record, mean margins of safety for the acute criterion are 295 and 243 for freshwater and brackish sites, respectively[8]. Analogous margins of safety for the chronic criterion are 74 and 52. This topic is discussed in more detail in Attachment A1.
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> With respect to the recently released Draft USEPA Criteria (2009) for the protection of sensitive freshwater mussels, it is important to note that those draft criteria (which are referenced in the issue paper) are still under review and have not been finalized by USEPA. Thus, the draft criteria are not appropriate for use in NPDES permitting decisions at this time. Additionally, the presence of sensitive freshwater mussels near the SRWTP discharge has not been established or documented at this time.
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> Delta smelt. No measurements of ambient un-ionized ammonia thus far reported from the freshwater or brackish Delta have exceeded the LC50 or LC10 for Delta smelt larvae obtained in 7-day acute toxicity tests in 2009 (Werner et al. 2009)[9]. No ambient un-ionized ammonia concentrations reported during POD years (2000-2009) from freshwater stations have exceeded the NOEC reported by Werner et al. (2009) for 7-day survival tests (wherein ammonia was supplied via additions of SRWTP effluent).
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> Delta copepods. Although chronic toxicity test results for Delta copeopods are not yet available (the life cycle tests referred to in the Issue Paper), very large margins of

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[6] The dataset and the screening are detailed in Engle, D.L., & G. Lau. 2009a. *Total and Un-ionized Ammonia Concentrations in the Upper San Francisco Estuary: A Comparison of Ambient Data and Toxicity Thresholds*. 9th Biennial State of the San Francisco Estuary Conference, Oakland, CA, September 29-October 1, 2009, and in Engle, D.L. (2010) (see below).

[7] The two exceedances occurred at IEP-EMP station C3 (Sacramento River at Greene's Landing) in October 1991, and at IEP-EMP station P8 (San Joaquin River at Stockton) in April 1976.

[8] Engle, D.L. (2010) Testimony before State Water Resources Control Board. Delta Flow Criteria Informational Proceeding. Other Stressors-Water Quality. Ambient ammonia concentrations: direct toxicity and indirect effects on food web. Avail. at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/sac_rcsd.shtml

[9] Werner, I., L.A. Deanovic, M. Stillway, and D. Markiewicz. 2009. Acute toxicity of ammonia/um and wastewater treatment effluent-associated contaminants on Delta smelt - 2009. Final Report, submitted to the Central Valley Regional Water Quality Control Board, December 17, 2009.

safety between ambient ammonia levels in the Delta and acute thresholds for *Eurytemora affinis* suggest that chronic toxicity is an unlikely explanation for population trends for this species. *Median* ambient un-ionized ammonia concentrations in the freshwater and brackish Delta during POD years[10] were 100 and 166 times lower, respectively, than the 96-hr LC50 for *E. affinis* (0.12 mg N/L) published by Teh et al. (2009)[11]. The 99th percentile values for un-ionized ammonia during POD years[12] are more than an order of magnitude lower than the *E. affinis* LC50.

Synergistic effects

Referring to tests described in Werner (2009), the Issue Paper states "*there are indications that additive or synergistic effects are occurring in the SRWTP effluent where ammonia may be combining with other unknown toxicants resulting in toxicity...The study showed that the test performed with SRWTP effluent was statistically more toxic than the test performed with river water seeded with ammonium chloride. This may be an indication that there are additional toxicants present in the SRWTP effluent that are resulting in chronic toxicity to delta smelt*."

It is not reasonable to conclude from the work of Werner et al. (2009) that synergistic effects would occur in the Sacramento River at the ambient ammonia levels downstream from the SRWTP discharge. The concentrations of SRWTP effluent that produced effects in these particular tests are significantly higher than the ambient concentrations existing below the SRWTP discharge. The 7-day effects thresholds in Werner et al. (2009) for 47-d old delta smelt, expressed as percent effluent, were as follows: LC50 (25.7%), LC10 (10.6%), NOEC (9%). In contrast, the percentages of effluent that occur in the Sacramento River below the SRWTP discharge are typically less than 3%[13]. In other words, ambient percentages of effluent in the Sacramento River just below the discharge are well below the *no effects* threshold for "percent effluent" obtained in Werner's effluent dosing experiment. The environmental relevance of ambient exposure concentrations has received less attention than deserved in investigations of contaminants in the Delta.

Inhibition of Phytoplankton Primary Production

The Issue Paper states "*It is unknown what the impact of ammonia is in the freshwater Delta between the SRWTP discharge and Suisun Bay*". The Issue Paper does not acknowledge recent research results which pertain to nitrogen/phytoplankton interactions between the

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[10] 0.00072 and 0.0012 mg N/L (un-ionized ammonia-N), respectively for freshwater and brackish stations (calculated using the dataset described in Engle (2010)).

[11] 0.12 mg N/L (un-ionized ammonia), obtained at representative pH 7.6. Published in: Teh, S.J, S. Lesmeister, I. Flores, M. Kawaguchi, and C. Final Report. Acute Toxicity of Ammonia, Copper, and Pesticides to Eurytemora affinis, of the San Francisco Estuary. Appendix A *In*: Reece, C., D. Markiewicz, L. Deanovic, R. Connon, S. Beggel, M. Stillway, and I. Werner. 2009. *Pelagic Organism Decline (POD): Acute and Chronic Invertebrate and Fish Toxicity Testing in the Sacramento-San Joaquin Delt*a. UC Davis Aquatic Toxicology Laboratory, Progress Report, 29 September 2009.

[12] 0.0063 and 0.014 mg N/L (un-ionized ammonia-N), respectively for freshwater and brackish station (calculated using the dataset described in Engle (2010)).

[13] Based on 7-day running averages for Sacramento River flow between 1998-2009, the 99.5th percentile percent effluent is 2.8% (M. Mysliwiec, Larry Walker Associates, unpublished data).

SRWTP and Suisun Bay. Since the August 2009 Ammonia Summit, results of detailed transect work in the Sacramento River between the SRWTP and Suisun Bay conducted by San Francisco State University (SFSU) investigators (Alex Parker, R. Dugdale, and others) have been presented at the 2009 State of the San Francisco Estuary Conference (Parker et al. 2009)[14] and in a draft report to the Regional Board[15], released in March 2010.

Several key elements of the ammonium inhibition hypothesis were not confirmed by the Sacramento River study referred to above. Grow-out tests showed that phytoplankton growth rates collapsed after ambient nitrate was depleted upstream of the SRWTP, whereas on the same time frame, phytoplankton growth was prolonged by ammonium uptake below the SRWTP. In the Sacramento River, specific uptake rates for ammonium were not lower than those for nitrate when ammonium was in abundance. Longitudinal patterns in biomass and primary production rates in the Sacramento River were *not* explained by ambient ammonium concentrations or differential uptake of ammonium and nitrate. Three results in particular illustrate that ammonium is not disrupting *in situ* primary production in the Sacramento River:

1. Carbon fixation rates declined along the river upstream of the SRWTP, despite the fact that nitrate dominated N uptake in that reach of the river.
2. No step-change in phytoplankton biomass or carbon fixation rates was associated with either (1) the location of the SRWTP discharge, or (2) a shift from predominantly nitrate uptake by phytoplankton to predominantly ammonia uptake below the discharge.
3. Significant increases in primary production rates occurred in the river between Rio Vista and Suisun Bay, despite the fact that inorganic nitrogen uptake in that reach was dominated by ammonium.

Finally, between the Yolo/Sacramento County line and Suisun/San Pablo Bays, small-celled phytoplankton and green algae exhibited similar longitudinal trends as large celled (presumably) diatoms. These observations so far refute the hypothesis that ammonium inputs create a competitive disadvantage for large diatoms compared to other taxa.

Shift in algal communities

The Issue Paper states: "*A hypothesis is that the elevated concentrations of ammonia in the Delta are responsible for shifting the competitive advantage to less nutritious bluegreen algae such as Microcystis in late summer...Microcystis abundance appears to be positively correlated with ammonium...*" A presentation given by Dr. Cecile Mioni (UCSC) at the August 2009 Ammonia Summit is cited as support for this hypothesis. However, as noted

[14] Parker A.E., R.C. Dugdale, F.P. Wilkerson, A. Marchi, J. Davidson-Drexel, J. Fuller, and S. Blaser. 2009. *Transport and Fate of Ammonium Supply from a Major Urban Wastewater Treatment Facility in the Sacramento River, CA*. 9th Biennial State of the San Francisco Estuary Conference, Oakland, CA, September 29-October 1, 2009.

[15] Parker, A.E., A.M. Marchi, J. Drexel-Davidson, R.C. Dugdale, and F.P. Wilkerson. 2010. Effect of ammonium and wastewater effluent on riverine phytoplankton in the Sacramento River, CA. Draft Final Report, submitted to the Central Valley Regional Water Quality Control Board, March 17, 2010.

in the District's letter regarding the Human Health Issue Paper (February 1, 2010), this presentation was based on preliminary, incomplete results from post-doctoral sampling work in the Delta in the summer of 2009. Subsequent analysis of more complete results from Dr. Mioni's research, including data from sampling events in October 2008, and June-August 2009, has revealed a lack of correspondence between ammonium concentrations and toxic *Microcystis* blooms. Dr. Mioni's more complete analysis was presented by her at several venues starting in late 2009 and more recently at the Oceans Colloquium at Hopkins Marine Station (April 23, 2010)[16], and the Delta Science Program Brown Bag Series in Sacramento (May 12, 2010)[17]. Among Dr. Mioni's current conclusions from her Delta research include the following:

- There is no apparent association between ammonium concentrations or NH_4^+:P ratios and either *Microcystis* abundance or toxicity.
- Water temperature is strongly correlated with *Microcystis* abundance and toxicity.
- Secchi depth and specific conductivity are likely correlated with *Microcystis* abundance and toxicity.

Regarding *Microcystis,* the Issue Paper states '*data collected to date is ambiguous*'. However, independent studies in several POD years (2004, 2005, 2008, 2009) consistently indicate that physical factors such as water temperature, flow, and turbidity best explain *Microcystis* abundance and toxicity in the Delta. While the Issue Paper acknowledges the work in Lehman et al. (2008),[18] which indicates that water temperature and low stream flow are positively linked to *Microcystis* abundance, it omits the additional result from this publication that ammonia was weakly *negatively* correlated with *Microcystis* abundance, meaning that higher ammonia concentrations were associated with fewer *Microcystis*. Finally, the lack of correspondence between ambient ammonia concentrations and the abundance of *Microcystis* in the Delta was recently confirmed in additional published work, Lehman et al. (2010)[19]:

> "Although ammonium-N concentration was elevated at some stations in the western and central delta and the Sacramento River at stations at CS and CV, neither it nor the total nitrogen (nitrate-N and nitrite-N plus ammonium- N) to soluble phosphorus molar ratio (NP) was significantly correlated with Microcystis abundance across all regions or within the western and central delta separately. Plankton group carbon or plankton species abundance at 1 m was not significantly correlated with any of the

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[16] Mioni, C.E. (2010) *What controls harmful algae and phytotoxins in the SF Bay?* Oceans Colloquium, Hopkins Marine Station, Monterey, CA. April 23, 2010.

[17] Mioni, C.E., and A. Paytan (2010) *What controls Microcystis bloom & toxicity in the San Francisco Estuary? (Summer/Fall 2008 & 2009)*. Delta Science Program Brownbag Series, Sacramento, CA. May 12, 2010.

[18] Lehman, P.W., G. Boyer, M. Satchwell, and S. Waller. 2008. The influence of environmental conditions on the seasonal variation of *Microcystis* cell density and microcystins concentration in the San Francisco Estuary. Hydrobiologia 600: 187-204.

[19] Lehman, P.W., S.J. Teh, 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.

> water quality conditions measured, including the NP ratio." (Lehman et al. 2010, p. 237).

An association between water temperature and and cyanobacterial blooms in the Delta would be consistent with observations from other estuaries. Increased residence time (e.g., during drought) and warmer temperatures are acknowledged as factors stimulating cyanobacterial blooms in other estuaries (Paerl et al. 2009[20], Paerl & Huisman 2008[21]).

Non-nutrient factors which affect the taxonomic composition of phytoplankton in estuaries have been neglected in the POD debate. For example, ammonium inhibition of nitrate uptake has received considerable attention as a hypothesized factor to explain changes in the relative abundance of diatoms in the estuary. However, physical factors (such as temperature, current speed, residence time, stratification, light penetration) may be strongly affecting competitive outcomes between diatoms and other phytoplankton taxa in the Delta, irrespective of nutrient concentrations or ratios. Published information indicating this is true is available for the Delta. Lehman (1996, 2000) associated a multi-decadal decrease in the proportional biomass of diatoms in the Delta and Suisun Bay to climatic influences on river flow. The deep, pool-like bathymetry of the Stockton Deepwater Ship Channel is hypothesized by some investigators to function as a trap for diatoms in transport in the San Joaquin River. Diatoms settle more rapidly than other taxa; unless current speeds are high, diatoms may not be able to remain in suspension for the length of the ship channel (P. Lehman, DWR, Feb. 2009, personal communication). The influence of flows and residence time on phytoplankton assemblages in estuaries is well acknowledged in other regions. For example, hydrologic perturbations, such as droughts, floods, and storm-related deep mixing events, overwhelm nutrient controls on phytoplankton composition in the Chesapeake Bay; diatoms are favored during years of high discharge and short residence time (Pearl et al. 2006)[22]. The role of flow and residence time in regulating estuarine microfloral composition was summarized by an expert panel convened by CalFed in March 2009. The panel's final document "*Ammonia Framework"* (Meyer et al. (2009)[23] states as follows:

> "Diatoms have fast growth rates and may be particularly good competitors during high flows with concomitant short residence times, when their fast growth rates can offset high flushing rates. In moderate flows, chlorophytes and cryptophytes become more competitive, whereas low flows with concomitant longer residence times allow the slower-growing cyanobacteria, non-nuisance picoplankton, and dinoflagellates to contribute larger percentages of the community biomass. These spatially and temporally-variable patterns of phytoplankton composition are typical of many

[20] Pearl, H.W., K.L. Rossignol, S. Nathan Hall, B.L. Peierls, and M.S. Wetz. 2009. Phytoplankton community indicators of short- and long-term ecological change in the anthropogenically and climatically impacted Neuse River Estuary, North Carolina, USA. Estuaries and Coasts. DOI 10.1007/s12237-009-9137-0

[21] Paerl, H.W., and J. Huisman. 2008. Blooms like it hot. Science 320: 57–58. doi:10.1126/science.1155398

[22] Pearl, H.W., L.M. Valdes, B.L. Peierls, J.E. Adolf, and L.W. Harding, Jr. 2006. Anthropogenic and climatic influences on the eutrophication of large estuarine ecosystems. Limnol. Oceanogr. 51(1, part 2): 448-462.

[23] 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. Final report submitted to CalFed Science Program, Sacramento, CA, April 13, 2009.

> estuaries [e.g., Chesapeake Bay, Maryland; Neuse-Pamlico Sound, North Carolina; Narragansett Bay, Rhode Island; Delaware Bay, Delaware]." Meyer et al. (2009)

Benthic grazing may also be altering phytoplankton composition in the estuary. Clam grazing selectively removes larger particles (Werner & Hollibaugh 1993)[24]; and, clams may consume a larger fraction of diatoms than nanoplanktonic taxa such as flagellates. Kimmerer (2005)[25] used long-term dissolved silica dynamics, corrected for mixing in the low salinity zone, as an indicator of diatom productivity in the northern San Francisco Estuary. He showed that there was a step decrease in annual silica uptake after 1986, which he attributed to efficient removal of diatoms by *Corbula amurensis* after its introduction in 1986. Grazing by *Corbicula fluminea* can cause shallow habitats in the freshwater Delta to serve as a net sink for phytoplankton (Lopez at al. 2006; Parchaso & Johnson 2008)[26]; it is possible that diatoms are differentially affected by benthic grazing (e.g., compared to motile or buoyant taxa) in both the brackish and freshwater Delta. In fact, benthic grazing has been implicated as a factor favoring *Microcystis* over other phytoplankton, as explained in the CalFed expert panel's "*Ammonia Framework:"*

> "However, in places where filter-feeding mussels and clams overlap with habitat suitable for *Microcystis* (i.e., low salinity), the presence of these invertebrates might enhance bloom formation by selectively rejecting large *Microcystis* colonies. That grazer selectivity can give *Microcystis* a grazer-resistant, competitive advantage over other phytoplankton, as Vanderploeg et al. (2001) reported for zebra mussels (*Dreissena polymorpha*) in the Great Lakes." (Meyer et al. 2009)

Finally, the Issue Paper states that removal of ammonia and nitrate is '*technically feasible*' (pp.6, 10) and "*commonly employed by most dischargers in the Central Valley Region*' (p.6-7). It should be clarified that the primary reasons for including nitrification and denitrification facilities at Central Valley POTWs has typically been to meet water quality based effluent limitations pertaining to ammonia toxicity based on adopted, applicable U.S. EPA criteria and/or nitrate MCLs for POTWs with little or no dilution in their receiving waters. In no cases in the Central Valley have POTWs been required to install facilities to remove ammonia, nitrate or phosphorus compounds to address purported biostimulatory impacts or the other hypotheses addressed above.

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[24] Werner, I., and J. T. Hollibaugh. 1993. *Potamocorbula amurensis*: Comparison of clearance rates and assimilation efficiencies for phytoplankton and bacterioplankton. Limnol. Oceanogr. 38: 949-964.

[25] Kimmerer, W. J. 2005. Long-term changes in apparent uptake of silica in the San Francisco Estuary. Limnol. Oceanogr. 50: 793-798.

[26] Lopez, C.B., J.E. Cloern, T.S. Shraga, A.J. Little, L.V. Lucas, J.K. Thompson, and J. R. Burau. 2006. Ecological values of shallow-water habitats: implications for the restoration of disturbed ecosystems. Ecosystems 9: 422-440.

Parchaso F., and J. Thompson. 2008. *Corbicula fluminea* distribution and biomass response to hydrology and food: A model for CASCaDE scenarios of change. CALFED Science Conference, Sacramento, CA., October, 2008. Avail at http://cascade.wr.usgs.gov/CALFED2008.shtm

LOW DISSOLVED OXYGEN

The Issue Paper discusses ambient dissolved oxygen data downstream of the SRWTP discharge and approaches to preventing dissolved oxygen levels below the Basin Plan objective. Information regarding these two topics is provided in this section.

Dissolved Oxygen Data Evaluation

The Issue Paper states that several water quality databases include dissolved oxygen data sowing that the Sacramento River below the SRWTP has been 'at times out of compliance with the Basin Plan's dissolved oxygen water quality objective [of 7 mg/L] while the river upstream of the SRWTP is always in compliance.'

As noted in the Issue Paper, the District has evaluated the effect of the SRWTP effluent on downstream dissolved oxygen concentrations. Based on Regional Water Board comments, the District has made substantial additions to the original dissolved oxygen analysis. In the evaluation, the District recognized that the available data from the various data sources were, at times, inconsistent and contradictory. The District and USGS measure dissolved oxygen at Freeport. The next site with dissolved oxygen data downstream from the discharge is the Department of Water Resources (DWR) Hood station, 8 miles downstream. In comparing the District and USGS dissolved oxygen to the Hood dissolved oxygen data, the difference between the two location ranges from more than 1.0 mg/L to over 2.0 mg/L, including periods of high river flow conditions where little change in dissolved oxygen would be expected between the two sites (i.e, high flow provides short travel time with little opportunity for decay and high flows result in high levels of dilution minimizing any impact of the SRWTP effluent). The data for Freeport and Hood are presented in Figure 1. In the modeling analysis, the dissolved oxygen data at Hood could not be depressed using realistic reaction rates. It was the difference between the Freeport data and Hood data that caused the District to conduct a Dissolved Oxygen data assessment for all data sets.

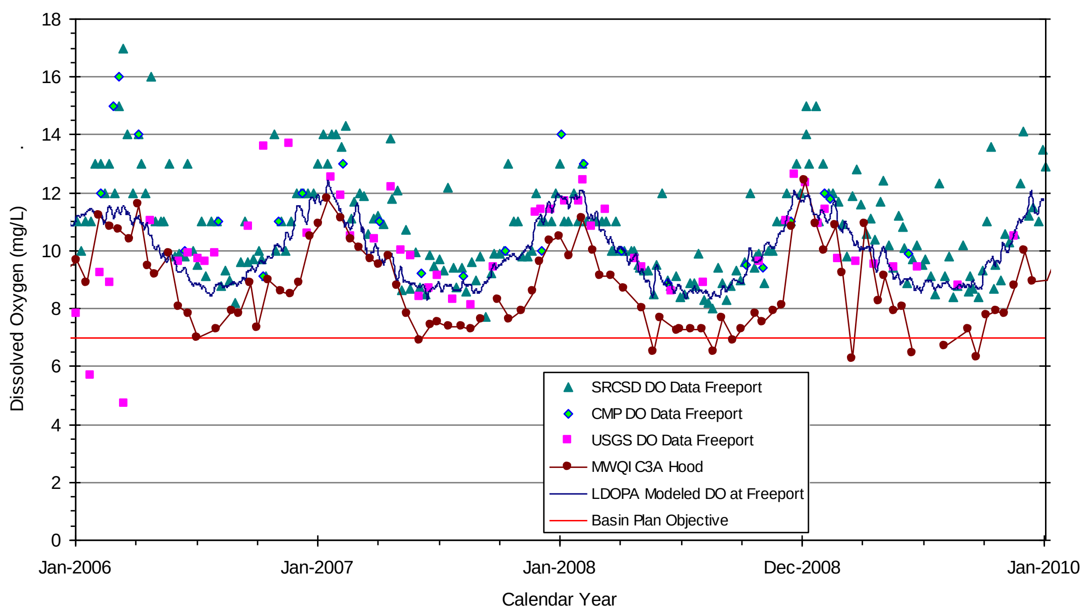

Figure 1: Dissolved Oxygen Concentration Comparison Between Freeport and Hood.

To further investigate the potential causes for inconsistencies between data sets, the District has been performing an ongoing data assessment of the available data sets, and methods used to collect the information. A summary of the programs collecting dissolved oxygen, the methods, and calibration is presented in Table 2. In the data assessment, the District is evaluating the available data, the quality assurance/quality control (QA/QC) procedures implemented by the programs, and the calibration records. Again, the data at Hood are not consistent with data collected at other locations on the River. The USGS and District dissolved oxygen data at Freeport are comparable. Likewise, the USGS and CDEC data at Rio Vista are also comparable. CDEC and MWQI data at Hood are comparable, however, there is no mechanism that can realistically account for the difference in dissolved oxygen concentrations between Freeport and Hood and Hood and Rio Vista. The data collected by the Regional Water Board[27] do not support a consistent dissolved oxygen sag between the point of SRWTP discharge and Hood. The Regional Water Board data does not support a sag that would then continue to deepen as the water continued downstream.

Table 2: Data Sources for Dissolved Oxygen in the Sacramento River.

	USGS	CMP	Regional Water Board	CDEC	City of Rio Vista
Site	Freeport and Rio Vista	Freeport and RM44	Multiple Sacramento River Locations	Hood and Rio Vista	Rio Vista
Field Meter Type and Model	YSI Multi-Parameter 600XL	YSI Multi-Parameter 600XL	YSI Multi-Parameter 556	YSI Clark/ Optical ROX[1]	YSI Multi-Parameter 550A
Method	Clark (amperometric)	Clark (amperometric)	Clark (amperometric)	Clark/ROX[1] (amperometric/ luminescent)	Clark (amperometric)
Time of Calibration	Morning of sampling event	Morning of sampling event	Morning of sampling event	Periodically[2]	-
Sample Location	Mid-Channel	Mid-Channel	Mid-Channel	Near Bank	Bank
Depth of Sample	1 to 2 feet	2-5 feet	-	1 meter	2 feet
Time of Sampling	Morning (10-12am)	Morning (10-12am)	-	Continuous (hourly)	-

[1] DWR changed sensor from Clark to optical in 2008
[2] Calibration schedule has not been provided

Additionally, the CDEC data are the uncorrected sensor reading and do not receive QA/QC. The data on CDEC are marked provisional and subject to change[28]. The District was able to

[27] Chris Foe, Adam Ballard and Stephanie Fong (2010), "Draft Nutrient Concentrations and Biological Effects in the Sacramento-San Joaquin Delta", May 2010

[28] http://cdec.water.ca.gov/faq.html#quality

review dissolved oxygen calibration results for the Hood station from March through December 2008[29]. In the period, there were three events (April 2, April 28, and December 10) where the dissolved oxygen was adjusted up by over 1.0 mg/L. The data in the CDEC database are not back corrected to account for the calibration adjustments. Due to concerns over the available data and the inconsistencies between programs and locations, the District concludes that the dissolved oxygen may be a field parameter that has not received the best quality control and care in measurement and recording. The District is especially concerned that the Regional Water Board would use the CDEC data directly in evaluations of the receiving water compliance with objectives due to the fact that they are provisional data and subject to change.

Reduction of Oxygen Demanding Substances

The Issue Paper states that the District is 'examining operational changes such as eliminating the high ammonia leachate from the sludge lagoons that is treated at the SRWTP.' The subject waste stream is mischaracterized as ammonia leachate. There has been no leachate collection and treatment from the SSBs. The ponds were flushed with treated effluent to control struvite production and odor, and returned to the headworks of the SRWTP. It is also a mischaracterization to say that the District is only examining operational changes. In fact, the SSB flushing was discontinued in May 2009 for 19 of 20 ponds and has resulted in an estimated 12% reduction in ammonia in the SRWTP effluent. The SRCSD is committed to further limiting oxygen demand in its effluent in order to maintain compliance with dissolved oxygen water quality objectives downstream of the discharge that may result at higher discharge rates in the future. Some of the alternatives that the District is considering are listed in the Low Dissolved Oxygen Prevention Assessment submitted to the Regional Board in May 2009 with an updated version submitted in May 2010 and include process optimization, treatment of internal return flows, expansion of the District's water recycling program, or treatment of a portion of the SRWTP effluent flow.

THERMAL CONDITIONS

The Issue Paper states that, since 2005, 'there has been a significant pelagic organism decline (POD), new species are threatened and there has been a change in the diffuser configuration.' Significant declines in the populations of the delta smelt and other species have been observed since 2000 with the steepest decline observed from 2000-2002; [30] however, water temperature in the Sacramento River has not been implicated as one of the direct contributions to the POD in any of the numerous studies evaluating stressors to Delta species. As discussed below, the SRWTP discharge has a negligible effect on temperatures in the lower Sacramento River upon fully mixing. Consequently, its contribution to Delta temperatures, and therefore any potential POD-related effects, is also negligible.

An assessment of the thermal effects of the SRWTP effluent plume on the aquatic community of the lower Sacramento River was recently conducted in support of the SRCSD's proposed Thermal Plan exceptions. This assessment was based on a dye study

[29] Email communication between Mike Dempsey, DWR and Kathleen Harder CVRWQCB, Feb 25, 2009.

[30] Pelagic Organism Decline Progress Report: 2007 Synthesis of Results; available: http://www.fws.gov/sacramento/es/documents/POD_report_2007.pdf

conducted in November 2007 (i.e., following the closure of the 25 eastern-most ports on the diffuser), three-dimensional simulations of the near field thermal plume using the computational fluid dynamics model FLOWMOD, and predicted far-field fully mixed thermal conditions using the U.S. Bureau of Reclamation's PROSIM model.

This assessment indicates that the near-field conditions in the plume would not pose substantial adverse effects on the balanced, indigenous aquatic community of the lower Sacramento River. Under all conditions modeled, a zone of passage at least 75 feet wide, in which temperatures are unaffected or minimally affected by the SRWTP effluent, occurs on each side of the diffuser, thereby leaving an adequate zone of passage around the plume. Furthermore, the closure of 25 diffuser ports in 2007 increased the zone of passage along the east side of the river by approximately 100 feet. Because the diffuser lies on the bottom of the river, the warmest temperatures occur near the bottom at the point of discharge, and temperatures within the plume are rapidly attenuated as the effluent rises and mixes toward the surface downstream of the diffuser. Consequently, surface temperatures within the river are only minimally affected by the time the plume approaches the surface downstream of the diffuser. In no case would the plume be expected to cause a thermal barrier to fish movement.

Because the warmest part of the thermal plume is located close to the outfall on the bottom of the river, few fish are expected to be exposed to the maximum temperature differentials between the effluent and river background, and exposure to the thermal plume would occur for short (i.e., minutes) periods of time. As actively swimming fishes approach the diffuser, they can readily avoid unfavorable temperatures within the plume by swimming around or over the portions of the plume. Passively drifting fishes or benthic macroinvertebrates may drift through the plume; however, given the rate of river flow and their thermal tolerances, they would not experience exposures to elevated temperatures for a sufficient period of time to cause lethal or sub-lethal effects.

Far-field temperature modeling results indicate that the probability with which any given fully mixed Sacramento River temperature would occur would not change substantially whether the SRWTP is operated to meet the: 1) Thermal Plan objective 5.A.(1)a year-round; 2) the current exception to this objective in the District's 2000 NPDES permit; or 3) the proposed Thermal Plan exceptions. This is due to the relatively infrequent occurrence of temperature differentials (between the SRWTP effluent and river background) that exceed 20°F. Consequently, the findings of this far-field assessment are consistent with a finding that the proposed Thermal Plan exceptions would be protective of the balanced, indigenous aquatic community of the lower Sacramento River and Delta.

PYRETHROIDS

The Issue Paper cites a recent study by Weston[31] to identify sources of pyrethroid pesticides in the Sacramento- San Joaquin Delta. Regarding the findings of this study, the issue paper states that "…although minimal toxicity was detected in the Sacramento River, SRWTP effluent contained pyrethroid pesticides in concentrations that may be toxic."

[31] Weston, D.P., Lydy, M.J., "Urban and Agricultural Sourcesof Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California", Environmental Science and Technology 2010, 44, 1833-1840.

The environmental relevance of any pyrethroids in SRWTP effluent is an important consideration. Because the SRWTP never discharges if the river to effluent flow is below 14:1 the impacts of undiluted effluent are not environmentally relevant. The statement regarding effluent pyrethroid levels in the issue paper implies that SRWTP effluent could be contributing to 'minimal toxicity' in the Sacramento River. The implication is misleading for several reasons:

- Toxicity related to pyrethroids in the Sacramento River was observed by Weston from samples that were taken upstream of the SRWTP discharge. Therefore, the 'minimal toxicity' observed in the receiving water was due to pyrethroids that occur in the absence of SRWTP discharge.

- Weston and Lydy (2010) did not collect samples or evaluate the toxicity of Sacramento River water downstream of SRWTP. Therefore, implications that SRWTP was causing toxicity due to pyrethroids in the receiving water environment are not supported by this study. Low ambient concentration estimates in the Delta and downstream of SRWTP discharge are validated by the rare instances of *H. azteca* toxicity reported in only 2% of samples in 2006-2007 by Werner et al.[32] and in only 0.5 % of samples in 2008 reported by Reece et al. [33]

- The toxicity to *Hyalella azteca* reported by Weston and Lydy (2010) in SRWTP effluent grab samples was in undiluted (100 percent) effluent. However, the SRWTP effluent is highly diluted when discharged into the Sacramento River, and the presence of toxicity in an undiluted sample provides no evidence of toxicity in the receiving water environment. Accounting for dilution of the effluent, downstream ambient concentrations (as shown in Table 3) would be well below those that have the potential to cause effects (pyrethroid EC50s reported in Weston and Lydy [2010] ranged from 1.7 to 21.1 ng/L). Note that permethrin, the least toxic pyrethroid with an EC50 of 21.1 ng/L, accounted for 36 to 82 percent of the summed pyrethroid concentrations in samples where pyrethroids were detected. There is, therefore, very little potential for toxicity in the Sacramento River from any pyrethroids discharged in SRWTP effluent.

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[32] Werner I, Moran K. 2008. Effects of pyrethroid insecticides on aquatic organisms. In Gan J, Spurlock F, Hendley P, Weston D (Eds). Synthetic Pyrethroids: Occurrence and Behavior in Aquatic Environments. American Chemical Society, Washington, DC.

[33] Reece, C., D. Markiewicz, L.Deanovic, R. Connon, S. Beggel, M. Stillway, and I Werner, I.L.2009. Pelagic Organism Decline (POD): Acute and Chronic Invertebrate and Fish Toxicity Testing in the Sacramento-San Joaquin Delta 2008-2010, Progress Report III. 29 September

Table 3

Estimated Pyrethroid Concentrations in the Sacramento River based on SRWTP Effluent Concentrations (Weston Study Results).

Sample Date	Units	1/27/2008	5/27/2008	7/15/2008	7/15/2008 (duplicate)	9/19/2008	11/2/2008	2/17/2009
Conditions	-	WET	DRY	DRY	DRY	DRY	WET	WET
Effluent Flow	MGD	193.5	143.8	149.3	149.3	158.8	248.8	215.7
dilution	(:1)	94	47.7	59.6	59.6	39.2	33.6	95.4
bifenthrin	ng/L	0	(0.057)	0	0	0	0	0
lamda-cyhalothrin	ng/L	0.06	0	0.06	0.11	0	0	0
esfenvalerate	ng/L	0	0	0	0	0.094	0	0
delatamethrin	ng/L	0	0	0	0	0	0	0
permethrin	ng/L	0.07	0	0.20	0.24	0.44	0	0.10
cyfluthrin	ng/L	(0.018)	0	0	0	0	0	0
cypermethrin	ng/L	0	0	0	0	0	0	0.18
fenpropathrin	ng/L	0	0	0	0	0	0	0
Summed Pyrethroids	ng/L	*0.15*	*(0.057)*	*0.26*	*0.35*	*0.53*	*0*	*0.28*

Notes:
Values in brackets were based on qualified results.
Concentrations could range from 0-3 ng/L for non-detects in effluent samples; therefore summed pyrethroid concentrations in the river could range from 0 – 0.71 ng/L even when none are detected.

- *H. azteca* are extremely sensitive to pyrethroids (effects in the 1-20 ng/L range are reported in Weston and Lydy 2010). Effects to this invertebrate are not necessarily indicative of effects to any other organism. In fact, aquatic wildlife are essentially unaffected by pyrethroids until concentrations are orders of magnitude above those that affect invertebrates.[34] Effect levels for fish are also well above the effect levels for invertebrates and are in the 60 to 6200 ng/L range.[35]

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[34]Beavers JB, Hoxter KA, Jaber MJ. 1990. PP321: A one-generation reproduction study with the mallard (Anas platyrhynchos). USEPA MRID: 41512101.

Roberts NL, Phillips C, Anderson A, MacDonald I, Dawe IS, Chanter DO. 1986. The effect of dietary inclusion of FMC 54800 on reproduction in the mallard duck. FMC Study No: A84/1260. EPA MRID: 00163099

Fletcher DW. 1983. 8-day dietary LC50 study with FMC 54800 technical in mallard ducklings. FMC Study No: A83/966. MRID: 00132535

Carlisle JC, Toll PA. 1983. Acute dietary LC50 of cyfluthrin technical to mallard ducks study number 83-175-02. Mobay Environmental Health Research Corporate Toxicology Dept. Stilwell, KS. Study number 85937. CDPR ID: 50317-003

[35] Kent SJ, Shillabeer N. 1997a. Lambda-cyhalothrin: Acute toxicity to golden orfe (Leuciscus idus). ZENECA Agrochemicals. CDPR ID: 50907-085.

Kent SJ, Shillabeer N. 1997b. Lambda-cyhalothrin: Acute toxicity to the guppy (Poecilia reticulata). ZENECA Agrochemicals. CDPR ID: 50907-085.

Surprenant DC. 1991. Acute toxicity of FCR 4545 technical to Rainbow Trout (Oncorhynchus mykiss) under flow-through conditions. Miles Incorporated. Springborn Laboratories Inc. Wareham, MA. USEPA MRID: 45375002.

McAllister WA. 1988. Full life cycle toxicity of 14C-FMC 54800 to the fathead minnow (Pimphales promelas) in a flow-through system. FMC Study No: A86-2100. EPA MRID: 40791301

The Issue Paper goes on to state that "In every sample of the SRWTP, at least 70 percent of the organisms were dead or unable to swim. Pyrethroids were detected in 4 of 6 SRWTP samples."

This statement demonstrates the lack of a causal relationship between the observed toxicity and pyrethroids reported in SRWTP effluent ($r^2 = 0.004$). Toxicity was relatively constant among the SRWTP effluent samples while pyrethroid concentrations varied greatly (Table 4). Complete TIE testing was not conducted on all samples by Weston and Lydy (2010) and the relative proportion of toxicity to *H. azteca* in SRWTP effluent from pyrethroids is not clear. Further research to evaluate the occurrence and potential for pyrethroid toxicity in effluent and in the receiving water would be needed to determine if there is any potential for effluent pyrethroid levels to cause toxicity.

Table 4

Pyrethroid Concentrations in SRWTP Effluent Grab Samples (Weston Study Results).

Sample Date	Units	1/27/2008	5/27/2008	7/15/2008	7/15/2008 (duplicate)	9/19/2008	11/2/2008	2/17/2009
Conditions		WET	DRY	DRY	DRY	DRY	WET	WET
bifenthrin	ng/L	0	(2.7)	0	0	0	0	0
lamda-cyhalothrin	ng/L	5.5	0	3.5	6.4	0	0	0
esfenvalerate	ng/L	0	0	0	0	3.7	0	0
delatamethrin	ng/L	0	0	0	0	0	0	0
permethrin	ng/L	7.0	0	12.2	14.2	17.2	0	9.4
cyfluthrin	ng/L	(1.7)	0	0	0	0	0	0
cypermethrin	ng/L	0	0	0	0	0	0	17
fenpropathrin	ng/L	0	0	0	0	0	0	0
Summed Pyrethroids	ng/L	*14.2*	*(2.7)*	*15.7*	*20.6*	*20.9*	*0*	*26.4*

Notes:

Values in brackets were qualified as estimated concentrations above the MDL but below the RL.

Concentrations could range from 0-3 ng/L for non-detects; therefore summed pyrethroids could range from 0 – 24 ng/L even when none are detected.

The Issue Paper states that Weston and Lydy (2010) "suggest at current flows, SRWTP discharges on average 9 grams per day (g/d) of pyrethroids in the dry season and 13 g/d during the wet season."

Weston and Lydy (2010) reported a "rough approximation" of the pyrethroid loading in the Sacramento River from SRWTP discharge. There is considerable uncertainty associated with this estimate that was understated in this publication. Detected pyrethroid concentrations reported in SRWTP effluent samples were quite variable among events, and for individual pyrethroids during each event (Table 4). Measured concentrations were also at or near reporting limits where the associated error is highest. Measurement error rates are demonstrated by the variable (±30%) ability of the analysis method to recover known quantities of pyrethroids spiked into quality assurance/quality control samples. Measurements were also based on single grab samples collected during each event and therefore provide little indication of the variability over various temporal scales. Load calculations compound these potential errors by multiplying concentrations by millions of liters discharged each day. Load estimates should include these uncertainties by reporting a range (i.e., 0 to 9 g/day) or an estimate of error (i.e., 9 ± 9 g/day) when discussing any calculated estimate.

The Issue Paper states that "at this time, the fate of the mass loading of pyrethroids from the SRWTP is unknown." Fate and transport play a key role in determining bioavailability and toxicity. Therefore, fate and transport must be considered in any assessment of pyrethroids. Factors that will affect the fate and transport of pyrethroids include:

- Pyrethroids are extremely hydrophobic and sorb strongly to particles and surfaces when in solution. The presence of suspended solids and sediments in samples greatly modifies and reduces bioavailability so that only the freely dissolved fraction exerts toxicity.[36] Therefore, the factors that affect bioavailability (e.g., organic carbon, suspended solids, dietary uptake, temperature) should be considered in any evaluations of potential toxicity. The potential for pyrethroid toxicity may be better estimated based on a measure of pyrethroids in the dissolved phase or from modeled bioavailable fractions.

- This tendency for pyrethroids to sorb to particles causes them to settle out of the water column and accumulate in the sediments. This transport mechanism will affect the media where pyrethroids are found and should be considered in evaluating pyrethroid fate and transport.

- Pyrethroids are largely degraded over a few weeks to months (20-60 day half-life) and do not accumulate in the environment (Laskowski, 2002).[37] This loss over time should also be considered in evaluations of pyrethroid fate, transport, and potential for toxicity.

Finally, the Issue Paper states that the 'Sacramento and San Joaquin Rivers were rarely toxic' which reinforces the contention that there is little evidence of pyrethroid concentrations in the SRWTP effluent having any environmentally relevant impact on receiving waters downstream of the discharge.

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[36] Amweg EL, Weston DP, Ureda NM. 2005. Use and toxicity of pyrethroid pesticides in the Central Valley, California, USA. Environ. Toxicol. Chem. 24:966-972

Day KE. 1991. Effects of Dissolved Organic Carbon on Accumulation and Acute Toxicity of Fenvalerate, Deltamethrin and Cyhalothrin to Daphnia magna (Straus). Environ. Toxicol. Chem. 10:91-101

Smith S, Lizotte RE. 2007. Influence of Selected Water Quality Characteristics on the Toxicity of l-cyhalothrin and g-cyhalothrin to Hyalella azteca. Bull. Environ. Contam. Toxicol. 79:548-551.

Yang WC, Gan JY, Hunter W, Spurlock F. 2006a. Effect of suspended solids on bioavailability of pyrethroid insecticides. Environ. Toxicol. Chem. 25:1585-1591

Xu YP, Spurlock F, Wang ZJ, Gan J. 2007. Comparison of five methods for measuring sediment toxicity of hydrophobic contaminants. Environ. Sci. Technol. 41:8394-8399

[37] Laskowski DA. 2002. Physical and chemical properties of pyrethroids. Rev. Environ. Contam. Toxicol. 174:49-170

WHOLE EFFLUENT TOXICITY

The Issue Paper discussed toxicity with respect to both acute and chronic toxicity assessments.

Acute toxicity

The Issue Paper states that "… recent flow-through bioassays conducted by SRCSD during regular effluent monitoring show intermittent toxicity, but the cause is unknown." The Issue Paper refers to violations of the requirement that no single bioassay may result in less than 70% survival and the requirement that the median result of consecutive bioassays may not be less than 90% survival.

SRCSD has spent considerable time and resources investigating possible sources of toxicity. To date, these investigations have not identified any toxicants that may be responsible for changes in effluent quality or any issues with maintenance or operations that may have contributed to toxicity. However, lower than average survival in control tanks could indicate that the quality of the fathead minnows used may be a contributing factor. The two violations with survivals less than 70% appear to be sporadic and the toxicity did not appear to be persistent. It is not unusual for a POTW to have intermittent toxicity from unknown causes and often it will go away without any specific treatment or process changes. Statistically speaking, the false positive rate for identifying toxicity based on the NOEC in non-toxic samples is 5 percent or 1 in 20.

With respect to the requirement that a median of three of any consecutive samples should not be below 90%, the SRWTP disagrees with Regional Water Board staff interpretation of this requirement. As noted in a letter to the V. Vasquez on February 10, 2010,[38]

> "*The permit language states that the median is calculated using "any three or more consecutive" test values. Since the 1985 permit, the SRWTP has been calculating and reporting the median on a monthly basis as is required by the EPA discharge self-monitoring report template. Our interpretation of the permit language is that the term "or more" was included to address variability in the number of weeks in a month and the intent was to apply the median calculation on a monthly basis. The self-monitoring report template only allows for one entry of the calculated median per month, supporting our interpretation that the median calculation is to be performed on a monthly basis. Based on our interpretation, there was one violation of this limit in November 2009, as reported in the self-monitoring reports.*

In addition, as stated in the February 10th letter,

- Extensive evaluation and additional sampling are conducted whenever low survival or a violation is experienced
- The SRWTP staff continue to investigate and evaluate the bioassay system and our procedures, including cause of low control survival rates

[38] Somavaru, P. 2010a. Letter to V. Vasquez, CVRWQB. 'Notice of Violation for Exceedances of the Acute Toxicity Bioassay Effluent Limitation, Sacramento Regional Wastewater Treatment Plant (SRWTP) (NPDES NO. CA 0077682, WDR Order No. R5-2000-0188). February 10, 2010.

- However, the frequency of testing (weekly) limits the extent to which system can be evaluated, as these investigation cannot be conducted when there is a test in progress
- Other than toxicity, compliance with effluent limits has been 100% since 2009
- Chronic WET testing for Fat Head Minnow have resulted with low chronic toxicity

The Issue Paper also refers to toxicity by unknown contaminants as identified by a UCD researcher.[39] It is important to consider that delta smelt acute toxicity testing with effluent-ammonia is now in its third year (2008-2010), and none of these smelt toxicity tests have showed toxicity at environmentally relevant concentrations of effluent or ammonia (Werner et al. 2009b; Werner et al. 2009c). To put this in context, toxicity by unknown contaminants was identified during a delta smelt bioassay in 2009, but no toxicity was identified in three other delta smelt bioassays conducted since 2008. In the one test conducted in 2009 that showed toxicity, effects were only significantly different from controls at ≥ 28 percent effluent (data from Werner et al. 2009c). This is 15-20 times greater than the effluent concentrations typically present in the Sacramento River. The two tests conducted in 2008 did not show any toxicity to delta smelt in up to 36 percent effluent, which is 18 times the typical concentration present in the Sacramento River (~2%). This effect has not demonstrated any persistence in SRWTP effluent by repeated observation and could have been an episodic event.

Alternative Test Species

The Issue Paper discusses the use of rainbow trout instead of fathead minnow as a test species for acute bioassays because it may be more applicable to Delta species. The EPA guidance document "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms"[40] provides a general description of the distribution, life cycle, and culture methods of fathead minnow and rainbow trout.

The native geographic range of rainbow trout is west of the Rocky Mountains and along the eastern Pacific Ocean, but the species has been widely introduced and established in cold water habitats worldwide. It thrives at temperatures between 3˚C in the winter to 21 ˚C in the summer, with an optimum temperature between 10-16 ˚C. It can tolerate lower and higher temperatures if acclimated gradually (but cannot tolerate temperatures above 27 ˚C).

The fathead minnow is widely distributed in North America, and its ease of propagation as a bait fish has led to its widespread introduction within and outside its native range. The species is found in a wide range of habitats, abundant in muddy brooks, streams, creeks, ponds and small lakes. It is tolerant of high temperature and turbidity, and low oxygen concentrations.

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[39] Werner, I, "Effects of Ammonia/um and Other Wastewater Effluent Associated Contaminants on Delta Smelt", presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[40] USEPA. 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition. U.S. Environmental Protection Agency Office of Water, Washington DC. EPA-821-R-02-012.

Both species seem suitable for use in toxicity testing of Sacramento River water given their native temperature ranges. There does not appear to be any strong advantage to using rainbow trout over fathead minnow.

As shown in the Table 5, several Delta dischargers are currently required to use fathead minnow minnows as the acute toxicity test organism in their NPDES permits, with Stockton Wastewater Control Facility the only discharger required to use rainbow trout.

Table 5: Toxicity Test Species in Central Valley Permits

Facility	Permit adopted	WET Testing Requirements	
		Acute toxicity testing	Chronic toxicity testing
Manteca WWQCF	2009	Fathead minnow	Water flea, fathead minnow, green algae
Rio Vista Beach WWTF	2008; amended 2009	Fathead minnow	Water flea, fathead minnow, green algae
Modesto WQCF	2008	Fathead minnow	Water flea, fathead minnow, green algae
Stockton WWCF	2008	Rainbow trout	Water flea, fathead minnow, green algae
Tracy WWTP	2007	Fathead minnow or Rainbow trout	Water flea, fathead minnow, green algae

In addition to consideration of rainbow trout, the Issue Paper states that "It may also be appropriate to required [sic] additional acute toxicity testing using *Hyalella azteca*…"

H.azteca is a standard toxicity test organism that is commonly used for testing the toxicity of sediment (EPA 2000a, method 600/R-99-064). There are issues with the toxicity testing method for *H.azteca* in water only exposures that have been identified and described in the recent 2009 USEPA Draft Ammonia Criteria document. *H.azteca* is an epibenthic invertebrate which lives on the sediment surface at the interface between sediment and surface water. *H.azteca* is stressed when presented with habitat or test conditions where there is no substrate, such as in a glass toxicity-testing beaker. Acute WET testing within an NPDES permit should be conducted with one of the standard test species listed in the EPA's Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms (EPA 2002a).[41] As listed in 6.1.2, these species are:

Freshwater Organisms

1. *Ceriodaphnia dubia* (daphnid)
2. *Daphnia pulex* and *D. magna* (daphnids)
3. *Pimephales promelas* (fathead minnow)
4. *Oncorhynchus mykiss* (rainbow trout) and *Salvelinus fontinalis* (brook trout)

[41] USEPA. 2002a. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Office of Water, Washington, DC. EPA-821-R-02-012.

H. Azteca is not included in toxicity testing requirements in any wastewater NPDES permits to date. In addition, *H. azteca* testing in the Delta has been extensive[42] in an effort to evaluate ammonia impacts. However, this testing has lead to inconclusive and varying results.[43]

Because of the existing problems with the test method and lack of precedent for use of this species for acute toxicity compliance determinations, the District strongly objects to the proposed use of *Hyallela azteca* as a test organism for acute testing in its NPDES permit.]

Hypothesis Testing vs. Point Estimate for Chronic Toxicity Testing

The Issue Paper states that "in situations where dilution has been allowed for chronic toxicity criteria, the point estimate may be a better method for determining compliance. The point estimate provides a more precise measurement of the magnitude of toxicity, which is needed when some level of effluent toxicity is allowed due to an approved mixing zone."

SRCSD agrees with this statement regarding the use of a point estimate for evaluating chronic toxicity testing results in the SRWTP NPDES permit. SRWTP effluent is highly diluted in the Sacramento River (the average hourly mean dilution ratio from 2006-2008 was 107:1); therefore, the point estimate is a relevant measure of toxicity for the SRWTP. In addition, there are other reasons why a point estimate measure of toxicity is a robust and safe method for use in NPDES permits that is more appropriate than hypothesis testing endpoints (i.e., the NOEC).

The use of NOEC in NDPES permitting has been criticized on statistical grounds by the scientific community.[44] In addition, EPA does not recommend its use for NPDES permitting,[45] and the European Organization for Economic Co-operation and Development

[42] Pelagic Organism Decline (POD): Acute and Chronic Invertebrate and Fish Toxicity Testing in the Sacramento-San Joaquin Delta 2006-2007. http://www.science.calwater.ca.gov/pdf/workshops/POD/2008_final/Werner_POD2006-07Tox_Final_Report.pdf

[43] Ammonia Summit, Various Presentations, http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/ambient_ammonia_concentrations/index.shtml

[44] Hoeven, N. van der, F. Noppert, and A. Leopold. 1997. How to measure no effect. Part I: Towards a new measure of chronic toxicity in ecotoxicology. Introduction and workshop results. Environmetrics 8: 241–248.

Chapman, P.M., R.S. Caldwell, and P.F. Chapman. 1996. A warning: NOECs are inappropriate for regulatory use. Environmental Toxicology and Chemistry 15 (2): 77-79

Kooijman, S. A. L. M. 1996. An alternative for NOEC exists, but the standard model has to be replaced first. Oikos 75: 310–316

Suter, G.W. 1996. Abuse of hypothesis testing statistics in ecological risk assessment. Human and Ecological Risk Assessment 2 (2): 331-347

Laskowski, R. 1995. Some good reasons to ban the use of NOEC, LOEC and related concepts in ecotoxicology. Oikos 73 (1): pp. 140–144

[45] U.S. Environmental Protection Agency (EPA). 1991. Technical Support Document for Water Quality-based Toxics Control. U.S. EPA Office of Water. March. EPA/505/2-90-001

(OECD) concluded that the NOEC should not be used (OECD, 2006).[46] Rather, both tend to promote the use of point estimates as toxicity endpoints for NPDES permitting. EPA (1991) evaluated the merits and limitations of these endpoints and determined that the 25 percent inhibition concentration (IC25) is the preferred statistical method for determining toxicity endpoints. This standing was reaffirmed in the WET final rule where EPA stated:

> *"as previously stated in the method manuals (USEPA, 1993; USEPA, 1994a; USEPA, 1994b) and the USEPA's Technical Support Document (USEPA, 1991), USEPA recommends the use of point estimation techniques over hypothesis testing approaches for calculating endpoints for effluent toxicity tests under the NPDES Permitting Program[47]"*

The Fourth Edition chronic WET methods manual (EPA, 2002) further emphasized the use of point estimates (i.e., IC25) over hypothesis testing endpoints (i.e., the NOEC).

> *"NOTE: For the NPDES Permit Program, the point estimation techniques are the preferred statistical methods in calculating end points for effluent toxicity tests"* [48]

"The NOEC is an approximation of the no effect concentration (NEC) but is not a good estimate of this actual concentration at which no effect occurs." (Chapman, 1996) Instead, point estimates "use the concentration-response relationship to interpolate the precise effluent concentrations where significant toxic effects begin to occur" (SIP, 2005).

Multi-party written comments submitted to the SWRCB strongly support the use of point estimation procedures for evaluation of chronic toxicity test results for reasonable potential, trigger/limit derivation, and trigger/limit compliance.[49]

> *"The USEPA, as well as many experts in the field of toxicology, has long expressed a strong preference for the use of point estimation techniques*

U.S. Environmental Protection Agency (EPA). 1994. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Third Edition. July. EPA-600-4-91-002.

U.S. Environmental Protection Agency (EPA). 2000b. Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing (40 CFR Part 136). Office of Water. EPA 821-B-00-004. July.

USEPA. 2002a. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Office of Water, Washington, DC. EPA-821-R-02-012.

[46] Organization for Economic Co-operation and Development (OECD). 2006. Current Approaches in the Statistical Analysis of Ecotoxicity Data: A Guidance to Application. Joint meeting of the chemicals committee and the working party on chemicals, pesticides, and biotechnology. Environmental Directorate. ENV/JM/MONO(2006)18. OECD Series on Testing and Assessment. Number 54

[47] 67 Fed. Reg. 69958 (November 19, 2002)

[48] U.S. Environmental Protection Agency (EPA). 2002b. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition. October. EPA-821-R-02-013

[49] Tri-TAC, CASA, BACWA, CVCWA, and SCAP. 2006. Comments on the Informational Document for Proposed Revisions to the Toxicity Control Provisions of the Policy of Implementation of Toxic Standards for Inland surface Waters, Enclosed Bays, and Estuaries of California. Letter to Regina Linville, State Water Resources Control Board. Dated 17 January.

(e.g., EC25/IC25) rather than hypothesis test procedures for compliance monitoring in the WET program. These recommendations are based upon a number of toxicological and statistical limitations of hypothesis test results, particularly when used in a compliance setting. In fact, since its inception, the acute toxicity program has successfully used effect-based statistics (i.e. LC50 or percent effect) for compliance determination. Use of point estimates to measure chronic toxicity is embracing the best science available and would demonstrably improve the consistency, reliability, and accuracy of the WET program within the State without any loss of environmental protection. Therefore, we urge the SWRCB to be consistent with these recommendations and join the growing number of State programs that use point estimates to regulate chronic toxicity."

The NOEC endpoint was never validated with field or laboratory test comparisons by EPA during interlaboratory testing (EPA, 2001)[50]. NOEC data were not part of EPA's Interlaboratory Variability Study (2001). Accordingly, the NOEC is not part of the adopted 40 CFR 136 Table 1A methods and should not be used for NPDES purposes (NACWA, 2006).[51] The NACWA (2006) white paper is found in Attachment A2 and provides additional discussion on the appropriateness of hypothesis and point estimates of toxicity.

It is also difficult to quantify the precision of NOEC endpoints between tests. In practice, the precision of results of repetitive chronic tests is considered acceptable if the NOECs do not vary by more than one concentration interval above or below a central tendency. This "acceptable" range is potentially very large and could vary from 6.25- to 25-percent effluent (4 to 16 NOEC TUc for tests using a 0.5 dilution factor; EPA, 2002b). When a substantial difference in toxicity endpoints exists between the NOEC and IC25, EPA concludes that the bioassay had a poorly defined dose-response curve and that results from these tests should be interpreted carefully. Additional dilution concentrations should be tested when there is a high degree of separation between the IC25 and NOEC endpoints.

The NOEC must be bounded by other test concentrations to be equal to one of the tested effluent concentrations. If an effect is observed in the lowest effluent concentration, then the test is inconclusive for the NOEC and it is reported as "less than" the lowest effluent dilution (e.g., NOEC <6.25%; >16 TUc).

Another drawback to results based on hypothesis testing is that most of the data is not used in the statistical analysis. The only data needed for the final result are the measured endpoints of the control treatment and no effect treatment. The variability between treatments (concentration-by-test interaction variance) is not considered in calculations to determine hypothesis-testing endpoints.[52] Furthermore, the statistical procedure protects

[50] U.S. Environmental Protection Agency (EPA). 2001. Final Report: Interlaboratory Variability Study of EPA Short-term Chronic and Acute Whole Effluent Toxicity Test Methods, Vol. 1. Office of Water . EPA 821-B-01-004. September.

[51] National Association of Clean Water Agencies (NACWA). 2006. Whole Effluent Toxicity (WET) NPDES Permit Testing and Limitations for Public Agencies. White Paper. January.

[52] Dhaliwal, B.S., R.J. Dolan, C.W. Batts, and J.M. Kelly. 1997. Warning: replacing the NOECs with point estimates may not solve regulatory contradictions. Environmental Toxicology and Chemistry 16 (2): 124−126

against drawing the wrong conclusion when a treatment has no effect (Type I Error or alpha), but gives little protection against drawing the wrong conclusion when the treatment does have an effect (i.e., low power [1-α]; Chapman et al., 1996). Point estimates use all WET test data to calculate a point (the test effluent concentration) on a regression to identify a concentration that causes a specific level of response.

A point estimate measure of toxicity can be considered "safe" to the receiving water because EPA (1991) considers an IC25 the approximate analogue of the NOEC. This conclusion was validated by Norberg-King (1991)[53] in 23 effluent and short-term chronic reference toxicant data sets for the fathead minnow, *Pimephales promelas*, and *C. dubia* where the reported IC25s were comparable to the NOECs.

As recognized by EPA (2000b), the NOEC is an unreliable measure under concentration-response relationships. An alternative toxicity endpoint analogous to the NOEC that is not hindered by the statistical limitation of hypothesis testing toxicity endpoints, and is supported by EPA (2002b), is a reasonable and safe alternative for an NPDES reporting basis for SRWTP toxicity tests. A point estimate measure of toxicity such as the IC25 would achieve this goal.

<u>Use of Synthetic Dilution Water</u>

As noted in the Issue Paper, the use of synthetic dilution water is allowed and is consistent with recently adopted Central Valley permits. The District also supports the use of synthetic dilution water.

The choice of what should be used as the dilution water is at the discretion of the permitting authority as EPA does not require that any single source be used (EPA 2002a):

> *"…no single dilution water type is required for all tests. The method manuals now clarify that receiving waters, synthetic waters, or synthetic waters adjusted to approximate receiving water characteristics may be used for dilution water, provided that the water meets the qualifications for an acceptable dilution water. EPA clarified in the method manuals that an acceptable dilution water is one which is appropriate for the objectives of the test; supports adequate performance of the test organisms with respect to survival, growth, reproduction, or other responses that may be measured in the test (i.e., consistently meets test acceptability criteria for control responses); is consistent in quality; and does not contain contaminants that could produce toxicity. EPA also provided clarification on the use of dual controls. When using dual controls, the dilution water control should be used for determining the acceptability of the test and for comparisons with the tested effluent. If test acceptability criteria (e.g., minimum survival, reproduction, or growth) are not met in the dilution water control, the test must be repeated on a newly collected sample. Comparisons between responses in the dilution water control and in the culture water control can be used to determine if the dilution water, which may be a receiving water, possesses ambient toxicity."*

[53] Norberg-King, T.J. 1991. Calculations of ICp Values of IC15, IC20, IC25, IC30, and IC50 for Appendix A of the Revised Technical Support Document. Memorandum to M. Heber, EPA

According to EPA, the use of river water under certain conditions is arguably inappropriate for conducting WET tests (EPA 2000):

> *"If the objective of the test is to determine the toxicity of an effluent in the receiving system, a local receiving water is recommended for use as dilution water* ***provided that the receiving water meets specific criteria****. The receiving water should be collected as a grab sample from upstream or near the final point of effluent discharge, have adequate year-round flow, support adequate performance of the test organisms,* ***be consistent in quality****, be free of contaminants that would produce toxicity and be free from pathogens and parasites that could affect WET test results. If the local receiving water fails to meet any of these criteria for use, a synthetic dilution water adjusted to approximate the chemical characteristics of the receiving water is recommended."*

Regional studies conducted on the Sacramento River show that instream toxicity upstream of the SRWTP discharge location has been documented in recent years. The State of California and Sacramento River Watershed Program (SRWP) have been conducting studies on the toxicity of ambient water in the Sacramento River Watershed since 1999 (Larsen and Connor 2002; List et al. 2002; SRWP 2003).[54] These studies have focused on algae (*Raphidocelis subcapitata*, also known as, *Selenastrum capricornutum*) and *Ceriodaphnia dubia*.

Numeric vs. narrative toxicity limit

The District agrees with the current State Board position (as reflected in the 2005 SIP) of using a narrative chronic toxicity limit with a numeric trigger for monitoring and further evaluation. This approach is consistent with other Central Valley permits. The Issue Paper states that the 'numeric trigger will be reconsidered in the permit renewal' with one option being to calculate maximum daily and average monthly triggers instead of a single trigger. The current numeric trigger in the SRWTP permit is >8 TUC which would correspond to dilution of 7:1, a value which does not occur downstream from the SRWTP. This value is more stringent than in other recently adopted Central Valley permits for discharges for which there is an acute and chronic mixing zone established which provides dilution credit as shown in Table 6.

A numeric trigger that would be consistent with the permits shown in Table 6 would be based on dilution at critical low flows. Dilution at critical low river flows (i.e., 1Q10 or 5400 cfs) would be 16:1 based on an effluent flow of 218 mgd which would correspond to a numeric trigger of 17:1.

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[54] Larsen, K. and V.M. Connor. 2002. Algae Toxicity Study Monitoring Results: 2000-2001. Regional Water Quality Control Board, Central Valley Region, California Environmental Protection Agency.

List, K., K. Larsen, and B. Stafford. 2002. Sacramento River Watershed Program Toxicity Testing Data Summary: 1999-2000. Regional Water Quality Control Board, Central Valley Region, California Environmental Protection Agency.

Sacramento River Watershed Program (SRWP). 2003. 2001-2002 Annual Monitoring Report (Public Draft). Sacramento River Watershed Program. http://www.sacriver.org

TABLE 6 - NUMERIC TOXICITY TRIGGERS (TUC) FOR ADOPTED NPDES PERMITS WITH ADOPTED ACUTE AND CHRONIC MIXING ZONES

Discharger	Order #	Numeric Monitoring Trigger Chronic Toxicity Unit (TUc) where TUc = 100/NOEC[55]	Acute/Chronic Dilution Credit
City of Chico, Chico Water Pollution Control Plant	R5-2010-0019	>10 TUc	47:1
City of Yuba City, City of Yuba City Wastewater Treatment Facility	R5-2007-0134-01 (as amended by Order No. R5-2010-0007)	>12 TUc	12:1
City of Angels, City of Angels Wastewater Treatment Plant	R5-2007-0031-01 (as amended by Order No. R5-2009-0074)	16 TUc	18:1 (Chronic) 9:1 (Acute)
Forest Meadows Wastewater Reclamation Plant, Calaveras County Water District and Cain-Papais Trust	R5-2008-0058	>25 TUc	67:1
Ironhouse Sanitary District, Wastewater Treatment Plant	R5-2008-0057	>16 TUc	20:1 (acute) 28:1 (chronic
Town of Discovery Bay, Discovery Bay Wastewater Treatment Plan	R5-2008-0179	10 TUc	13:1 (acute) 23:1 (Chronic)
City of Portola, Wastewater Treatment Plant	R5-2009-0093	20 TUc	20:1
City of Rio Vista, Beach Wastewater Treatment Facility	R5-2008-0108	>16 TUc	20:1

[55] NOEC = No Observed Effect Concentration