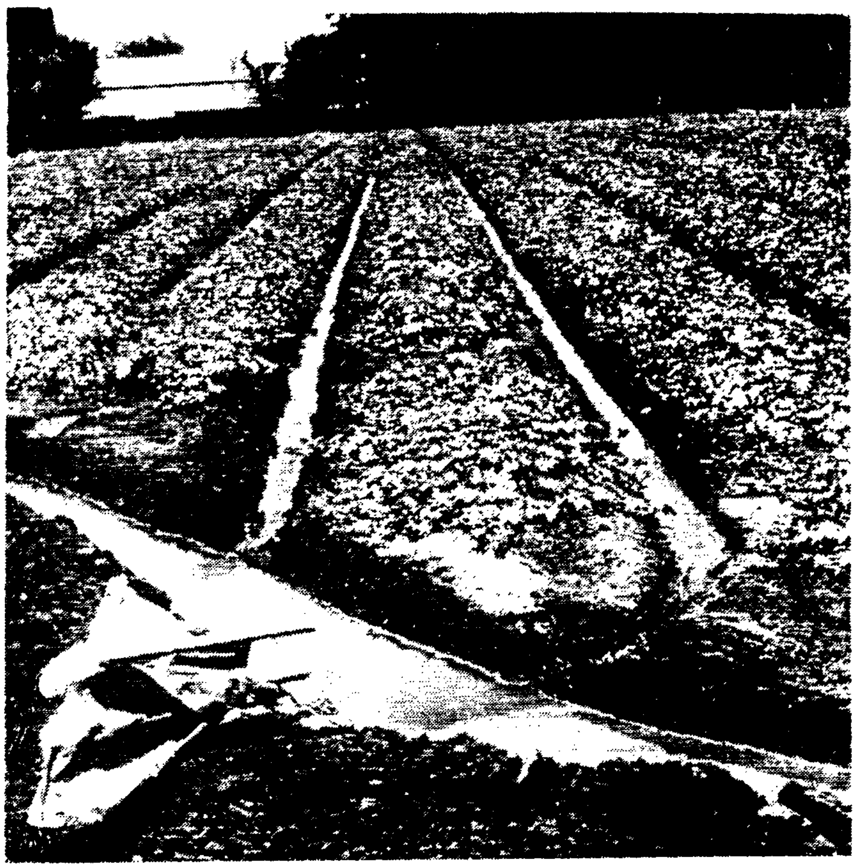
INSECTICIDE CONCENTRATIONS AND INVERTEBRATE BIOASSAY MORTALITY IN AGRICULTURAL RETURN WATER FROM THE SAN JOAQUIN BASIN



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December 1995

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

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This document was prepared, in part, through agreement numbers 0-104-150-1 and 0-103-150-1 with the California State Water Resources Control Board.

FORWARD

This project has been funded by the United States Environmental Protection Agency using both Federal 201(G)(1)(B) and 205 (J) grant funds under Assistance Agreements C-9009532-90-0 and C-060000-29-0 to the State Water Resources Control Board, and by Agreement No. 0-104-150-1 in the amount of $99,190.00 and by Agreement No. 0-103-150-1 in the amount of $88,000.00 to perform toxicity and pesticide analyses in the San Joaquin River Basin. The contents of this document do not necessarily reflect the views and policies of the U.S. Environmental Protection Agency or the California State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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EXECUTIVE SUMMARY

A two and a half year bioassay study was undertaken between 1988 and 1990 to assess the quality of all the major types of water moving through the San Joaquin Basin employing the EPA three species freshwater test (Foe and Connor, 1991;EPA, 1985). The principal conclusion of the study was that there was a 43 mile reach of the San Joaquin River between the confluence of the Merced and Stanislaus Rivers which tested toxic about half the time to *Ceriodaphnia dubia*, the invertebrate component of the EPA three species bioassay test. Toxicity appeared to be caused by pesticides in storm and tailwater runoff from row and orchard crops. The chemicals were believed to be transported to the River by seventy-six agricultural drains which were estimated during the 1988-90 irrigation season to comprise 40 to 45 percent of the River's flow above the confluence of the Stanislaus River. Orestimba Creek and Turlock Irrigation District Lateral Number 5 (TID 5) were monitored as representative of west and eastside agriculturally dominated surface water inputs. The two tested toxic 42 and 75 percent of the time, respectively. Both years of study were during a drought and it is not known whether the findings are applicable to other water years.

The 1988-90 findings are of regulatory significance as the Central Valley Regional Water Quality Control Board's Basin Plan contains a narrative toxicity objective for this River stating that "all waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses...in aquatic life". In 1985 the U.S. EPA recommended that the EPA three species bioassay procedure be considered one method of assessing compliance with state narrative toxicity objectives (54FR23868). Board staff have concluded that the toxicity observed in water samples collected from the San Joaquin River Basin is a violation of the narrative toxicity objective (Foe and Connor, 1991).

The present bioassay study was designed to follow-up on the earlier San Joaquin results and had three objectives. The first was to determine whether the water quality of TID 5 and Orestimba Creek was representative of other east and westside agricultural drains and, if so, to ascertain the seasonal pattern of toxicity on either side of the River. The second was to determine whether the critical 43 mile reach of the San Joaquin which previously tested toxic about half the time would continue to do so during a second time period. The final objective was to identify, if possible, the primary agricultural chemicals responsible for invertebrate bioassay mortality and the farming practices that contribute to the offsite pesticide movement.

The major finding of the present study was that 22 percent of water samples[1] collected from the San Joaquin Basin in 1991-92 tested toxic[2] in *Ceriodaphnia* bioassays. Insecticide concentrations were sufficiently elevated in 70 percent of these to, at least partially, explain the observed mortality. Pesticide concentrations were also measured in 120 water samples[3] testing non-toxic. One or more insecticides were detected in 83 percent of these samples. However, only on one occasion was a pesticide measured in a non-toxic sample at a concentration known to cause mortality. Board staff again conclude that the presence of insecticides in surface water at concentrations that cause death to bioassay organisms is a violation of the Basin Plan narrative toxicity objective.

The first objective of the study was to evaluate the assumption that TID 5 and Orestimba Creek were representative of other east and westside inputs. Toxicity at Orestimba Creek was compared with that of three other westside inputs (Del Puerto Creek, Ingram-Hospital Creeks and the Spanish Grant Combined Drain) while bioassay mortality at TID 5 was compared with values obtained at TID 3 and 6. The frequency of toxicity in the four westside drains was similar. Likewise, mortality in the three eastside drains was the same. Based on the present survey, it appears that bioassay water quality from Orestimba Creek and TID 5 can be considered representative of other discharges from their respective sides of the River. Comparisons of mortality at Orestimba Creek demonstrate no changes in the frequency of toxicity between 1988-90 and 1991-92 (41.6 and 44.7 percent, respectively). However, the frequency of mortality at TID 5 decreased from 75.0 to 26.8 percent. This decline was statistically significant ($P<0.05$, Chi-Square). The cause of the decrease is not known. It may result from the increasing severity of the drought as the discharge from all TID drains decreased by 37 percent between 1988-90 and the present study[4]. The decrease in irrigation return flow is due, at least in part, to substantial decreases in tailwater volume. This is important as tailwater is assumed to be the major mechanism responsible for transporting pesticides off fields during the irrigation season. Decreases in tailwater runoff should result in lower pesticide concentrations in surface return flow.

The second objective of the study was to determine whether the San Joaquin River would continue to be toxic under conditions of different water availability in the Basin. The toxicity of water samples collected from the River at Laird Park was monitored weekly to evaluate

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[1]121 of 559 samples.

[2]Toxicity was defined as a statistically ($P<0.05$) greater mortality rate than measured in the laboratory control.

[3]22 percent of all samples analyzed with bioassays.

[4]This drop is on top of an 85 percent decrease between 1984 (the last normal water year in the Basin) and 1988-90.

C-034210

this objective. Less toxicity was noted in the present study (4.6 percent) than during 1988-90 (41.7 percent). The decrease was statistically significant ($P<0.05$, Chi-Square). The cause of the decline is not known but may be related to the drop in toxicity of eastside inputs. Decreases in toxicity between years strongly suggests that changing farm practices, probably induced by the drought, can significantly lower pesticide concentrations in the San Joaquin River.

The final objective of the study was to identify the principal crops, associated water management practices and pesticides responsible for inducing toxic conditions in the return flows. Analysis of the seasonal pattern of toxicity demonstrated that most of the mortality was restricted to two time periods: January-March and April-June. No evidence was obtained during either period indicating any illegal use. The data suggest that the recommended application instructions for some insecticides may be inadequate to protect aquatic life.

January-March is in the rainy season in California so most water in agriculturally dominated creeks and large constructed drains is assumed to be from subsurface seepage and from storm runoff. Half of all samples taken between January and March tested toxic. Toxicity was ascribed to off-target movement of insecticides from orchards, alfalfa, sugarbeets and truck farming. Toxicity data for each is reviewed below. The primary use of diazinon, chlorpyrifos and parathion in the San Joaquin basin between December and February is as a dormant spray on stonefruit[5] and apple, pear, and almond orchards for boring insect control. Dormant spray insecticides were detected 182 times in surface water between December and March of 1991 and 1992. Sixty-seven of the detections were at concentrations toxic to *Ceriodaphnia*.

A major use of diazinon, malathion and chlorpyrifos in March and April is on alfalfa for aphid and weevil control. Chlorpyrifos is also used at this time on sugarbeets for worm control. The three insecticides were detected 106 times in March and April of 1991 and 1992. Twenty-five of these were at concentrations toxic to *Ceriodaphnia*.

Truck farming is also an emerging industry on the west side of the River. The principal winter use of methomyl is on cauliflower while the only reported winter use of fonofos is on broccoli. Methomyl and fonofos were detected five times in December and January in Ingram-Hospital Creek. Three measurements were at concentrations toxic to *Ceriodaphnia*.

April is the beginning of the irrigation season. In both years of the study, the last precipitation fell by mid-April. Most water in agriculturally dominated creeks and constructed drains after the end of March is assumed to be irrigation return flow with tailwater making up the largest proportion of the flow. Tailwater is believed to be the

[5]Apricots, cherries, nectarines, peaches, plums and prunes.

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primary vehicle responsible for transporting pesticides into surface water. Slightly less than half of the water samples (47%) collected from the westside of the Valley between April and June tested toxic. This is in contrast to the eastside where the frequency of toxicity was only 17%. The difference was significant (Chi-Squared, $P<0.05$) and is believed to result from differences in cropping patterns.

Four insecticides--chlorpyrifos, diazinon, fonofos and carbaryl--appear responsible for most of the toxicity. The toxicity of the four are summarized below. Chlorpyrifos is a wide spectrum insecticide used extensively during the irrigation season so the precise crops from which the chemicals originated are not known. Chlorpyrifos was detected 85 times between April and June of 1991 and 1992. Eighteen of these were at concentrations toxic to *Ceriodaphnia*. Major uses of chlorpyrifos are on walnuts and almonds, minor uses are on apples and corn. Diazinon is another commonly used agricultural insecticide. It was detected 81 times between April and June of 1991 and 1992. Four of these were at concentrations toxic to *Ceriodaphnia*. Diazinon runoff originates predominately from the westside of the River. The principal seasonal westside use is on melons, tomatoes and apricots. Unlike chloryrifos and diazinon, fonofos is broadcast and incorporated into the soil by tillage prior to planting. The chemical was only observed in water samples collected from the westside. Fonofos was measured 24 times between April and June of 1991 and 1992. Four of these were at concentrations toxic to *Ceriodaphnia.* The major use of fonofos in western Stanislaus County is on beans and tomatoes for wireworm control. The fourth insecticide, carbaryl, is a common foliar spray and was detected five times in May in water samples collected from the westside. One of these was at a concentration toxic to *Ceriodaphnia*. Common westside uses during the early irrigation season are on beans and tomatoes.

Overall, thirteen pesticides were detected in the study: diazinon, chlorpyrifos, ethyl parathion, fonofos, malathion, carbaryl, methomyl, DEF, ethion, methyl parathion, isofenfos, disyston, and carbofuran. Twelve of these are insecticides, one (DEF) is an herbicide. The Central Valley Regional Water Quality Control Plan has a conditional prohibition of discharge[6] for irrigation return flows containing carbofuran, malathion, and methyl parathion. Basin Plan performance goals for carbofuran and malathion were exceeded in 1 and 6 samples, respectively. No exceedances were noted for methyl parathion. Numerical performance goals are not available for any of the other compounds. However, of these diazinon and chlorpyrifos appear to pose the greatest threat to aquatic life as the two were detected 328 times in the year and a half study. Over half of these measurements were at concentrations greater than the recommended draft California Department of Fish and Game Hazard Assessment criteria to protect freshwater aquatic life of 0.04 and 0.015 ppb,

[6]The prohibition of discharge is lifted if the discharger is following management practices approved by the Board. To receive approval, the management practices must be expected to meet performance goals set by the Board.

respectively (Menconi and Cox, 1994; Menconi and Paul, 1994). Ninety measurements were at concentrations toxic to *Ceriodaphnia.* Finally, almost half of all water samples analyzed during this study for pesticides (toxic and non-toxic) contained both chemicals and the toxicity of the two are additive (Huang et al., 1994). This suggests that future water quality objectives for the two insecticides should consider additivity.

C-034213

INTRODUCTION

The San Joaquin River Basin is located in the southern half of the great Central Valley of California. It is known as the bread basket of the nation with an estimated two million acres of land under irrigated agriculture. Agriculture is also the main water user in the Valley. The San Joaquin River carries all water, including agricultural return flow, out of the Basin and into the Sacramento-San Joaquin Delta Estuary. The River is the second largest tributary of the Estuary with an unimpaired flow of 3.4 to 7.4 million acre-feet per year depending upon annual precipitation (Kratzer *et al.*, 1987).

A two and a half year bioassay study was undertaken between 1988 and 1990 to assess the quality of all the major types of water moving through the San Joaquin River (Foe and Connor, 1991). The study employed the EPA three species freshwater test (EPA, 1985) to assess potential water quality threats to the main stem of the River from mining and silviculture in the mountains, from municipal and industrial discharges throughout the northern half of the Valley and from trace elements, fertilizers, and pesticides in agricultural return flow from the Valley floor. The study was conducted during a drought period and it is not known whether the findings are applicable to other hydrologic conditions.

The principal conclusion of the study was that there was a 43-mile reach of the San Joaquin River between the confluence of the Merced and Stanislaus Rivers which tested toxic about half the time to *Ceriodaphnia dubia*, the invertebrate component of the EPA three species bioassay test. It was assumed that the decrease in toxicity below the confluence of the Stanislaus was because the Stanislaus's flow was always of sufficient quality and magnitude to dilute contaminant concentrations in the San Joaquin River to non-toxic levels for *Ceriodaphnia*.

Invertebrate toxicity in the San Joaquin River appeared to be caused by pesticides which were carried in storm and tailwater runoff from row and orchard crops. The chemicals seemed to be transported to the River by seventy-six agricultural drains located along the River (James *et al.*, 1989). These drains were estimated during the 1988-90 irrigation season to comprise 40 to 45 percent of river flow above the confluence of the Stanislaus. Orestimba Creek and Turlock Irrigation District Lateral Number 5 (TID 5) were monitored as representative of west and eastside agriculturally dominated surface water inputs. The two tested toxic 42 and 75 percent of the time, respectively. On five occasions toxic water samples were submitted for chemical analysis. Diazinon, parathion, carbaryl, and carbofuran were measured in both drain and River water at concentrations in excess of EPA recommended criteria to protect freshwater aquatic life or of concentrations reported in the literature to be toxic to sensitive invertebrates including *Ceriodaphnia*.

The conclusions of the San Joaquin River bioassay study are of regulatory significance as the Water Quality Control Plan for this River contains a narrative toxicity objective stating that "all waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses...in aquatic life". In 1985 the U.S. EPA recommended that the EPA three species bioassay procedure be considered one method of assessing compliance with State narrative toxicity objectives (54FR23868). Board staff have concluded that the toxicity observed in water samples collected from the San Joaquin River Basin is a violation of the narrative toxicity objective (Foe and Connor, 1991).

The present study was designed to follow-up on the earlier San Joaquin River bioassay results and had three main objectives. The first was to determine whether the water quality of TID 5 and Orestimba Creek was representative of other east and westside agricultural drains and, if so, what was the seasonal pattern of toxicity on either side of the River. The second was to identify, if possible, the primary agricultural chemicals responsible for invertebrate bioassay mortality and the water management practices which contributed to the off-target movement. The final objective was to determine whether the critical 43-mile reach of the San Joaquin River which previously tested toxic about half the time, would continue to do so.

BACKGROUND

Water Year

The study was conducted during an unusually dry period. The San Joaquin River Water Quality Control Plan (1975) defines water years based upon each year's percentage of the average annual flow during the period of record (1906-94). Both years of this study were classified as critically dry. They were preceded by three similar critically dry water years. The five year period is the driest on record in the Basin.

Seasonal and annual unimpaired flows for the San Joaquin River Basin for a wet (1983), normal (1984), dry (1985), and both critically dry years of the present study are compared in Appendix A. Total irrigation season unimpaired flows in 1991-92[1] were about 95% less than in 1983. Interestingly, the San Joaquin input-output model (Kratzer *et al.*, 1987) predicts that the proportion of River volume composed of irrigation return water should increase during dry years. For example, between 1983 and 1991-92 the model predicts an increase from 2.5 to 32 percent. The increase is caused by the much larger relative decrease in flow from the three eastside tributary Rivers[2] than from irrigation return flow. Some caution must be used in interpreting these numbers, however, as no estimate was made of drought induced changes in irrigation efficiency[3].

Precipitation

Rainfall is summarized from the Stockton Weather Service Office in Table 1. Also included are sampling dates. As is typical for the Basin, most rain fell between November and March. No month received an unusually large amount of rain, most months were very dry. The monitoring schedule was arranged with the bioassay laboratory about a month in advance of sampling, so the selection of monitoring dates was independent of rainfall.

Hydrology of agriculturally dominated creeks and constructed drains

The agricultural year has been divided into four seasons to help illustrate general changes in the sources of water in agriculturally dominated creeks and constructed drains. The patterns described are obviously very general and change from year to year based on precipitation, temperature and crop rotation. This information is used later as the rationale for dividing the bioassay data into the same time intervals to help ascertain whether changes

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[1]From 10,572,590 to 569,321 acre-feet per year.

[2]The Merced, Tuolumne and Stanislaus Rivers.

[3]The Input-Output model assumes that 30% of the irrigation supply water is returned to the River as tailwater regardless of the amount initially available (Kratzer *et al.*, 1987).

in water sources can help explain seasonal changes in the performance of the bioassay organisms.

Flows during the first time period, January-March, are primarily the result of subsurface seepage and overland runoff from large storms. Little to no agricultural water use occurs. A possible exception is that during dry years some pre-irrigation of stonefruit may occur prior to bloom. The second time period, April-June, is characterized by a decreasing probability of rain and an increasing incidence of tailwater[4] runoff. Extensive pre-irrigation of row and field crops occurs between mid March and early May to help fill the soil profile with moisture and provide additional water for later crop use. The first irrigation of crops typically occurs between late April and early June. Therefore, tailwater is the primary source of most of the flow during the second time period. Some operational spill water[5] may also be present. The third period, June-September, is a season of intense irrigation and no rain. A large portion of the return flow is pumped out and reused on agriculture. Finally, October to December is a time of little irrigation but increasing probability of rain runoff. Flows tend to be small, erratic and controlled by subsurface seepage, periodic irrigation and rainfall.

Cropping Patterns

The study area was roughly located between Highway 99 to the east, Interstate 5 to the west, Airport Way (County Road J3) to the north, and the confluence of Salt Slough to the south (figure 1). The area has about 228,000 acres in agricultural production (Bailey *et al.*, 1989). One hundred and forty-nine thousand acres are located on the east and 79,000 on the westside of the River. Cropping patterns in 1991-92 are provided for representative east and westside irrigation districts in Table 2. The westside was dominated by a fairly even mix of field, vegetable and orchard crops. Most field and vegetable crops were grown for human consumption--beans, tomatoes, and melons. An exception was the 4,500 acres of alfalfa. A small westside winter truck farming industry of spinach, broccoli, cauliflower, celery and peas was also present. Principal orchard products were apricots and smaller stands of almonds and walnuts. In contrast, the eastside was composed mostly of field and orchard crops. The field crops were grown primarily to support the large local dairy industry--field corn, oats, alfalfa, and pasture. The total number of acres of orchards on the eastside was about twice that of the westside. Principal tree crops were almonds, peaches and walnuts.

[4]Water from irrigated orchard, row and field crops.

[5]Irrigation supply water discharged as a result of canal operations.

C-034217

METHOD AND MATERIALS

Bioassay and water collection procedures

The invertebrate component of the EPA three species test was employed to ascertain whether dissolved contaminants were present at concentrations causing mortality within four to seven days. Water samples were collected as one time subsurface grabs in amber glass containers[6] and held in the laboratory at <4.0°C. until use. All bioassays were started within 24 hours of water collection. The tests were conducted at Sierra Foothill Laboratory[7] employing, with two exceptions, the procedures described in EPA (1989). The first exception was that dissolved oxygen, pH, and electrical conductivity were only measured at the beginning and end of the test instead of daily. These parameters were monitored to insure that all were within limits known not to cause mortality. The same parameters were remeasured at the end of any 24-hour period when greater than 50 percent mortality occurred in a treatment. Ammonia was only measured at the start of a test[8]. No hardness or alkalinity measurements were made. The second exception to the EPA method was that when a sample had an electrical conductivity greater than 2,000 μmho/cm, it was diluted back to 2,000 μmho/cm with glass distilled laboratory water[9]. No dilution over 50 percent was made. If a sample required dilution, then a dilution control was also run. The dilution control was prepared by amending glass distilled laboratory water with salts to an EPA moderately hard conductivity (U.S. EPA, 1985a). Ninety samples, 16 percent of the total, were diluted. What impact dilution may have had on reducing contaminant concentrations and toxicity is not known.

Dissolved oxygen, electrical conductivity and pH were measured with a calibrated Hach portable 16046 meter, an Amber Science 604 meter, and an Orion 611 meter with a Ross combination electrode. Ammonia was measured with a calibrated Orion 9512 ion selective electrode (EPA method 350.3). The laboratory distilled water was collected from a Synbron Barnstead FI-instream glass still. Calaveras Spring water was used as the laboratory control water. Finally, bioassay organisms were obtained from an in-house culture and were less than 24 hours old at the start of the test.

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[6]Environmental Sampling Supply QC glass sampling bottles.

[7]Sierra Foothill Laboratory, 823 South Highway 49, P.O. Box 1268, Jackson CA 95642.

[8]No ammonia measurements were made on 16, 23, and 30 March and 6 April, 1992, as the probe in use at the laboratory was found to be defective and a new one was on order.

[9]Electrical conductivity control experiments demonstrate that Ceriodaphnia bioassay performance is independent of the addition of seawater to an EC of 2,000 μmho/cm (Foe, 1988).

Water quality data, including the amount of all dilutions, is summarized by survey date in Appendix B. All parameters measured, with the occasional exception of ammonia, appear to have been within limits known to support aquatic life. The possible role that ammonia may have played in contributing to the *Ceriodaphnia* toxicity is discussed later.

Bioassay Quality Control Testing was conducted to assess bioassay precision both within and between tests. Within test precision was determined on 45 occasions by collecting a duplicate water sample from a randomly selected site and submitting it to the laboratory under the name of a second location which was scheduled for sampling but was not visited. The difference in mortality between the two sets of samples was compared.

Between test precision was ascertained monthly by determining the 96 hour LC_{50} concentration of a sodium chloride reference toxicant. Monthly variations in LC_{50} concentrations were analyzed by procedures recommended in U.S. EPA (1989).

Definition of bioassay toxicity A water sample was classified as toxic if *Ceriodaphnia* mortality was statistically greater ($P<0.05$, Fisher exact test) than the laboratory and, if applicable, the dilution control treatment[10].

Pesticide analysis

Additional water was collected from all sites and stored in amber glass containers in the dark at <4.0°C for possible pesticide analysis. When the bioassay results suggested the presence of toxicants, then samples were analyzed for total recoverable organophosphate and carbamate pesticides at the U.S. Geological Survey Laboratory at Arvada, Colorado. Both analyses were liquid-liquid extractions followed by a gas chromatograph determination with flame-photometric detectors for the organophosphates (Wershaw et al. 1987). For carbamates the extract was concentrated and analyzed by high performance liquid chromatography using a C_{18} reverse phase column and a dual channel variable wavelength ultraviolet detector. Compounds in each scan, reporting limits, and U.S. Geological Survey estimates of accuracy and precision are listed in Tables 3 and 4.

On average, field samples were held 7 to 12 days before extraction. This is longer than the seven days recommended by U.S. EPA (1994). The excessively long holding time resulted from the fact that the bioassay screening took 4-7 days, express mailing samples to Arvada

[10]If no mortality occurred in the controls, then a 40 percent or higher death rate was statistically significant. This is much greater than the 5 to 10 percent death rate recommended as ecologically safe by the Netherlands Working Group on Statistics and Ecotoxicology (Straalen *et al.*, 1994).

Colorado an additional 2 days and extraction a further 2 days. It is not known how exceeding the recommended holding time may have affected the analytical results.

One hundred and thirty-four samples[11] which tested non-toxic in bioassays were also submitted for pesticide analysis. This analysis was done to help ascertain both the baseline pesticide concentration present in ambient waters and also the range of pesticide concentrations which did not induce a bioassay response. Forty-two of these samples were analyzed for both carbamate and organophosphate pesticides while another ninety-two were only analyzed for organophosphorus pesticides. The emphasis was placed on the organophosphate scan as these insecticides appeared to be responsible for most of the toxicity observed in field samples.

Finally, a quality control program was undertaken to ascertain the accuracy of the pesticide data. Seven samples were spiked with selected insecticides by the California Department of Pesticide Regulation and submitted for analysis to both their Sacramento laboratory and to the U.S. Geological Survey Central Laboratory in Arvada, Colorado. In addition, 34 field samples from two Lagrangian special studies (Ross, 1991; 1992b) were collected and split by the Department of Pesticide Regulation for organophosphate pesticide analysis at both their Sacramento Laboratory and at the U.S. Geological Survey Central Laboratory. Finally, six travel blanks were submitted during the course of the study for both organophosphate and carbamate analysis.

Sampling Locations

The lower San Joaquin River was sampled at 13 sites (Figure 1). The location of each is described in Appendix C. Sites were chosen to collect information about all of the principal types of water being discharged to the River throughout an annual hydrologic cycle. All sources were monitored as close to their confluence with the San Joaquin River as possible.

There are 4 main sources of River water: eastside tributary Rivers, eastside constructed agricultural drains, Salt and Mud Sloughs, and westside agriculturally dominated creeks and constructed drains. Seasonal and annual unimpaired flows for each are provided in Appendix A. The three eastside tributary Rivers contributed about 58 percent of the annual unimpaired flow of the River. Each was monitored regularly. Turlock Irrigation District (TID) Lateral No. 6, 5 and 3 were sampled as representative of eastside agricultural drains while Orestimba, Del Puerto, and Ingram-Hospital Creeks and the Spanish Grant Combined Drain were monitored as representative of a combination of westside agriculturally dominated creeks and constructed drains. These seven sites were estimated in an earlier critically-dry

[11]35 percent of all samples submitted for pesticide analysis.

water year (1981) to comprise about 56% of the total surface agricultural return flow from the study area (Kratzer *et al.*, 1987). Salt Slough was sampled about half the time as representative of inputs from Salt and Mud Sloughs. These two drainages were estimated to provide between 10 and 14 percent of River volume during the study. The Slough was not sampled between 25 February and 2 July, 1991, and again between 9 October and 24 February, 1992, because of lack of money. Three San Joaquin River sites were also monitored regularly. The San Joaquin River at Hills Ferry Road, the most upstream site, is believed to primarily reflect the water quality of its principal source, Salt Slough. Laird Park is located near the midpoint of the study area and was monitored as representative of the critical 43-mile reach of River which tested toxic about half the time between 1988 and 1990. Finally, the San Joaquin River at Airport Way is, by definition, the legal boundary of the Sacramento-San Joaquin Delta Estuary. Water quality at this location is thought to be indicative of what the Basin exports to the Estuary.

C-034221

RESULTS

BIOASSAYS

Test Acceptability U.S. EPA (1989, 1991a) recommends that *Ceriodaphnia* bioassay results be considered acceptable if control survival is at least 90 percent in four-day and 80 percent in seven-day tests. Control survival met these criteria on all dates[12] except the 20 January 1992 survey and the 27 January-3 February 1992 Lagrangian special study. On both occasions high control mortality was traced to the use of a new brand of plastic wrap used to cover the top of the test containers. Bioassay results with high control mortality are listed in the summary appendices but were not used in any subsequent analysis.

On four occasions[13] there was excessive mortality in the glass distilled dilution control water. Glass distilled water was used to dilute samples with electrical conductivities in excess of 2,000 μmho/cm. However, no toxicity was observed in any of the diluted field samples, suggesting that the glass distilled water did not contribute measurable toxicity to any of them. All bioassay data from these dilutions have been used in the subsequent analysis.

Within and between test precision Within and between survey test precision was estimated to help establish the repeatability of the bioassay results. On forty-five occasions a duplicate blind sample was submitted to Sierra Foothill Laboratory to ascertain within-test variability. The results of thirty-nine of these were from four day and six were from 7 day tests (Table 5). The average percent difference in *Ceriodaphnia* survival was 3.8 and 1.7 percent, respectively. The differences were not significant (P>0.05, Mann-Whitney test) so the two data sets have been combined. The overall mean percent difference in survival was 3.6 percent with a coefficient of variation[14] of 167 percent.

No other within-test precision estimate of *Ceriodaphnia* mortality was found in the literature. Therefore, the mortality precision estimate was compared with a precision estimate of the initial electrical conductivity of the same set of duplicate blind samples (Table 5). This comparison was made as electrical conductivity is a common and well accepted water quality measurement. The average percent difference in electrical conductivity was 2.7 percent with a coefficient of variation of 151 percent. The precision of the electrical conductivity and mortality measurements were similar (T-test, P> 0.05).

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[12]49 surveys

[13]18 April, 1991, and 20 January, 20 April and 6 June 1992.

[14]Standard deviation divided by the mean and multiplied by 100.

Between test variability was assessed monthly for the sixteen month study with 96-hour sodium chloride LC_{50} reference toxicant testing. U.S.EPA (1989) recommends reference toxicant testing to ascertain whether changes in animal sensitivity occurred during the test period. Of particular interest are the detection of either outlier values located beyond the 95 percent confidence limits of the long-term mean or of general trends of changing animal sensitivity. Neither were noted in the control chart (Figure 2).

In conclusion, all quality control measurements appear acceptable and suggest that the bioassay data are reliable.

SAN JOAQUIN BASIN Five hundred and fifty-nine *Ceriodaphnia* toxicity tests were conducted in the San Joaquin area between February 1991 and June 1992 (Table 6 and Appendix D). One hundred and twenty-one samples (22 percent) tested toxic. Eighteen were collected from Rivers and one hundred and three were from agriculturally dominated creeks and constructed drains. Toxicity was observed in both creeks and drains during every month of the year except August. Below, the creek-drain, tributary River and main stem San Joaquin River bioassay data have been separated and each analyzed for inter-annual, site specific and seasonal differences.

Agriculturally dominated creeks and constructed drains--Inter-annual The annual frequency of toxicity in each agriculturally dominated creek and constructed drain was calculated to ascertain whether inter-annual differences existed. No difference was detected ($P>0.05$, Chi-Squared Heterogeneity test). Therefore, the 1991 and 1992 data for each drain were combined.

Site specific Next, the frequency of toxicity among east (TID 3, 5, and 6) and westside (Orestimba, Del Puerto, Ingram-Hospital and Spanish Grant Combined Drain) agricultural inputs was compared to ascertain whether toxicity was similar in all water courses on the same side of the River. Again, no difference was observed ($P<0.05$, Chi-Squared Heterogeneity test). Therefore, the data were combined into a single set of east and westside values.

Seasonal Next, the seasonal frequency of toxicity in all inputs was calculated (Table 7). The resulting quarterly data were analyzed to ascertain whether there were seasonal differences. The frequency of toxicity was found to be greater during the first six months of the year ($P<0.001$, three dimensional contingency table with subsequent subdivision of the table; Zar, 1984).

River bank Finally, the frequency of toxicity on either side of the River was compared by quarter (Table 8). No difference was noted except for the time period of April to June when westside inputs had a higher frequency of toxicity (47.1%) than eastside ones (17.0%; chi-square P<0.001).

Tributary Rivers

The Merced, Tuolumne, and Stanislaus River data also were analyzed to ascertain whether inter-annual, site specific or seasonal differences existed in the frequency of *Ceriodaphnia* toxicity. No temporal or spatial difference was noted (P>0.05, Chi-Squared). The average frequency of toxicity in water samples collected from the three eastside Rivers during the sixteen month study was 9.5 percent.

San Joaquin River

A similar analysis was also conducted for the three San Joaquin River sites. Again, no temporal or spatial difference was detected (P>0.05, Chi-Squared). The average incidence of toxicity in the River was 4.3 percent.

PESTICIDES

Quality Control

A quality control program was conducted to assess the accuracy of the U.S Geological Survey pesticide concentration data. The program consisted of the periodic submission of blind spikes, split field samples and blind travel blanks. Spiked samples were prepared by the Department of Pesticide Regulation and were submitted to both the Sacramento Laboratory of the Department of Pesticide Regulation and to the U.S. Geological Survey (Table 9). The spiking program emphasized the organophosphate pesticides most commonly observed in field samples. Average percent organophosphate recovery by the U.S. Geological Survey and by the Department of Pesticide Regulation was 79 and 101 percent, respectively. The pesticide recovery rate reported by the Survey was significantly lower than both the nominal spiked concentrations and the values reported by the Department of Pesticide Regulation (P<0.05, sign test). Particularly noteworthy was the chlorpyrifos values which averaged 58 percent of spiked concentrations.

Thirty-four duplicate field samples were collected by the Department of Pesticide Regulation during two Lagrangian special studies and split between the Department's laboratory and the U.S. Geological Survey (Tables 10 and 11). All carbamate pesticides detected by the Department of Pesticide Regulation were below Survey reporting limits. Conversely, some organophosphate insecticides were observed by the Survey but were below Department of Pesticide Regulation reporting limits. Only on four occasions (8% of the time) was a compound (always diazinon) observed by one laboratory (always the Survey) at concentrations above the other's reporting limit but not confirmed by the second facility. Diazinon and chlorpyrifos were the only organophosphate insecticides detected by both laboratories and were observed 3 and 15 times, respectively. There did not appear to be a laboratory bias in the chlorpyrifos data for either lagrangian run or for diazinon for the 23-26 April 1991 Lagrangian survey. However, diazinon concentrations reported by the Survey averaged 46 percent lower than Department values for the 27-31 January 1991 Lagrangian survey. This difference was significant (paired T-test, $P<0.01$) but appears similar to the recovery rate reported by the U.S. Geological Survey for the method (Table 3).

Seven blind travel blanks were submitted to the U.S. Geological Survey during the San Joaquin study. No pesticides were detected.

In conclusion, both the U.S. Geological Survey and Department of Pesticide Regulation had a high rate of pesticide detection when compounds were present at concentrations above their reporting limits. However, reported U.S. Geological Survey organophosphate concentrations were somewhat lower than Department of Pesticide Regulation ones. No correction has been made to the pesticide data to reflect the fact that the U.S. Geological Survey data may have under reported actual field pesticide concentrations.

San Joaquin Basin

Five hundred and six pesticide detections were noted in four hundred and thirty-nine water samples[15] (Appendix D). Ninety-eight percent of these were organophosphate insecticides. The smaller frequency of carbamate detections was thought, at least in part, to result from the fact that the carbamate reporting limit was 50 times higher than the organophosphate one. Both the U.S. Geological Survey and the Department of Pesticide Regulation have monitoring programs in the San Joaquin Basin with lower carbamate reporting limits and both have observed a higher incidence of carbamate pesticides than this study (MacCoy *et al*., 1995; Ross, 1991; 1992a,b; 1993a,b,c).

Thirteen pesticides were detected: diazinon, chlorpyrifos, ethyl parathion, fonofos, malathion, carbaryl, methomyl, DEF, ethion, methyl parathion, isofenfos, disyston, and carbofuran (Table 12). Twelve of these are insecticides, one (DEF) an herbicide. The most common insecticides were chlorpyrifos, diazinon, parathion and fonofos. At least one of the four was present in 90 percent of all (toxic or non toxic) samples analyzed.

Below, the pesticide data have been analyzed to help ascertain the insecticides most likely responsible for causing bioassay mortality and to establish baseline concentrations in the San Joaquin River and its tributaries.

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[15] 272 analysis for organophosphates and 167 for carbamates.

Probable cause of toxicity--Pesticides Water samples testing toxic were analyzed for organophosphate and carbamate pesticides to ascertain whether any chemicals were present at concentrations likely to cause mortality. Measured insecticide concentrations were divided by their reported 96 hour *Ceriodaphnia* LC_{50} value[16] (Table 13) to determine which were at biologically significant levels. The resulting value is defined as a pesticide LC_{50} unit. All values above half a unit are reported in Appendix D and Table 14. An effort was made in Table 13 to collect all reported toxicity values for each chemical. However, a high value was deliberately chosen for the pesticide LC_{50} unit determination, when multiple values were available, to be conservative about the possible cause of mortality. Finally, in samples where multiple pesticides were detected, LC_{50} units were added to provide a single estimate of the amount of available insecticide toxicity.

The addition assumes that the toxicity of organophosphate and carbamate insecticides are additive when present as mixtures. Toxicants that work on the same organ system are generally assumed to be additive (Sittig, 1981). Both classes of insecticide are acetylcholinesterase inhibitors, central nervous system toxins. Much experimental data has been collected with mammals which demonstrate additivity for mixtures of the two classes of insecticide (Hayes and Laws, 1991). However, less information is available for aquatic invertebrates. Huang *et al.,* (1994) report that the acute toxicity of mixtures of the organophosphate insecticides diazinon-chlorpyrifos-methidathion and malathion-methyl parathion-carbofuran[17] have an additive type of toxicity in tests with *Neomysis mercedis.* The acute toxicity of diazinon and chlorpyrifos is reported to be additive in *Ceriodaphnia* (personal communication, Miller). Finally, Norberg-King *et al.,* (1991) have demonstrated that the chronic toxicity of malathion and carbofuran are additive in tests with *Ceriodaphnia.* More aquatic invertebrate information is needed to verify that the toxicity of insecticide mixtures are additive, particularly at chronic levels.

One hundred and twenty-one samples tested toxic to *Ceriodaphnia*. Seven of these were not analyzed for pesticides. Seventy percent of the remaining samples contained insecticides at concentrations above half an LC_{50} unit (Table 14 and Appendix D). Pesticides of concern include chlorpyrifos, parathion, diazinon, fonofos, methomyl and carbaryl. Of these, diazinon, chlorpyrifos, and parathion account for over 90 percent of all detections exceeding half an LC_{50} unit. Obviously, the above analysis does not preclude that other unmeasured contaminants might not also have been present in some samples and have contributed to the overall toxicity.

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[16]Concentration that kills 50 percent of test organisms in 96 hours in laboratory water.

[17]The latter is a carbamate insecticide

One hundred and twenty non-toxic samples were also analyzed for organophosphate insecticides (Table 15). One hundred and fifty-one insecticide detections were reported. However, only on one occasion was a chemical measured at a concentration above half an LC_{50} unit and no toxicity observed. Chlorpyrifos was reported at Laird Park on 23 April (Lagrangian study) at 0.07 ppb[18]. No *Ceriodaphnia* mortality was observed in the sample within 4 days (Table 10).

An advantage of an LC_{50} type analysis is that it can help identify bioassay samples where there appears to be an insufficient amount of contamination to explain the observed mortality. Two criteria were employed to help identify such situations. The first was when a sample tested toxic but contained less than half an LC_{50} unit of either pesticide or ammonia. The second was when complete mortality occurred within 48 hours but less than one LC_{50} unit[19] of toxicant was measured. Thirty-nine samples both this criteria (Table 16).

There are at least three possible explanations for the discrepency between the observed toxicity and the lack of contaminants. First, animal sensitivity is known to vary both between laboratories and at the same facility over time. As previously noted, this study deliberately selected a high *Ceriodaphnia* LC_{50} insecticide value (Table 13), when a range of concentrations were available, to provide a conservative estimate of the cause of death. On occasion our test organisms may have been more sensitive than the LC_{50} analysis would predict. The use of a lower LC_{50} concentration, particularily for chlorpyrifos and diazinon, could help account for some additional unexplained mortality. Second, the U.S. Geological Survey pesticide spike-recovery data (Table 3) suggested that organophosphorus insecticide concentrations may be under-reported by up to 30 percent. Errors of this magnitude appear important for chemicals like diazinon and chlorpyrifos which often appear in the data set at values close to but below the threshold known to induce toxicity. The third possibility is that the toxicity may have been caused by other unmeasured contaminant(s), including other insecticide(s). Four hundred and twenty-eight different pesticides with a combined active ingredient weight of about 28 million pounds were applied in Merced, Stanislaus and San Joaquin Counties in 1990 (California Department of Pesticide Regulation, 1990). This study only screened water samples for 20 of these compounds[20] although traces of all are possible in the samples.

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[18]Department of Pesticide Regulation measured chlorpyrifos in a split of this sample at 0.05 ppb. The 96 hr LC_{50} was assumed to be 0.1 ppb (Table 13).

[19]Enough contaminant to kill up to half the test animals in 96 hours.

[20]By weight the twenty account for less than 4 percent of all the active ingredients applied in the three Counties.

An analysis of the location and timing of the unexplained incidents of toxicity may be useful in identifying situations when other important contaminants could be entering the watershed (Table 16). Twenty-seven such samples were collected from agricultural drains and 12 from Rivers and Salt Slough. Interestingly, all but one of the unexplained agricultural drain toxicity events fell into two time periods. The first time interval was between February and March of 1992 when there were 12 unexplained events. Half of these occurred on the East and the other half on the westside of the River. The second time period was between April and June of both 1991 and 1992 when there were 14 unexplained events. All but one of these occurred on the westside of the River. Similarly, all of the unexplained River toxicity also occurred between February and June. It is possible, therefore, that unidentified contaminant(s) present in agricultural return flow may also be causing toxicity in the River. Future monitoring and toxicity identification evaluation work should focus on this critical time period.

<u>Ammonia</u>

In a similar fashion to pesticides, un-ionized ammonia LC_{50} units were also calculated and are provided in Appendix D. Un-ionized ammonia concentration[21] is a function of total ammonia, pH and temperature and was estimated according to U.S. EPA procedures (1985c). Ammonia and pesticide toxicities were not assumed to be additive.

Ammonia was detected in 40 samples (Appendices B and D). Twenty-one of these detections were at concentrations above half an LC_{50} unit. Fourteen of the twenty-one samples tested toxic (Table 17). However, seven of these were also contaminated with high pesticide levels so both ammonia and pesticides are assumed to contribute to the toxicity. All but one of these samples[22] was collected from the eastside between September and April. Most were taken from TID 5. High ammonia levels have previously been observed in water samples collected from this drain in winter (Foe and Connor, 1991). The primary source of the ammonia is believed to be from the City of Turlock's publically-owned sewage treatment plant and from surrounding dairies. The City of Turlock has recently submitted a time schedule to the Regional Board for removal of toxic concentrations of ammonia from their effluent (City of Turlock letter of 1 November, 1994).

Perplexingly, seven water samples were calculated to contain more than half an LC_{50} unit of un-ionized ammonia but did not test toxic (Table 18). The discrepancy does not appear to

[21]Calculated using the highest pH recorded in the bioassay (Appendix B) and a temperature of 25°C.

[22]On 3 April 1992 elevated levels of ammonia was measured in a water sample collected from Del Puerto Creek.

result from poor ammonia analysis as all analyses were made with a calibrated probe and there was good agreement in the ammonia concentration of all duplicate blind field samples which contained measurable amounts of ammonia[23]. The disparity may have arisen because it is the concentration of un-ionized ammonia which is toxic. The fraction of the total ammonia which is in an un-ionized state in any sample is a function of water pH. Increasing pH results in an increasing proportion of un-ionized ammonia. EPA does not recommend that pH be controlled during a bioassay. In this study, pH typically varied by up to 1.0-1.5 units during the 24 hours between water changes. Hydrogen ion changes of this magnitude cause a 10-15 fold increase in un-ionized ammonia concentrations. Un-ionized ammonia concentration was calculated from the highest pH value measured during the 4 to 7 day test. Ammonia is a fairly fast acting toxicant, however, the calculated un-ionized ammonia concentration may not always have been present in the bioassay water for sufficient time to cause the predicted mortality. In the future, it is recommended that toxicity identification evaluations be conducted on samples with high ammonia concentrations to more precisely ascertain the amount of *Ceriodaphnia* mortality contributed by the un-ionized ammonia fraction.

In conclusion, ammonia may have contributed to *Ceriodaphnia* mortality on 14 occasions (12 percent of all toxic samples). However, unlike insecticides, there does not appear to be a good correlation between the presence and absence of toxic concentrations of ammonia and the presence and absence of *Ceriodaphnia* mortality.

<u>Baseline Pesticide Concentrations in San Joaquin River</u> Pesticide samples were collected weekly from the San Joaquin River at Laird Park between September 1991 and June 1992 to ascertain baseline concentrations (Table 19). Thirty-three samples were analyzed for organophosphate and carbamate pesticides over the ten month period. All but one sample had a detectable amount of pesticide. Over fifty percent of the samples were contaminated with two or more compounds. Chlorpyrifos and diazinon were most common and were present in 60 and 85 percent of the samples at mean concentrations of 0.03 and 0.01 ppb, respectively. Trace amounts of parathion, fonofos and malathion also were occasionally observed. There did not appear to be any seasonal pattern in the distribution of diazinon as the chemical was present every month sampled. In contrast, chlorpyrifos was not observed between September and December. Parathion and fonofos were most common during December-January and April-May, respectively. Ammonia was only measured once. No carbamate pesticides were ever detected.

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[23]Three duplicate blind field samples had measurable amounts of ammonia (Table 18). All paired ammonia measurements were identical.

Baseline pesticide concentrations in tributaries

Organophosphate pesticide concentrations were measured in all San Joaquin River tributaries on eight occasions between 27 April and 22 June, 1992 (Appendix D). Eighty-one percent of the samples had detectable amounts of pesticide. The most common insecticides were diazinon and chlorpyrifos. The highest concentrations of both were measured in westside agriculturally dominated creeks and constructed drains (Table 20, $P<0.05$, Kruskall Wallis test). Fonofos was only detected there. Salt Slough had diazinon concentrations comparable to the westside but undetectable amounts of chlorpyrifos. The lowest concentrations of chlorpyrifos and diazinon were observed in the three eastside tributary Rivers ($P<0.05$, Kruskall-Wallis test). Interestingly, the Tuolumne always had measurable amounts of pesticides while the Merced and Stanislaus had only occasional traces of chlorpyrifos. Eastside constructed drains had pesticide concentrations intermediate between those of westside agricultural return water and eastside tributary Rivers.

In conclusion, diazinon and chlorpyrifos were fairly ubiquitous with the highest concentrations in westside agricultural inputs. This result is consistent with both the conclusion that pesticides are the primary cause of bioassay mortality in agricultural return water and the observation that the highest frequency of mortality in the spring occurred in samples collected from the westside (Table 8).

DISCUSSION

The principal conclusion of the study is that 21 percent of water samples[24] collected from the San Joaquin River Basin in 1991-92 tested toxic in *Ceriodaphnia dubia* bioassays (Table 6 and Appendix D). Insecticide concentrations were sufficiently elevated in 70 percent of these to, at least partially, explain the observed mortality (Table 14). Pesticide concentrations were also measured in 120 water samples[25] testing non-toxic (Table 15). One or more insecticides were detected in 83 percent of these samples. However, only on one occasion was a pesticide measured in a non-toxic sample at a concentration known to cause mortality. Staff conclude that the presence of insecticides in surface water at concentrations that cause death in bioassays is a violation of the Basin Plan narrative toxicity objective.

The primary conclusion of an earlier bioassay study was that there was a 43-mile stretch of the San Joaquin River between the confluence of the Merced and Stanislaus Rivers which tested toxic about half the time to *Ceriodaphnia* (Foe and Connor, 1991). Toxicity was ascribed to pesticides entering the River in agricultural return water from row and orchard crops. There are 76 agricultural drains discharging to the San Joaquin River between Salt Slough and Vernalis (James *et al.*, 1989). Orestimba and TID 5 were monitored as representative of west and eastside inputs. The drains tested toxic 41 and 75 percent of the time, respectively.

The present study was designed to follow up on the bioassay conclusions of the earlier work and had three major objectives. The first was to evaluate the assumption that TID 5 and Orestimba were representative of other east and westside inputs. To ascertain this, toxicity at Orestimba Creek was compared with that of three other westside inputs (Del Puerto Creek, Ingram-Hospital Creeks and the Spanish Grant Combined Drain) while bioassay mortality at TID 5 was compared with values obtained at TID 3 and 6. In an earlier critically dry year (1981), the seven water sources were estimated to provide about half of all surface agricultural return flow to the River (Kratzer *et al.*, 1986). The present study found that the frequency of toxicity in the four westside drains was similar. Likewise, the toxicity of the three eastside ones was the same. Therefore, it appears that bioassay water quality from Orestimba Creek and TID 5 can be considered representative of other discharges from their respective sides of the River.

Comparisons of mortality at Orestimba Creek demonstrate no changes in the frequency of toxicity between 1988-90 and 1991-92 (41.6 and 44.7 percent, respectively, Table 21).

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[24] 121 of 559 samples.

[25] 24 percent of all samples analyzed with bioassays.

Similarly, no difference was noted between the two studies in the incidence of toxicity at Salt Slough or the three eastside tributary Rivers. However, frequency of mortality at TID 5 decreased from 75 to 27 percent. This decline was statistically significant ($P<0.05$, chi-square). Some of the decrease may have occurred during the first three months of the irrigation season (April to June). The cause of the decline is not known. However, it may, at least in part, result from the increasing severity of the drought. No good estimate is available of changes in the amount of water consumed in the Turlock Irrigation District as water is supplied by both private wells and diversions from the Tuolumne River. However, some idea of water scarcity can be obtained by comparing changes in the volume of agricultural return flow to the River. The discharge from all TID drains decreased by 85 percent between 1984 (the last normal water year) and 1988-90. Discharges dropped another 37 percent between 1988-90 and 1991[26] The decrease in irrigation return water must have been accomplished, at least in part, by substantial decreases in tailwater volume. As will be discussed later, tailwater is assumed to be the major mechanism responsible for transporting pesticides off fields during the irrigation season. Decreases in tailwater runoff should result in lower pesticide concentrations in surface return flow.

The second objective of the study was to determine whether the midsection of the San Joaquin River would continue to test toxic under different hydrologic conditions. The toxicity of water samples collected from the River at Laird Park was monitored weekly to evaluate this objective. This site is centrally located in the critical River section which previously tested toxic about half the time. Less toxicity was noted in the present study (5 percent) than in the 1988-90 study (42 percent). The decrease is statistically significant ($P<0.05$, Chi-Square). The cause of the decline in toxicity is not known. However, it may be related to the drop in toxicity of eastside inputs. Decreases in toxicity between years strongly suggest that changing agricultural practices, probably induced by the drought, can significantly lower pesticide concentrations in the San Joaquin River. Additional studies are needed to better understand the factors which control pesticide concentrations and toxicity in both agricultural return flow and in the main stem of the River.

The final objective of the study was to identify, if possible, the principal crops and associated water practices responsible for toxic concentrations of pesticide in agricultural return water. Analysis of the seasonal pattern of toxicity in the return water demonstrated that most of the mortality was restricted to two time periods: January-March and April-June (Table 7, $P<0.05$). A discussion follows on the crops most likely responsible for inducing toxicity during each period. It is important to note that no evidence has been obtained that any

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[26]The sum of TID 2, 3, 5, and 6 irrigation season agricultural return flows were 75,165, 19,872, 19,428, 18,700, and 12,246 acre-feet in 1984, 1988, 1989, 1990, and 1991, respectively (personal communication, Grober).

chemical was used illegally. Rather, the data suggest that the recommended application instructions for some insecticides are inadequate to protect aquatic life.

Wet Season January to March is the rainy season in California. As previously mentioned, most water in drains during this time is from subsurface seepage and storm runoff. Little irrigation occurs. Therefore, it is assumed that stormwater runoff is the primary mechanism responsible for transporting pesticides from agricultural areas into surface water.

Half of all samples taken between January and March tested toxic with the frequency of mortality being similar on the east and westside of the River (Table 8, $P<0.05$). Toxicity is ascribed to off-target movement of insecticides from orchards, alfalfa, sugarbeets and truck farming. Cropping patterns in the San Joaquin River Basin are consistent with these conclusions as half the arable land on the east and westside of the River was planted in orchards and alfalfa during the study period (Table 2). Truck farming was primarily on the westside of the River.

Orchards The primary use of diazinon, chlorpyrifos and parathion in the San Joaquin River Basin in winter is as a dormant spray on stonefruit[27] and apple, pear and almond orchards. Three hundred and forty-seven thousand pounds of insecticide are estimated to have been applied on about 164 thousand acres of orchards in Stanislaus and Merced Counties in 1990 (Appendix E; Department of Commerce, 1987). Most of the insecticide was applied by ground rig between late December and mid-February. Dormant spray insecticides were detected 182 times in surface water between December and March of 1991 and 1992 (Appendix D). Sixty-seven of the detections were at concentrations toxic to *Ceriodaphnia*. Toxic concentrations of insecticide were observed in drains during both dry (23 December 1991, 13 January and 3 February 1992,) and wet periods (10 and 17 February 1992). Both the frequency of impairments and the concentration of the chemicals appear to increase with rain. For example, 5 of 7 sites tested toxic on 17 February after a week of rain. Elevated concentrations of dormant spray were also observed in the Merced and Tuolumne Rivers and San Joaquin River at Airport Way (Appendix D).

Off-target movement of orchard dormant spray insecticides have been confirmed by others. Foe and Sheipline (1993) conducted a study to ascertain whether the presence of dormant sprays in surface water was restricted to Stanislaus and Merced Counties or occurred wherever there are orchards in the Central Valley. As in the present study, toxic concentrations of dormant spray insecticide were found in about half of all small water courses surveyed during dry periods. All drainages became toxic after a large storm. A

[27]Apricots, cherries, nectarines, peaches, plums and prunes.

consequence of the increased concentration of insecticides in small drainages during storm events is that the concentration of insecticides also increased in rivers receiving the runoff. For example, the San Joaquin River at Vernalis was acutely toxic to *Ceriodaphnia* for eight days after the 17 February rainfall event (Foe and Sheipline, 1993). Of the four dormant sprays, diazinon appears to pose the greatest threat to aquatic organisms as it was regularly present with the greatest number of toxic units[28]. Kuivila and Foe (1995) followed up on these observations in the winter of 1993 and attempted to measure dormant spray insecticides in both the Sacramento and San Joaquin Rivers after rainstorms. Elevated concentrations of diazinon were observed in both Rivers after the two largest rainfall events of the year. During the first storm, the San Joaquin River at Vernalis contained acutely lethal concentrations of diazinon to *Ceriodaphnia* for 12 days. On the second occasion, diazinon levels in the Sacramento River were sufficiently high at Rio Vista to kill test organisms for three consecutive days. Toxic concentrations were subsequently traced as far seaward in the Estuary as Chipps Island. The Department of Pesticide Regulation confirmed the presence of diazinon in stormwater in the San Joaquin River in January 1992 and February 1993 and in the Sacramento River in February 1994 (Ross, 1992b;1993c; personal communication, Nordmark). In conclusion, the presence in Central Valley and Delta waterways of orchard dormant sprays at lethal concentrations to sensitive aquatic organisms appears to an annual occurance.

Potential mechanisms inducing off-target movement of orchard sprays in winter are reviewed in Foe and Sheipline (1992). Possible mechanisms include drift during application, runoff of contaminated rainwater from orchard surfaces, and volatization and subsequent atmospheric scavenging and redeposition of insecticides in fog and rainfall. The relative importance of the three mechanisms are, as of yet, unknown. However, ascertaining their relative importance is an essential first step to help prioritize the development of future best management practices to minimize aquatic toxicity.

<u>Alfalfa and sugarbeets</u> Forty-two thousand pounds of diazinon, malathion and chlorpyrifos active ingredient were applied on alfalfa in Stanislaus and Merced Counties in 1990 (Appendix E). Most was sprayed by air and ground rig in March for aphid and weevil control. An additional 2,700 pounds of chlorpyrifos was applied on sugarbeets for worm control. The three insecticides were detected 106 times in March and April of 1991 and 1992 (Appendix D). Twenty-five of these were at concentrations toxic to *Ceriodaphnia.* It is possible that some of the insecticide present in surface water in March was from earlier orchard applications. However, an unknown but larger amount is more likely from new

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[28]Ambient chemical concentration/concentration killing 50 percent of test organisms in laboratory water in 96 hours.

applications on alfalfa and sugarbeets. This conclusion is reinforced by the observation of an increase in the frequency of toxicity from both diazinon and chlorpyrifos on 23 March 1992 after a much lower incidence of mortality for both during the previous three surveys[29] (Appendix D). As with orchards, the frequency of toxicity appeared to increase with rain. For example, twelve of thirteen samples collected during the heavy rains of March 1991 (4 and 19 March 1991, Table 1) tested toxic.[30] As previously noted, only half the samples normally collected in March are expected to do so (Table 7).

A limited number of other studies have identified pesticides from alfalfa in surface water. In 1991 the U.S. Geological Survey began daily monitoring of the San Joaquin River at Airport Way for pesticides (Crepeau *et al.,* 1991). A well defined carbofuran and diazinon peak and traces of chlorpyrifos were detected coincident with heavy rains in early March. The pesticides were believed to result from applications on alfalfa. Simultaneously, the Survey conducted a study to assess the concentration and distribution of alfalfa pesticides in the Sacramento-San Joaquin Delta Estuary (Kuivila *et al.,* 1992). Carbofuran, but not diazinon, increased westward in the Estuary to Chipps Island. The increase in carbofuran was attributed to inputs from local unmeasured alfalfa sources within the Delta while the decrease in diazinon was thought to result from dilution with uncontaminated seawater. Foe and Sheipline (1993) attempted to confirm Kuivila's results and determine whether carbofuran would reappear in the Estuary the next year. The spring of 1992 was unusually dry and little toxicity from alfalfa applications was observed. The U.S. Geological Survey also saw no diazinon, chlorpyrifos or carbofuran in surface water in the spring of 1992 (MacCoy *et al.*, 1995). Finally, the Department of Pesticide Regulation monitored insecticide concentrations in the San Joaquin River Basin in 1991 and 1992. Diazinon, malathion, and carbofuran were detected in samples collected from both drains and the San Joaquin River in March and April of both years (Ross, 1991 and 1993a). Chlorpyrifos was only measured in 1991. In conclusion, application of alfalfa insecticides probably pose a threat to sensitive aquatic invertebrates in small Central Valley water courses each year while organisms in the rivers and Delta are only at risk during wet springs.

<u>Truck Farming</u> Truck farming is an emerging industry on the west side. Principal winter and spring crops are spinach, carrots, broccoli, cauliflower and onions (Table 2). Methomyl and fonofos were detected five times in December and January at Ingram-Hospital Creek (Appendix D). Three of these were at concentrations known to be toxic to *Ceriodaphnia*. In addition, both compounds were also detected in October in the same drainage. It is

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[29]The change in the frequency of toxicity cannot be ascribed to rain as the entire month of March, 1992 was dry.

[30]TID 6 was not toxic on 4 March 1991.

difficult, because of the limited number of detections, to be completely certain of the responsible crops. However, broccoli and cauliflower are planted between late August and mid-October and harvested between November and January (University of California, 1981). The principal winter use of methomyl is on cauliflower[31]. The only reported winter use of fonofos is on broccoli.[32] More monitoring needs to be conducted to verify that winter truck farming is the source of these two chemicals.

Irrigation Season April is the beginning of the irrigation season. In both years the last precipitation fell by mid-April (Table 1). Therefore, most of the water present in agriculturally dominated creeks and constructed drains after the end of March is from irrigation return flow. It is assumed, therefore, that tailwater runoff from row and orchard crops is the primary vehicle responsible for transporting pesticides into surface water during the irrigation season.

Slightly less than half of the water samples collected from the westside of the Valley between April and June tested toxic (Table 8). This is in contrast to the eastside where the frequency of toxicity was only 17%. The difference was significant (Chi-Squared, $P<0.05$). As described below, the difference in toxicity between the two sides of the River is primarily believed to result from differences in cropping patterns.

Four insecticides--chlorpyrifos, diazinon, fonofos and carbaryl--appear responsible for most of the toxicity. Outlined below are the primary seasonal uses of each chemical and the crops from which they most likely came.

Chlorpyrifos is a wide spectrum insecticide used extensively in agriculture on a variety of crops. The chemical was detected 85 times between April and June 1991-92 (Appendix D). Eighteen of these were at concentrations toxic to *Ceriodaphnia*. All samples collected between 27 April and 22 June 1992 were analyzed for organophosphorus insecticides. Chlorpyrifos was detected in 82 % of the drain samples[33] from both the east and westside of the River. Unlike the other pesticides discussed below, the frequency of chlorpyrifos detections were the same on both sides of the River (Chi-Square, $P>0.05$). Some detections in early April, such as at Salt Slough on 13 April 1992, are likely to have resulted from late applications on alfalfa and sugarbeets. However, the continued presence of chlorpyrifos in

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[31]In 1990, 2,442 and 318 pounds of methomyl active ingredient were applied on cauliflower and onions in Stanislaus County (Appendix E).

[32]In 1990, 110 pounds of fonofos active ingredient was applied on broccoli in Stanislaus County (Appendix E).

[33]43 of 53 samples.

drains throughout the season suggests additional applications. The precise crops responsible are not known. However, the principal uses in Stanislaus County are on walnuts and almonds for coddling moth and twig borers control (Appendix E; Sheipline, in press; personal communication Walt Heimgartner). Two minor uses are on apples and corn. Most of the almonds and corn are grown on the eastside while walnuts and apples are evenly distributed on both sides of the River (Table 2). Therefore, the distribution pattern of chlorpyrifos detections is consistent with the distribution of crops upon which it is applied.

Diazinon is another commonly used agricultural insecticide. It was detected 81 times between April and June of 1991 and 1992. Four of these were at concentrations toxic to *Ceriodaphnia*. Diazinon runoff appears to be predominately a westside problem. All toxic concentrations of the chemical were observed there. In addition, 97 percent of all westside samples collected between 27 April and 22 June 1992 contained diazinon as compared with only 23 percent on the Eastside. The difference was significant (Chi-Square, $P<0.05$).

Off-target movement of diazinon is likely to result from multiple agricultural uses. The principal seasonal use of diazinon in Stanislaus County is on almonds (Appendix E, Sheipline in press; personal communication Walt Heimgartner). Secondary uses are on melons, tomatoes, peaches, apricots, and walnuts. Almonds and peaches are mostly grown on the eastside while melons, tomatoes and apricots are westside crops (Table 2). Walnut stands occur on both sides of the River. Therefore, melons, tomatoes, and apricots appear to be the crops most likely responsible for the diazinon runoff.

Fonofos is an organophosphorus insecticide which is broadcast and then incorporated into the soil profile by tillage prior to planting. The chemical was only observed in water samples collected from the westside of the River. Fonofos was detected 24 times between April and June of 1991-92. Four of these were at concentrations toxic to *Ceriodaphnia*. The principal seasonal use of fonofos in Stanislaus County is on beans and tomatoes to control wireworms (Appendix E, Sheipline in press; personal communication Walt Heimgartner). Both commodities are almost exclusively grown on the westside. Therefore, the geographic pattern of fonofos detections is also consistent with its principal agricultural use.

Carbaryl is the last of the four insecticides. It is a commonly used foliar spray. Carbaryl was detected five times in May. All detections were in water samples collected from the westside. One of these was at a concentration known to be toxic to *Ceriodaphnia*. However, caution must be exercised in evaluating both the frequency and spatial pattern of the distribution as the detection limit for the carbamate analysis was fifty times higher than for the organophosphorus one. As a result, water samples were only analyzed for carbamate insecticides when toxicity was observed. Therefore, both the frequency of carbaryl detections and their spatial distribution may be larger than is suggested by this data.

Common uses during the early irrigation season in Stanislaus County are on almonds, beans, corn, grapes, peaches and tomatoes. Of these only beans and tomatoes are commonly grown on the westside.

As previously mentioned, the Department of Pesticide Regulation monitored insecticide concentrations in April of 1991 and 1992 in the San Joaquin River Basin. No monitoring was conducted during May or June of either year. Diazinon, chlorpyrifos, and carbaryl were detected in April of one or both years (Ross, 1991 and 1993a). Fonofos was not observed in the summer by the Department.

The U.S. Geological Survey collected water daily from the San Joaquin River at Vernalis between November 1991 and April 1994 and combined them into two day composites for dissolved pesticide analysis (MacCoy *et al.*, 1995). Diazinon, carbaryl and chlorpyrifos were observed 43, 31, and 2 times, respectively, between the months of April and June. Fonofos was not measured. The higher frequency of carbaryl detections by the U.S. Geological Survey than in the present study (Table 19) is thought to result from the Survey's approximate tenfold lower reporting limit. Conversely, the present study observed a higher incidence of diazinon and chloryprifos. Again, the bias is thought to result from the approximate threefold lower organophosphate reporting limits employed here.

Factors influencing the concentration of pesticides in tailwater have not been extensively evaluated. In the only comprehensive study known, Spencer *et al.* (1985) investigated factors influencing pesticide levels in runoff from irrigated fields in the Imperial Valley. The authors found that there was a strong positive relationship between the amount of insecticide present in the top one cm of furrow soil and the subsequent concentration in tailwater. For chlorpyrifos and diazinon, the tailwater usually contained about 1 to 1.5 percent of the amount of chemical present in the soil. Two factors influenced soil insecticide concentrations. The most important of these was the amount of time elapsed since the application as soil and tailwater pesticide concentrations were observed to decrease exponentially with time. Chlorpyrifos and diazinon soil half-lives were determined to be 3-11 and 13-15 days, respectively. The second factor influencing the amount of pesticide bound to the soil was the proportion of wettable furrow covered by crop canopy at the time of application. In general, crop leaf surfaces are not wetted during irrigation. Therefore, pesticides attached to them are unlikely to be remobilized with irrigation tailwater. This finding is consistent with observations obtained in the present study as most westside bioassay mortality occurred early in the irrigation season (April-June) when crops were young and of a relatively small stature (Table 8). Similar amounts of the same insecticides are reported to be applied later in the irrigation season on (presumably) larger plants. Less mortality was observed in bioassays then.

Two factors which did not affect the amount of insecticide in tailwater were the concentration of suspended sediment and the method of pesticide application. Spencer *et al.* (1985) found that about 15 percent of the chlorpyrifos carried in tailwater was bound to sediment while 85 percent was in the dissolved phase. Diazinon was even more hydrophilic. As a result, there was no relationship between the amount of total suspended sediment and the insecticide concentration. These observations are toxicologically important as it is the dissolved insecticide fraction which is believed to be biologically available and responsible for the observed mortality. Finally, Spencer *et al.* found no difference in tailwater insecticide concentrations when the chemical was applied by ground or air rig.

Spencer *et al.* (1985) suggest three possible best management practices to help reduce transport of pesticides from irrigated fields in the Imperial Valley. The first was to insure that the pesticide application and the irrigation event never co-occurred. The second was to delay irrigation for as long as possible after applying pesticides to insure that the greatest amount of chemical degradation possible had occurred. Finally, the authors recommend that minimal amounts of tailwater be released after pesticide applications.

DiGiorgio *et al.* (1995) has completed the second of a three-year bioassay study of agricultural return water in the Imperial Valley. Forty-one percent of the water samples collected from the Alamo River and its principal agricultural tributaries tested toxic to *Ceriodaphnia*. Modified phase I toxicity identification evaluations (U.S.EPA, 1988; Bailey *et al.*, 1995) were conducted on twenty toxic samples. Non polar organics were implicated in nineteen of the toxicity identification evaluations. Chemical analysis supported these conclusions and revealed that the samples contained diazinon, chlorpyrifos, malathion, carbaryl, and carbofuran at concentrations near or above the *Ceriodaphnia* LC_{50} value. The study assumed that the insecticides were transported to the River in tailwater from row and field crops.

A similar bioassay study is presently being conducted in the Sacramento-San Joaquin Delta Estuary (Deanovic *et al.*, in prep). *Ceriodaphnia* mortality has been observed in water samples collected from upland agriculturally dominated creeks and constructed drains and from the back sloughs to which they drain. Diazinon, chlorpyrifos and carbofuran were measured in the samples at concentrations reported toxic to *Ceriodaphnia* and other sensitive local aquatic organisms. Again, the primary source of the chemicals is believed to be tailwater runoff from upland row and orchard crops.

In conclusion, the aquatic threat posed by insecticides in tailwater does not appear to be restricted to the San Joaquin River Basin. More work needs to be undertaken to better understand the primary factors controlling pesticide concentrations in tailwater from all areas of the State. This information is essential, as with dormant sprays, to help direct the development of best management practices to minimize the threat of insecticides to the aquatic community.

Ecological impacts

The ecological impact of elevated pesticide levels in the San Joaquin River Basin is not known. However, indirect evidence suggests that impacts may be occurring to sensitive aquatic organisms in both the Central Valley and the Sacramento-San Joaquin Delta Estuary.

Direct evidence of ecological impacts on aquatic communities is difficult to measure (Clements and Kiffney, 1994; DeVlaming, 1995). The U.S. EPA developed the three species bioassay approach (U.S.EPA, 1985a;1989) as an early warning system of potential pollutant impacts. The Agency attempted to validate the approach by conducting eight freshwater studies to ascertain whether there was a correlation between toxicity in receiving water as measured by their tests and instream impacts (reviewed in U.S. EPA, 1991b). The bioassay results predicted receiving water impacts at seven sites. At each location differences were measured in the abundance and distribution of aquatic organisms below the site as compared to above it. At one location no difference was predicted by the bioassay testing and none was detected in the receiving water. Subsequent field work by Eagleston *et al.*, (1990), Birge *et al* (1990) and Dickson *et al.* (1989) provide further support for the hypothesis that bioassays can be an indirect method of assessing whether pollutants are impacting freshwater organisms. These results have lead the U.S. EPA to recommend bioassay testing as an acceptable surrogate to the measurement of the abundance and distribution of organisms at sites where impacts from pollutants are suspected. However, the method has been criticized by Marcus and McDonald (1992) and Parkhurst (1995). Recently, DeVlaming (1995) has reviewed all critiques conducted to date and concluded that there is a good qualitative relationship between bioassay results and aquatic ecosystem response. Predictions about ecological impacts are particularly strong if acute toxicity is observed in bioassays conducted on ambient water samples.

Sheipline (in press) reviewed the sensitivity of different classes of aquatic organisms to the pesticides reported in water samples from the San Joaquin Basin. Surprisingly little information was available for many insecticides. However, in general, cladocerans appeared to be the most sensitive aquatic forms and exhibited pesticide tolerances similar to *Ceriodaphnia*. Support for this conclusion was obtained from a large mesocosm study sponsored by Ciba-Geigy, the manufacturer of diazinon (Giddings, 1992). In the study, replicate ponds were dosed with increasing concentrations of diazinon and the abundance of different classes of organisms compared with the undosed control. The study found reduced numbers of cladocerans and caddisflies in the lowest treatment (about 2.4 ppb). However, both classes of organisms returned to normal about 10 weeks after pesticide dosing stopped. While interesting, the latter observation may not be applicable to water bodies in the San

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Joaquin River Basin which are subjected to repeated episodes of acute invertebrate toxicity from pesticide exposure.

An analysis of fifteen years of Department of Fish and Game zooplankton tow net data has recently been completed (Obrebski *et al.*, 1992). The analysis is particularly valuable as it eliminates the impact of salinity (flow) and seasonality, two variables that have confounded previous analysis. The study demonstrates a decline in abundance of zooplankton species (copepods, rotifers and cladocerans) in the freshwater portion of the Estuary. In contrast, population levels of species inhabiting intermediate and marine salinities have largely remained stable. The cause of the decline of freshwater forms is not known. However, historically, it seems likely that a portion of the freshwater zooplankton community in the Delta was the result of a continuous repopulation with individuals from slow moving, warm, eutrophic back waters in the Central Valley. The repopulation is probably most important for the Rivers and upper Delta with their strong seaward flow. The primary nursery areas in the Central Valley are likely to have included the agriculturally dominated creeks and constructed drains which now contain pesticides at toxic concentrations to many zooplankton species.

Zooplankton are important in aquatic systems, in part, as food for larval and juvenile fish. Zooplankton densities in the freshwater portion of the Estuary are now reported to be one to two orders of magnitude lower than in the early seventies (Obrebski *et al.*, 1992). The population of many freshwater fish in the Estuary are also in decline, including species like splittail, delta smelt and striped bass whose larvae feed almost exclusively on small zooplankton. Laboratory evidence suggests that food levels in the Estuary are limiting, at least for striped bass larvae (reviewed in Herbold *et al.*, 1992). However, no evidence of field starvation (death from lack of food) has been found for bass although increased larval predation rates are hypothesized because of suppression in growth from both toxins and lack of food (Bennett *et al.*, 1995).

<u>Regulatory significance of insecticide findings</u>

Thirteen pesticides were detected in this study (Table 12). The Water Quality Control Plan for the San Joaquin River Basin (Basin Plan) contains a conditional prohibition of discharge[34] for irrigation return flows containing carbofuran, malation and methyl

[34]The prohibition of discharge is lifted if the discharge is following management practices approved by the Regional Board. To receive approval, the management practices must be expected to meet performance goals set by the Board.

parathion[35]. Carbofuran and malathion performance goals were exceeded in 1 and 6 samples, respectively. No exceedance was observed for methyl parathion. Use of a fourth compound, ethyl parathion, is now banned because of human health concerns. Performance goals are not available for any of the other compounds. Therefore, water quality criteria have been assembled for the remaining nine chemicals (Table 12) to help evaluate their aquatic threat. Also included is the lowest reported concentration of each insecticide known to cause *Ceriodaphnia* toxicity.

The analysis suggests that of the thirteen compounds, diazinon and chlorpyrifos pose the greatest threat to aquatic life in the Basin. The two were detected a total of 328 times in the year and a half study. Over half of these measurements were at concentrations greater than the draft California Department of Fish and Game Hazard Assessment criteria to protect freshwater aquatic life (Menconi and Cox, 1994; Menconi and Paul, 1994). Ninety measurements were at concentrations reported in the literature to be toxic to *Ceriodaphnia.* Finally, almost half of all water samples analyzed for pesticides were contaminated with both chemicals and the toxicity of the two is additive, at least for *Ceriodaphnia* (personal communication, Dr Miller). This suggests that water quality objectives for both insecticides should consider additivity.

[35]Performance goals for methyl parathion, malathion and carbofuran are 0.01, 0.1 and 0.4 ppb, respectively, Central Valley Basin Plan (1990).

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Acknowledgements *Ceriodaphnia* bioassays were conducted under the direction of Sandy Nurse at Sierra Foothill Laboratory. Dr Joseph Domagalski was the contract manager for pesticide analysis at the U.S. Geological Survey. Jerry Bruns, Val Connor, Rudy Schnagl and Dennis Westcot reviewed an earlier draft of the manuscript. The help of all the above individuals is gratefully acknowledged.

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Table 1. Daily precipitation in inches at the City of Stockton. Shading indicates sampling dates. "T" denotes trace amounts of precipitation.

	1991											1992					
Date	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1		.70		T									.10	.06			
2	.50	.11												.06			
3		.78												T			
4	.73	.42										.03					
5	.17											.69	T	.71			
6											.01	.11	.33	.03			
7											.34	.22	.09				
8																	
9													.26				
10		.13											.46				
11													.80				
12		.10											.80		.72		
13		.26		.12			.05						.03		T		
14		T					.02						1.19	.24			
15		.07											.27	.05			.08
16													.64	.04			
17		.32		T						.34	.01	T		T			
18		.03									T		.03				
19		.10				.02							.14				
20		.50	.41										.23				
21			.04										.01				
22													T	.11			
23		.36															
24		1.13							.10								
25		.01						T	.44								
26		.33							1.44								
27	.62				T						.21						
28	.30				.11						.02	.34					
29											.17						.04
30																	
sum	2.32	5.35	0.45	0.12	0.11	0.02	0.07	t	1.98	0.34	0.76	1.39	5.37	1.30	0.72	0	0.12

Table 2. Cropping patterns (%) for representative irrigation districts located on the east and west side of the San Joaquin River. Percentages sum to more than 100% because of double cropping.

	EASTSIDE		WESTSIDE			
	Turlock Irrigation District		Patterson Irrigation District		W. Stanislaus Irrigation District	
CROP	1991	1992	1991	1992	1991	1992
ORCHARDS						
Almonds	29.6	28.4	0.5	0.6	4.1	4.3
Apples	0.5	0.7	0.1	0.1	0.3	0.3
Apricots		0.1	20.2	16.1	7.8	8.6
Cherries	0.1	0.1	1.6	1.4	0.5	0.5
Peaches	5.0	5.1				
Walnuts	3.7	3.7	4.5	4.5	3.9	4.5
TOTALS	39.1	38.4	27.5	23.2	16.6	18.3
FIELD						
Alfalfa	15.1	17.7	21.6	23.9	7.0	5.2
Corn	27.2	28.0		1.7		
Grain	5.6	2.3				
Clover	0.4	0.8				
Oats	20.9	21.7	4.0	0.6	0.4	
Pasture	10.0	9.5	2.1	2.3		
Sudan	0.6	0.8	0.6			0.2
Barley					0.5	
Wheat				1.1	0.6	2.1
Beans	1.7	1.7	15.9	19.3	30.9	28.7
Cotton						
Sugarbeets			0.4	1.6		0.4
Turf			1.6	2.8	0.8	0.3
TOTALS	81.5	82.5	46.2	53.3	40.2	36.9

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Table 2 . (Continued)

	EASTSIDE		WESTSIDE			
	Turlock Irrigation District		Patterson Irrigation District		W. Stanislaus Irrigation District	
CROP	1991	1992	1991	1992	1991	1992
VEGETABLE						
Melons	0.6	0.9		0.9	11.8	12.7
Tomatoes			12.8	11.6	13.6	16.5
Onions					1.7	1.7
Peas			2.7		3.8	3.3
Pumpkins	0.2	0.4	0.1			
Celery			0.5	1.3	0.5	
Spinach			1.2	0.4	0.3	
Carrots				0.8		
Broccoli				2.1	1.7	2.0
Cauliflower					2.3	1.5
Peppers			0.2		2.2	3.0
TOTALS	0.8	1.3	23.4	19.2	37.9	40.7
OTHER						
Vines	4.9	4.0				
Duck Clubs						
Fallow			2.2	2.1	2.5	1.6
Seed crops			0.8	0.9		
TOTALS	4.9	4.0	3.0	3.0	2.5	1.6
Irrigated Acreage	146,371	148,887	13,716	13,585	26,586	25,347
Acreage double cropped	43,038	43,834	1,023	915	1,821	2,921

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Table 3. Organophosphate pesticides and associated reporting limits (ug/l) for U.S. Geological Survey total recoverable organophosphate scan 1319. Also included are reported accuracy and precision estimates obtained by spiking seven replicates of each insecticide into laboratory water (Wershaw *et al.* 1987)

Compound	Reporting Limits (ug/l)	Concentration Spiked (ug/l)	Mean Concentration Recovered	Mean (%) Recovery	Relative Standard Deviation
Chlorpyrifos	0.01				
DEF	0.01				
Diazinon	0.01	0.230	0.150	65.0	20.0
Disulfoton	0.01				
Ethion	0.01	0.15	0.120	80.0	7.4
Fonfos	0.01				
Malathion	0.01	0.260	0.180	69.0	32.0
Methyl Paration	0.01	0.220	0.160	73.0	9.2
Parathion	0.01	0.150	0.120	80.0	6.3
Phorate	0.01				
Trithion	0.01	0.250	0.180	73.0	7.6

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Table 4. Carbamate pesticides and associated reporting limits (ug/l) for U.S. Geological Survey total recoverable Carbamate scan 1359. Also included are reported accuracy and precision estimates obtained by spiking four replicates of each insecticide into surface water (Wershaw *et al.* 1987).

Compound	Reporting Limits (ug/l)	Concentration Spiked (ug/l)	Mean concentration Recovered	Mean (%) Recovery	Relative Standard Deviation
Methiocarb	0.50				
Propoxur	0.50				
Methomyl	0.50	2.52	2.13	84.9	20.0
Propham	0.50	7.05	5.68	80.6	5.7
Sevin	0.50	2.36	2.33	97.0	5.7
1-Naphthol	0.50				
3-hydroxy carbofuran	0.50				
Aldicarb sulfoxide	0.50				
Aldicarb sulfone	0.50				
Oxyamyl	0.50				
Carbofuran	0.50				
Aldicarb	0.50				

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Table 5. Comparison of *Ceriodaphnia* survival and electrical conductivity (umho/cm) in duplicate blind field samples submitted to Sierra Foothill Laboratory for analysis. Bioassay survival is for a four day test unless noted otherwise. Electrical conductivity measurements were made before the addition of *Ceriodaphnia* food.

		Survival			Electrical Conductivity		
Location	Date	Sample	Duplicate	Difference (%)	Sample	Duplicate	Difference (%)
TID 5[1]	2-25-91	100	90	10	2050	2060	0.5
SJR[2] @ Airport Wy	3-4-91	80	100	20	1082	1076	0.6
Orestimba Ck	3-19-91	0	0	0	904	910	0.7
SJR @ Hills Ferry	4-4-91	90	100	10	2300	2440	6.1
TID 5	4-18-91	100	100	0	899	900	0.1
TID 5	5-3-91	100	100	0	525	525	0.0
TID 6	5-15-91	100	100	0	1028	1020	0.7
TID 3	6-12-91	100	90	10	838	916	9.3
Spanish Grant	6-26-91	100	90	10	1736	1771	2.0
SJR @ Airport	7-2-91	100	100	0	904	909	0.6
TID 3	7-15-91	100	100	0	748	757	1.2
Spanish Grant	7-30-91	90	100	10	1353	1337	1.2
Spanish Grant	8-6-91	890	100	20	1035	1029	0.6
Spanish Grant	9-6-91	100	100	0	1535	1589	3.5
Orestimba Creek	9-18-91	100	100	0	1042	1020	2.1
Ingram-Hospital	9-26-91	90	100	10	1647	1676	1.8
TID 3	10-9-91	90	90	0	1010	1004	0.6
TID 5	10-24-91	100	100	0	500	506	1.2
Spanish Grant	10-30-91	100	100	0	788	779	1.0
TID 5	11-13-91	100	100	0	1148	1140	0.7
Orestimba Creek	11-25-91	100	100	0	878	882	0.5
Ingram-Hospital	12-4-91	0	0	0	1472	1477	0.2
Spanish Grant	12-11-91	100	100	0	1386	1358	2.0
TID 3	12-18-91	100	100	0	1023	1041	1.8
Merced R[3].	1-5-92	100	100	0	188	225	19.7
Center Rd Drain	1-13-92	100	100	0	1879	1805	3.9
TID 6	1-20-92	0	0	0	850	850	0.0
Ingram-Hospital	2-3-92	100	100	0	1671	1693	1.3
Merced R[3].	2-10-92	100	100	0	141	146	3.5
SJR @ Airport	2-17-92	0	0	0	467	467	0.0

[1]Turlock Irrigation District [2]San Joaquin River [3]Seven day test

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Table 5. Continued

Location	Date	Survival			Electrical Conductivity		
		Sample	Duplicate	Difference (%)	Sample	Duplicate	Difference (%)
Del Puerto Ck	2-24-92	100	100	0	1065	1149	7.9
TID 6	3-2-92	100	100	0	1172	1170	0.2
Tuolumne R[3].	3-9-92	100	100	0	187	174	7.0
TID 5	3-16-92	100	90	10	1435	1402	2.2
Salt Slough[3]	3-30-92	100	100	0	2260	2330	3.1
Ingram-Hospital	4-6-92	100	100	0	1990	1968	1.1
TID 6	4-13-92	80	100	20	468	486	3.8
Ingram-Hospital	4-20-92	90	80	10	1626	1618	0.5
Ingram-Hospital	5-4-92	0	0	0	1733	1748	0.9
Tuolumne R[3]	5-11-92	90	100	10	81.6	95	16.4
Tuolumne R[3]	5-18-92	100	100	0	286	297	3.9
Ingram-Hospital	5-25-92	0	0	0	1530	1517	0.8
Ingram-Hospital	6-1-92	100	100	0	1548	1557	0.5
Ingram-Hospital	6-15-92	100	100	0	1642	1653	0.7
Ingram-Hospital	6-22-92	80	90	10	1394	1431	2.6

[1]Turlock Irrigation District [2]San Joaquin River [3]Seven day test

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Table 6. Summary of percent Ceriodaphnia survival in water samples collected from the San Joaquin in 1991-92. Toxicity was defined as any sample with statistically (P<0.05) more death than the laboratory control. These events are indicated by shading. Results are for four day tests unless noted otherwise. Blanks indicate no sample taken.

	1991																		
	2-25	3-4	3-19	4/4	4/18	5-3	5-15	5-28	6-12	6-26	7-2	7-15	7-30	8-16	9-6	9-18	9-26	10-9	10-24
Salt Slough[1]											80	90	100	90	100	100	80		
SJR[2] @ Hills Ferry[1]		100	90	90	70	100	100	90	0	100	100	90	100	100	100	100	100	100	90
SJR @ Laird Park[1]	100	100	80	100	100	100	100	80	0	100	90	90	100	100	100	90	90	100	100
SJR @ Airport Way[1]	100	80	90	90	90	90	80	80	90	100	100	100	100	100	100	100	100	100	100
Merced R[1].	100	100	100	100	100	100	100	90	100	90								20	100
Tuolumne R[1].	100	100	100	100	80	80	100	90	100	100								100	100
Stanislaus R[1].	90		100	100	50	100	100	100	60	90								80	100
TID[3] 6	100			70			100	0		90		60		90	90	100		100	
TID 5	100	0	0	10	100	100		100	100	100			100	100	100	100	90		100
TID 3	100	0	0	0	100	100	100		100	100	100	100	90	100	100			90	
Orestimba Ck	20	0	0		0	100	0	100	90	100	100	90	0			100	100	100	90
Del Puerto Ck	100	0	0	100	80	90	0	0	100		100	100	100	100	90	100	90	100	100
Ingram-Hospital Cks	100	0	0	90	100	100	0	0	10	100	100	100		100	0	'100	90	100	0
Spanish Grant Drain	100	0	0		60	90	0	0	10	100	100	90	90	80	100	90	100	100	100
Laboratory Control	100	100	100	90	100	100	100	100	100	100	100	100	90	100	100	100	100	100	100

[1]Results are for a seven day test after 25 November 1991. [2]San Joaquin River. [3]Turlock Irrigation District

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Table 6. (Continued).

	1991							1992											
	10-30	11-13	11-25	12-4	12-11	12-18	12-23	1-5	1-13	2-3	2-10	2-17	2-24	3-2	3-9	3-16	3-23	3-30	4-6
Salt Slough[1]														100	90	0	100		100
SJR[2] @ Hills Ferry[1]	100	100	100	100	90	90	90	90	100	90	100	100	100	100	100	20	100	100	100
SJR @ Laird Park[1]	100	100	100	100	100	100	90	100	100	100	90		80		0	100	90	100	70
SJR @ Airport Way[1]	100	100	100	70	90	90	90	100	80	100	100	0	80	90	0	80	100	90	100
Merced R[1]	100	100	100	60	80	90	100	100	100	100	100	0	100	100	40	80	90	90	100
Tuolumne R[1].	100	90	100	90	100	90	100		100	100	80	0	100	100	100	90	100	100	100
Stanislaus R[1]	100	90	100	80	90	90	90	100	80	100		90	90	100		100	80	70	90
TID[3] 6			0		80		90	100	0	0	0	0	100	100	90	100	100	100	0
TID 5	100	100	100	100	90	0	100	40	0	0	0	0	0		0	100	100	100	100
TID 3		100			100	100		0			0	0	0	0	0	0	0	100	
Orestimba Ck		100	100	100	50			100		90	0	0			0		0	100	100
Del Puerto Ck	100	100	100	100		0	0	0	0	0	0	100	100	100	100	70	0	100	10
Ingram-Hospital Cks		100	100	0	90		0	0		100	0	100	0	100	0	0	0	100	100
Spanish Grant Drain	100	100		100	100	70	70	0			10	0	80	100	90	100	0	100	100
Laboratory Control	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	90	100	90

[1]Results are for a seven day test after 25 November 1991. [2]San Joaquin River. [3]Turlock Irrigation District

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Table 6. (Continued).

	1992									
	4-13	4-20	4-27	5-4	5-11	5-18	5-25	6-1	6-15	6-22
Salt Slough[1]	0	90	100	70	100	90	100	100	90	90
SJR[2] @ Hills Ferry[1]	100	90	100	100	80	100	100	100	100	100
SJR @ Laird Park[1]	100	100	90	100	90	100	80	100	100	90
SJR @ Airport Way[1]	100	100	70	80	90	90	80	100	100	100
Merced R[1].	0	100	100	90	100		100	100	80	50
Tuolumne R[1].	80	90	90	70	90	100	100	100	90	40
Stanislaus R[1].	90	100	90	60		90	70	100	100	40
TID[3] 6	80	100	90	100	50	100		0	100	100
TID 5		100	100	100	100	100		100	100	100
TID 3	90		80	100	90	100				0
Orestimba Ck	100	20	0	0	0	90	0	100	100	0
Del Puerto Ck	100	100	100	0	0	100	0	100	100	100
Ingram-Hospital Cks	100	90	70	0	0	0	0	100	100	80
Spanish Grant Drain	40	0	0	0	0	0		0	100	0
Laboratory Control	100	100	90	100	100	100	100	100	100	100

[1]Results are for a seven day test after 25 November 1991. [2]San Joaquin River. [3]Turlock Irrigation District

Table 7. Percent frequency of acute *Ceriodaphnia* toxicity in water samples collected from agricultural return flow in the San Joaquin Basin in 1991-92. Values with the same letter are not statistically different ($P<0.05$).

Season	Frequency of toxicity (%)
January-March	58.9 a
April-June	35.8 a
July-September	7.7 b
October-December	17.8 b

Table 8. Percent frequency of acute *Ceriodaphnia* toxicity in water samples collected from east and westside agricultural return flows during 1991-92. Eastside inputs were Turlock Irrigation District Lateral No. 3, 5 and 6. Westside ones were Orestimba, Del Puerto, and Ingram-Hospital Creeks and the Spanish Grant Combined Drain. Values with the same letter are not statistically different (P>0.05).

	Frequency of toxicity (%)	
Season	Eastside	Westside
January-March	62.2 a	55.1 a
April-June	17.0 b	47.1 a
July-September	7.1 b	8.0 b
October-December	12.5 b	20.6 b

Table 9. Results of spiked organophosphate and carbamate samples prepared by the California Department of Pesticide Regulation and submitted to their Sacramento Laboratory and to the U.S. Geological Survey. U.S. Geological Survey reporting limits for organophosphate and carbamate pesticides were 0.01 and 0.5 ppb, respectively. Department of Pesticide Regulation reporting limits were 0.05 ppb.

Date	Chemical	Nominal Concentration (ppb)	U.S.Geological Survey (ppb) [1]	Department of Pesticide Regulation (ppb)[1]
23 April 1991	diazinon	0.250	0.200 (80%)	0.22 (88%)
	ethyl parathion	0.05	0.04 (80%)	0.05 (100%)
	carbaryl	0.10	<0.50	no analysis
	diazinon	0.10	0.08 (80%)	no analysis
	carbofuran	0.450	<0.5	0.40 (89%)
20 January 1992	chlorpyrifos	0.05	0.04 (80%)	0.05 (100%)
	ethyl parathion	0.05	0.04 (80%)	0.05 (100%)
	diazinon	0.05	0.05 (100%)	0.05 (100%)
	methidathion	0.05	[2]	0.05 (100%)
24 February 1992	chlorpyrifos	0.05	0.03 (60%)	0.05 (100%)
	ethyl parathion	0.05	0.04 (80%)	0.06 (120%)
	diazinon	0.05	0.05 (100%)	0.06 (120%)
	methidathion	0.05	[2]	0.05 (100%)
23 March 1992	carbofuran	0.50	<0.05	0.05 (100%)
	diazinon	0.06	0.04 (67%)	0.06 (100%)
	malathion	0.06	<0.01	0.06 (100%)
	chlorpyrifos	0.06	0.02 (33%)	0.05 (83%)
18 May 1992	diazinon	0.05	0.06 (120%)	no analysis
	fonofos	0.05	0.04 (80%)	no analysis
	chlorpyrifos	0.05	0.03 (60%)	no analysis
	carbaryl	1.0	<0.50	no analysis

[1]Measured concentration (percent recovery) [2]Not in the U.S. Geological Survey organophosphate scan.

Table 10. *Data from lagrangian study conducted in cooperation with the California Department of Pesticide Regulation.* Bioassays were conducted by Sierra Foothill Laboratory. All samples were analyzed for both organophosphate and carbamate pesticides. U.S. Geological Survey reporting limits for organophosphate and carbamate pesticides were 0.01 and 0.5 ppb, respectively. Department of Pesticide Regulation reporting limits were 0.05 ppb. Blanks indicate no detections.

Dates: 23 to 26 April 1991							
Station	Ceriodaphnia Survival (%) by day				U.S. Geological Survey (ppb)	Department of Pesticide Regulation (ppb)	Difference between laboratories[1]
Salt Slough @ HWY 165[2]	100	100	100	100	diazinon=0.02	diazinon=0.07 oxamyl=0.140	diazinon=-0.05
Mud Slough[2]	100	100	90	90	diazinon=0.02 chlorpyrifos=0.01		
SJR[3] @ HWY 165[2]	80	80	80	80	diazinon=0.05		
Los Banos Creek[2]	100	100	100	100	chlorpyrifos=0.01 diazinon=0.01		
SJR @ Fremont Ford[2]	100	100	100	100	chlorpyrifos=0.01 diazinon=0.21 malathion=0.01	diazinon=0.08 oxamyl=0.120	diazinon=0.13
Newman Wasteway[2]	100	100	100	100	chlorpyrifos=0.01 diazinon=0.01 fonofos=0.01 parathion=0.01		
Merced River[2]	100	100	100	100	chlorpyrifos=0.01		
SJR @ Hills Ferry[2]	90	90	80	80	diazinon=0.09	diazinon=0.08 oxamyl=0.120	diazinon=0.01
Orestimba Creek[4]	100	100	100	100	chlorpyrifos=0.01		
TID[5] 5[4]	0	0	0	0	chlorpyrifos=0.19 diazinon=0.02	chloropyrifos=0.230	chlorpyrifos=-0.04
SJR @ West Main[4]	100	90	70	60	chlorpyrifos=0.09 diazinon=0.06[7]	chloropyrifos=0.08	chlorpyrifos=0.01
Del Puerto Creek[4]	100	100	100	100	chlorpyrifos=0.04 diazinon=0.05[7]		
Tuolumne River[4]	100	100	80[6]	80			
SJR @ Laird Park[4]	100	100	100	100	diazinon=0.06[7] chlorpyrifos=0.07	chloropyrifos=0.05	chlorpyrifos=0.02
Stanislaus River[4]	100	100	100	100	chlorpyrifos=0.01 diazinon=0.01		
Ingram Hospital Creek[4]	100	100	90	90	chlorpyrifos=0.03 parathion=0.02 diazinon=0.04	carbofuran=0.05	
SJR @ Maze Blvd.[4]	100	100	100	100	chlorpyrifos=0.02 diazinon=0.02		
SJR @ Airport Road[4]	100	100	100	100			
Laboratory Control #1	100	100	100	100			
Laboratory Control #2	100	100	100	100			
Dilution Control #1	100	90	90	90			

[1] Dfferences only calculated for insecticides detected by both laboratories. Difference=USGS-DPR. [2]Bioassay laboratory control #1 applies. [3]San Joaquin River. [4]Bioassay laboratory control #2 applies. [5]Turlock Irrigation District. [6] One animal accidentally killed by laboratory personnel. [7] U.S. Geological Survey reported diazinon at concentrations above Department reporting limit. The Department of Pesticide Regulation did not detect the diazinon.

Table 11. Data from lagrangian study conducted in cooperation with the California Department of Pesticide Regulation. Bioassay data was invalidated because of high laboratory control mortality. Organophosphate and carbamate pesticide analysis were conducted by the Department of Pesticide Regulation. Only organophosphate analysis was conducted by the U.S. Geological Survey. U.S. Geological Survey and Department of Pesticide Regulation reporting limits are 0.01 and 0.05 ppb, respectively.

Dates: 27 to 31 January 1992			
Station	California Department of Pesticide Regulation (ppb)	U.S. Geological Survey (ppb)	Difference between laboratories[1]
Salt Slough	organophosphates=nd	diazinon=0.01	
Mud Slough	organophosphates=nd	organophosphates=nd	
SJR[3] @ HWY 165	diazinon=0.150	diazinon=0.03	diazinon=-0.12
Los Banos Creek	organophosphates=nd	diazinon=0.02	
SJR @ Fremont Ford Park	organophosphates=nd	chlorpyrifos=0.01	
Newman Wasteway	diazinon=0.09	diazinon=0.03	diazinon=-0.06
Merced River	diazinon=0.1	chlorpyrifos=0.02 diazinon=0.08	diazinon=-0.02
SJR @ Hills Ferry Road	diazinon=0.09	chlorpyrifos=0.02 diazinon=0.03	diazinon=-0.06
Orestimba Creek	no flow		
TID[4] 5	diazinon=0.45	chlorpyrifos=0.01 diazinon=0.54	diazinon=0.09
SJR @ West Main	diazinon=0.08	chlorpyrifos=0.01 diazinon=0.05	diazinon=-0.03
Del Puerto Creek	no flow		
Tuolumne River	diazinon=0.09	chlorpyrifos=0.01 diazinon=0.04	diazinon=-0.05
SJR @ Laird Park	diazinon=0.09	chlorpyrifos=0.02 diazinon=0.04	diazinon=-0.05
Stanislaus River	diazinon=0.1	chlorpyrifos=0.01 parathion=0.01 diazinon=0.04	diazinon=-0.06
Ingram Hospital Creek	diazinon=0.06	chlorpyrifos=0.01 diazinon=0.09	diazinon=0.03
SJR @ Maze Blvd.	diazinon=0.11	chlorpyrifos=0.01 diazinon=0.07	diazinon=-0.04
SJR @ Airport Road	diazinon=0.09	chlorpyrifos=0.03 diazinon=0.05	diazinon=-0.04

[1] Difference only calculated for insecticides detected by both laboratories. Difference=USGS-DPR. [3]San Joaquin River. [4]Turlock Irrigation District.

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Table 12. Summary statistics for pesticide detections in the San Joaquin study 1991-92. The data includes pesticide detections in samples testing both toxic and non toxic in bioassays but does not include information obtained from the two Lagrangian special studies done in cooperation with the Department of Pesticide Regulation.

Pesticides	frequency of detection	number of detections	mean concentration (ppb)	median concentration (ppb)	range	number of samples exceeding				number of samples exceeding lowest *Ceriodaphnia* LOEC[4]
						NAS[1]	F&G[2]	EPA[3]	Basin Plan[4]	
Diazinon	65.4	178	0.14	0.04	0.01-2.60	178	84			52
Chlorpyrifos	55.2	150	0.07	0.02	0.01-1.60		82	45		38
Parathion, ethyl	18.0	49	0.16	0.03	0.01-2.10			31		20
Fonofos	15.4	42	0.07	0.03	0.01-0.54					3
Malathion	5.1	14	0.10	0.01	0.01-0.42			6	6	
Carbaryl	3.6	6	2.9	1.9	0.06-8.4					0
Methomyl	1.8	3	3.7	3.2	2.6-5.4					0
DEF	1.1	2	0.01	0.01	0.01					
Ethion	0.7	2	0.03	0.03	0.01-0.05					
Parathion, methyl	0.4	1	0.02	0.02					0	
Isofenfos	0.4	1	0.07	0.07						
Disyston	0.4	1	0.06	0.06						
Carbofuran	0.6	1	0.8	0.8			1		1	0

[1]National Academy of Sciences Criteria (1973) of 0.009 ppb. [2] California Department of Fish and Game Draft Hazard Assessment Criteria for diazinon, chlorpyrifos and carbofuran of 0.04, 0.015 and 0.4 ppb, respectively (1993a,b;1994a,b). [3]U.S. EPA recommended freshwater criteria to protect aquatic life for chlorpyifos, ethyl parathion and malathion of 0.041, 0.013, and 0.1 ppb, respectively (U.S. EPA 1986b;c;a). [4]Table 13. [4]Basin Plan performance goals for malathion, methyl parathion, and carbofuran of 0.1, 0.13, and 0.4 ppb, respectively (Central Valley Regional Water Quality Control Board, 1990)

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Table 13. Reported toxicity to *Ceriodaphnia* of contaminants (ppb) detected in this study. Un-ionized ammonia concentration is reported as mg/l ammonia.

	Toxicity					
Contaminant	96 Hr LC_{50}[1]	48 Hr LC_{50}	24 HR LC_{50}	Pesticide LC_{50} value[8]	OTHER	SOURCE
Ammonia	2.47, 1.35			1.91	4 da NOEC[2]=0.95 4 da LOEC[3]=1.88	Bailey *et al.*, 1995
		3.99			7 da LC_{50}=2.50	per. comm. Tom Willingham
Chlorpyrifos	0.08, 0.13			0.10		per. comm. Robert Fujimura
	0.06				4 da NOEC=0.03, 0.05	Bailey *et al.*, 1995
Diazinon	0.51, 0.47			0.50		per. comm. Robert Fujimura
	0.47, 0.41				4 da NOEC=0.29, 0.33	Bailey *et al.*, in prep
		0.35				Amato *et al.* (1992)
					7 da LOEC<0.08	Hansen *et al.* (1994)
Malathion	1.4			1.4		Norberg-King *et al* (1991)
Oxamyl	103.65			103.65	4 da NOEC[7]=75.0	Issac and Phillips, 1994
Methomyl	5.56			5.56	4 da NOEC[7]=4.0	Issac and Phillips, 1994
Fonofos	0.27			0.27	4 da NOEC[7]=0.19	Issac and Phillips, 1994
Parathion (ethyl)	0.07			0.07	4 da NOEC[7]=0.04	Issac and Phillips, 1994
Carbaryl		11.6		11.6	7 da NOEC[6]=7.2 7 da LOEC[3]=10.6	Oris *et al* (1991)
Methyl Parathion		2.6	5.5		7 da NOEC[2]=1.0	Norberg-King *et al* (1991)
Carbofuran		2.4		2.4	7 da NOEC[2]=1.3 7 da LOEC[3]=2.6	Norberg-King *et al* (1991)

[1]Concentration causing 50 percent mortality in 96 hours. [2]Highest concentration not causing significant mortality in 7 days. [3]Lowest concentration causing significant mortality in 7 days. [6]Lowest concentration causing a significant decrease in reproduction. [7]Highest concentration not causing significant mortality in 4 days. [8]Value used to calculate pesticide or ammonia LC_{50} unit concentration.

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Table 14. Water samples collected in the study which tested toxic to *Ceriodaphnia* and contained toxic amounts of insecticide. Insecticide concentration is reported both in ppb and in *Ceriodaphnia* LC_{50} units (pesticide concentration/96 hr LC_{50} value). The number of LC_{50} units of ammonia in each toxic sample is also reported.

Date	Location	Survival (day^{-1})				Pesticides[1]	Pesticide[3] LC_{50} units	Ammonia LC_{50} unit
25 Feb 91	Orestimba	90	90	40	20	Parathion=0.24(3.4)	3.4	
14 Mar 91	TID[2] 3	0	0	0	0	Chlorpyrifos=0.12(1.2) Parathion=0.37(5.3)	6.5	
	Orestimba	0	0	0	0	Parathion=0.31(4.4)	4.4	
	Del Puerto	30	0	0	0	Parathion=0.13(1.9)	1.9	
	Ingram-Hospital	60	0	0	0	Parthion=0.12(1.7)	1.7	
	Spanish Grant	40	0	0	0	Parthion=0.09(1.3)	1.3	
19 Mar 91	TID 5	0	0	0	0	Chloropyrifos=0.05(0.5) NH_3=13.75(7.2)	0.5	7.2
	TID 3	0	0	0	0	Chloropyrifos=0.23(2.3)	2.3	
	Orestimba	60	0	0	0	Diazinon=0.3(0.6) Chlorpyrifos=0.05(0.5)	1.1	
	Del Puerto	40	0	0	0	Chlorpyrifos=0.12(1.2)	1.2	
	Ingram-Hospital	0	0	0	0	Chlorpyrifos=0.57(5.7)	5.7	
	Spanish-Grant	0	0	0	0	Chlorpyrifos=0.47(4.7) Parathion=0.04(0.6)	5.3	
4 Apr 91	TID 3	100	50	10	0	Chlorpyrifos=0.06(0.6) NH_3=2.25(1.2)	0.6	1.2
18 Apr 91	Orestimba	50	0	0	0	Chlorpyrifos=0.15(1.5)	1.5	
	Spanish Grant	100	90	80	60	Chlorpyrifos=0.11(1.1)	1.1	
18 May 91	Orestimba	0	0	0	0	Chloryprifos=0.12(1.2)	1.2	
	Ingram-Hospital	100	20	0	0	Carbaryl=8.4(0.7)	0.7	
	Spanish Grant	0	0	0	0	Chlorpyrifos=0.22(2.2)	2.2	
28 May 91	TID 6	100	50	0	0	Chlorpyrifos=0.15(1.5)	1.5	
	Del Puerto	0	0	0	0	Diazinon=0.42(0.8) Parathion=0.72(10.3)	11.1	
	Ingram-Hospital	0	0	0	0	Parathion=0.91(9.1)	9.1	
	Spanish-Grant	0	0	0	0	Chlorpyrifos=0.21(2.1) Fonofos=0.20(0.7)	2.8	
12 Jun 91	Spanish Grant	100	100	70	10	Chlorpyrifos=0.08(0.8)	0.8	
30 Jul 91	Orestimba	0	0	0	0	Chlorpyrifos=0.72(7.2)	7.2	
6 Sept 91	Ingram-Hospital	0	0	0	0	Chlorpyrifos=0.33(3.3)	3.3	

[1]ug/l(LC_{50} units) [2]Turlock Irrigation District. [3]Sum of all pesticide LC_{50} units greater than half a unit.

Table 14. (Continued).

Date	Location	Survival (day^{-1})							Pesticides[1]	Pesticide[3] LC_{50} unit	Ammonia LC_{50} unit
24 Oct 91	Ingram-Hospital	0	0	0	0				Methomyl=3.2(0.6)	0.6	
4 Dec 91	Ingram-Hospital	0	0	0	0				Methomyl=2.6(0.5) Diazinon=0.31(0.6) Fonofos=0.28(1.0)	2.1	
18 Dec 91	Del Puerto	0	0	0	0				Parathion=2.1(30)	30.0	
23 Dec 91	Del Puerto	40	40	0	0				Parathion=0.24(3.4)	3.4	
	Ingram-Hospital	100	100	0	0				Parathion=0.16(2.3)	2.3	
5 Jan 92	TID 3	20	0	0	0				Parathion=0.1(1.4)	1.4	
	Del Puerto	0	0	0	0				Parathion=0.51(7.3)	7.3	
	Ingram-Hospital	0	0	0	0				Parathion=0.12(1.7) Methomyl=5.4(0.6)	2.3	
	Spanish Grant	0	0	0	0				Parathion=0.29(4.1)	4.1	
13 Jan 92	TID 6	0	0	0	0				NH_3=1.66(0.9) Chlorpyrifos=0.24(2.4) Parathion=0.05(0.7)	3.1	0.9
	Del Puerto	0	0	0	0				Parathion=0.46(6.6)	6.6	
3 Feb 92	TID 6	100	30	0	0				Chloryprifos=0.05(0.5)	0.5	
	TID 5	100	20	0	0				Diazinon=0.26(0.5) NH_3=2.66(1.4)	0.5	1.4
	Del Puerto	0	0	0	0				NH_3=3.99(2.1) Diazinon=2.6(5.0) Parathion=0.22(3.1)	8.1	2.1
10 Feb 92	TID 6	0	0	0	0				Chlorpyrifos=0.1291.2) Diazinon=0.91(1.8) NH_3=10.64(5.6)	3.0	5.6
	TID 5	0	0	0	0				Diazinon=0.29(0.6) NH_3=9.31(4.9)	0.6	4.9
	TID 3	0	0	0	0				Chlorpyrifos=0.73(7.3) Diazinon=2.6(5.2)	12.5	
	Orestimba	60	0	0	0				Diazinon=0.26(0.5)	0.5	
	Del Puerto	0	0	0	0				Diazinon=1.3(2.6) Parathion=0.07(1.0)	3.6	
	Ingram-Hospital	80	0	0	0				Diazinon=0.24(0.5)	0.5	
	Spanish Grant	100	90	30	10				Chlorpyrifos=0.08(0.8) Parathion=0.12(1.7)	2.5	
17 Feb 92	SJR Airport Way	20	0	0	0	0	0	0	Diazinon=0.28(0.6)	0.6	
	Merced R.	30	0	0	0	0	0	0	Chlorpyrifos=0.05(0.5) Diazinon=0.32(0.6)	1.1	
	Tuolumne R.	100	100	100	50	10	0	0	Diazinon=0.35(0.7)	0.7	
	TID 6	0	0	0	0				Diazinon=0.35(0.7)	0.7	
	TID 5	0	0	0	0				Chlorpyrifos=0.08(0.8) Diazinon=0.5(1.0)	1.8	

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Table 14. (Continued).

Date	Location	Survival (day^{-1})	Pesticides[1]	Pesticide LC_{50} units	Ammonia LC_{50} units
17 Feb 92	TID 3	0 0 0 0	Chlorpyrifos=0.83(1.6) Diazinon=0.82(1.6)	3.3	
	Orestimba	20 0 0 0	Parathion=0.04(0.6) Diazinon=0.38(0.8)	1.4	
24 Feb 92	TID 5	0 0 0 0	Diazinon=0.45(0.9) NH_3=2.66(1.4)	0.9	1.4
2 Mar 92	TID 3	80 0 0 0	Diazinon=0.33(0.7)	0.7	
9 Mar 92	TID 5	0 0 0 0	Chlorpyrifos=0.08(0.8)	0.8	
	TID 3	0 0 0 0	Diazinon=0.27(0.5) Chlorpyrifos=0.12(1.2)	1.7	
16 Mar 92	Salt Sl	30 0 0 0	Diazinon=0.33(0.7)	0.7	
	SJR Hills Ferry	100 100 100 20	Diazinon=0.38(0.8)	0.8	
	Ingram Hospital	90 10 0 0	Chlorpyrifos=0.06(0.6)	0.6	
24 Mar 92	Orestimba	0 0 0 0	Chlorpyrifos=0.29(2.9)	2.9	
	Del Puerto	0 0 0 0	Fonofos=0.54(2.0)	2.0	
	Ingram-Hospital	0 0 0 0	Parathion=0.04(0.6) Chlorpyrifos=0.05(0.5) Diazinon=0.29(0.6)	1.7	
	Spanish Grant	0 0 0 0	Chlorpyrifos=0.06(0.6) Parathion=0.11(1.1)	1.7	
6 Apr 92	TID 6	40 0 0 0	Chlorpyrifos=0.14(1.4) NH_3=19.5(10.2)	1.4	
	Del Puerto	100 100 70 10	Fonofos=0.52(1.9)	1.9	
13 Apr 92	Salt Slough	100 90 90 90 90 90 0	Chlorpyrifos=0.12(1.2)	1.2	
	Merced R.	100 100 100 100 100 100 0	Chlorpyrifos=0.13(1.3)	1.3	
20 Apr 92	Orestimba	100 100 90 70	Fonofos=0.21(0.8)	0.8	
27 Apr 92	Orestimba	100 10 0 0	Chlorpyrifos=0.09(0.9)	0.9	
	Spanish Grant	0 0 0 0	Chlorpyrifos=0.19(1.9)	1.9	
4 May 92	Orestimba	0 0 0 0	Chlorpyrifos=0.08(0.8)	0.8	
	Spanish Grant	0 0 0 0	Chlorpyrifos=0.07(0.7)	0.7	
11 May 92	TID 6	100 70 50 50	Chlorpyrifos=0.07(0.7)	0.7	
	Spanish Grant	0 0 0 0	Diazinon=1.2(2.4)	2.4	

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Table 14. (Continued).

Date	Location	Survival (day^{-1})				Pesticides[1]	Pesticide[3] LC_{50} units	Ammonia LC_{50} units
18 May 92	Spanish Grant	100	70	0	0	Chlorpyrifos=0.05(0.5)	0.5	
25 May 92	Orestimba	0	0	0	0	Diazinon=0.88(1.8)	1.8	
	Ingram-Hospital	0	0	0	0	Diazinon=1.8(3.6)	3.6	
1 Jun 92	TID 6	0	0	0	0	Chlorpyrifos=0.25(2.5)	2.5	

[1]ug/l(LC_{50} units) [2]Turlock Irrigation District. [3]Sum of all pesticide LC_{50} units greater than half a unit.

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Table 15. Pesticide concentrations in water samples testing non toxic to *Ceriodaphnia*. Samples were only submitted for organophosphate pesticide analysis unless noted otherwise. Also included is the sum of the pesticide 96 hour LC_{50} units (pesticide concentration/LC_{50} concentration) for all instances when insecticide concentration was above half a unit. Only one such value was noted (San Joaquin River at Laird Park on 4-23-91). Blanks indicate no pesticide detection.

			Insecticide (ppb)					
Date	(days)	Location	Diazinon	Malathion	Parathion	Chlorpyrifos	Fonofos	sum of LC_{50} units
5-18-91	4	SJR[1] @ Laird Park	0.01			0.01	0.01	
5-18-91	4	SJR @ Airport Way	0.01			0.01		
5-28-91	4	SJR @ Laird Park	0.06		0.03	0.02	0.02	
6-12-91	4	SJR @ Airport Way[2]	0.01					
9-6-91	4	SJR @ Laird Park	0.01					
9-26-91	4	Del Puerto Ck	0.01					
9-26-91	4	SJR @ Laird Park	0.01					
10-9-91	4	Stanislaus River						
10-24-91	4	SJR @ Laird Park	0.01					
10-30-91	4	SJR @ Laird Park	0.01					
11-13-91	4	SJR @ Laird Park	0.01					
12-18-91	4	SJR @ Laird Park			0.01			
12-23-91	4	SJR @ Laird Park			0.01			
1-5-92	7	SJR @ Laird Park	0.02	0.02				
1-13-92	7	SJR @ Laird Park	0.01					
2-3-92	7	SJR @ Laird Park	0.06			0.01		
2-10-92	7	SJR @ Laird Park	0.07					
2-17-92	7	Stanislaus R.	0.06					
2-24-92	7	SJR @ Laird Park	0.08			0.01		
2-24-92	4	TID 6	0.02			0.01		
3-16-92	7	SJR @ Laird Park	0.07	0.08		0.01		
3-24-92	7	SJR @ Laird Park	0.14	0.01		0.01		
3-30-92	7	SJR @ Laird Park	0.03			0.01		
4-13-92	7	SJR @ Laird Park	0.02			0.02		
4-20-92	7	SJR @ Laird Park	0.02			0.03		
4-27-92	7	Salt Slough	0.17					
4-27-92	7	SJR @ Hills Ferry	0.07			0.01		
4-27-92	7	SJR @ Laird Park	0.03			0.02		
4-27-92	7	SJR @ Airport Way				0.01		
4-27-92	7	Merced River					0.01	

San Joaquin River 2/ Isofenfos = 0.074 3/ Turlock Irrigation District

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Table 15. (Continued)

Date	(days)	Location	Diazinon	Malathion	Parathion	Chlorpyrifos	Fonofos	sum of LC_{50} units
			Insecticide (ppb)					
4-27-92	7	Tuolumne River				0.01		
4-27-92	4	TID 6				0.01		
4-27-92	4	TID 5	0.01			0.02		
4-27-92	4	TID 3						
4-27-92	4	Del Puerto Ck	0.02			0.03		
4-27-92	4	Ingram Hospital Cks	0.02			0.01		
5-4-92	7	Salt Slough	0.06					
5-4-92	7	SJR @ Hills Ferry	0.06					
5-4-92	7	SJR @ Laird Park	0.02			0.02		
5-4-92	7	SJR @ Airport Way				0.01		
5-4-92	7	Merced River				0.01		
5-4-92	7	Tuolumne River				0.01		
5-4-92	4	TID 6				0.01		
5-4-92	4	TID 5	0.01			0.01		
5-4-92	4	TID 3						
5-11-92	7	Salt Slough	0.02			0.02		
5-11-92	7	SJR @ Hills Ferry	0.02			0.02		
5-11-92	7	SJR @ Laird Park[4]				0.02		
5-11-92	7	SJR @ Airport Way						
5-11-92	7	Merced River						
5-11-92	7	Tuolumne River				0.01		
5-11-92	4	TID 5	0.01			0.05		
5-11-92	4	TID 3	0.01			0.01		
5-18-92	7	Salt Slough	0.03					
5-18-92	7	SJR @ Hills Ferry	0.02					
5-18-92	7	SJR @ Laird Park	0.04			0.01		
5-18-92	7	SJR @ Airport Way	0.05					
5-18-92	7	Merced River	0.01			0.01		
5-18-92	7	Tuolumne River	0.02					
5-18-92	7	Stanislaus River						
5-18-92	4	TID 6						
5-18-92	4	TID 3				0.01		
5-18-92	4	Orestimba Ck	0.07			0.01		

1/ San Joaquin River 2/ Isofenfos = 0.074 3/ Turlock Irrigation District 4 disyston=0.06

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Table 15. (Continued)

Date	(days)	Location	Insecticide (ppb)					sum of
			Diazinon	Malathion	Parathion	Chlorpyrifos	Fonofos	LC_{50} units
5-18-92	4	Del Puerto Ck	0.01			0.01		
5-25-92	7	Salt Slough	0.04					
5-25-92	7	SJR @ Hills Ferry	0.03					
5-25-92	7	SJR @ Laird Park	0.02					
5-25-92	7	SJR @ Airport Way	0.06					
5-25-92	7	Tuolumne River	0.03			0.01		
5-25-92	7	Merced River						
5-25-92	4	TID 3						
5-25-92	4	TID 5				0.01		
5-25-92	4	Spanish Grant	0.07			0.03	0.02	
6-1-92	7	Salt Slough	0.02					
6-1-92	7	SJR @ Hills Ferry	0.02					
6-1-92	7	SJR @ Laird Park	0.02			0.01		
6-1-92	7	SJR @ Airport Way	0.01					
6-1-92	7	Merced River						
6-1-92	7	Stanislaus River						
6-1-92	7	Tuolumne River	0.01					
6-1-92	4	TID 5				0.01		
6-1-92	4	Orestimba Ck	0.02				0.02	
6-1-92	4	Del Puerto Ck	0.02			0.02	0.01	
6-1-92	4	Ingram-Hospital Cks	0.07					
6-15-92	7	Salt Slough						
6-15-92	7	JR @ Hills Ferry Rd						
6-15-92	7	SJR @ Airport Way						
6-15-92	7	Merced River						
6-15-92	7	Stanislaus River						
6-15-92	4	TID 6						
6-15-92	7	SJR @ Laird Park				0.01		
6-15-92	7	Tuolumne River				0.01		
6-15-92	4	Orestimba				0.01		
6-15-92	4	Del Puerto	0.01			0.01	0.03	
6-15-92	4	Ingram-Hospital	0.01			0.01		
6-15-92	4	Spanish Grant	0.01			0.01		
6-22-92	7	Salt Slough	0.01					

Table 15. (Continued)

Date	(days)	Location	Insecticide (ppb) Diazinon	Malathion	Parathion	Chlorpyrifos	Fonofos	sum of LC_{50} units
6-22-92	7	SJR @ Hills Ferry	0.01					
6-22-92	7	SJR @ Laird Park	0.02			0.01		
6-22-92	7	SJR @ Airport Way						
6-22-92	4	TID 6				0.01		
6-22-92	4	TID 5				0.01		
6-22-92	4	Del Puerto Ck	0.02			0.04		
6-22-92	4	Ingram-Hospital	0.01			0.01		
--Lagrangian cooperative study with the California Department of Pesticide Regulation--								
4-23-91	4	Salt Slough	0.02					
4-23-91	4	Mud Slough	0.02			0.01		
4-23-91	4	SJR @ HWY 165	0.05					
4-23-91	4	Los Banos	0.01			0.01		
4-23-91	4	SJR @ Fremont Ford	0.21	0.01		0.01		
4-23-91	4	Newman Wasteway	0.01		0.01	0.01	0.01	
4-23-91	4	Merced River				0.01		
4-23-91	4	SJR @ Hills Ferry	0.09					
4-23-91	4	Orestimba Ck				0.01		
4-23-91	4	SJR @ Laird Park	0.06			0.07(0.7)		0.7
4-23-91	4	Tuolumne River						
4-23-91	4	Del Puerto Ck	0.05			0.04		
4-23-91	4	Stanislaus River	0.01			0.01		
4-23-91	4	Ingram-Hospital Ck	0.04		0.02	0.03		
4-23-91	4	SJR @ Maze Blvd	0.02			0.02		
4-23-91	4	SJR @ Airport Way						

Table 16. Water samples which tested toxic in biossays but did not appear to contain sufficient toxic material to explain the observed bioassay results. See text for selection criteria.

Date	Location	Survival (day^{-1})							Contaminants[1] (ppb)
18 April 91	Stanislaus R.	100	90	50	50				
18 May 91	Ingram-Hospital	0	0	0	0				Chloropyrifos=0.01 Fonofos=0.06 Diazinon=0.03 Carbaryl=8.4(0.7)
12 June 91	SJR @ Hills Ferry	0	0	0	0				Chlorpyrifos=0.01 Diazinon=0.01
9 Oct 91	Merced R.	90	80	80	70				
24 Oct 91	Ingram-Hospital	0	0	0	0				Methomyl=3.2(0.6) Fonofos=0.05 Diazinon=0.19
10 Feb 92	Orestimba	60	0	0	0				Chloropyrifos=0.02 Parathion=0.01 Diazinon=0.26(0.5)
10 Feb 92	Ingram-Hospital	80	0	0	0				Chlorpyrifos=0.01 Fonofos=0.02 Diazinon=0.24(0.5) Parathion=0.02
17 Feb 92	SJR @ Airport	20	0	0	0				Chlorpyrifos=0.02 Parathion=0.01 Diazinon=0.28(0.6)
17 Feb 92	TID 6	0	0	0	0				Chlorpyrifos=0.04 Malathion=0.01 Diazinon=0.35(0.7) Parathion=0.01
17 Feb 92	Spanish Grant	40	0	0	0				Diazinon=0.06 Parathion=0.01
24 Feb 92	TID 3	0	0	0	0				Chlorpyrifos=0.03 Diazinon=0.23
24 Feb 92	Ingram-Hospital	100	0	0	0				Chlorpyrifos=0.01 Parathion=0.01 Diazinon=0.2
2 Mar 92	TID 3	80	0	0	0				Chlorpyrifos=0.04 Diazinon=0.33(0.7)
9 Mar 92	SJR @ Laird Park	100	90	90	40	0	0	0	Chlorpyrifos=0.04 Diazinon=0.04
9 Mar 92	SJR @ Airport Way	100	100	100	90	40	0	0	Chlorpyrifos=0.03 Diazinon=0.04
9 Mar 92	Merced R.	100	100	100	100	100	80	40	Chlorpyrifos=0.01 Parathion=0.01 Diazinon=0.04
9 Mar 92	TID 5	0	0	0	0				Chlorpyrifos=0.08(0.8) Diazinon=0.08

[1]Value in brackets is the number of pesticide LC_{50} units.

Table 16. (Continued).

Date	Location	Survival (day^{-1})							Contaminants[1] (ppb)
9 Mar 92	Ingram-Hospital	0	0	0	0				Chlorpyrifos=0.01 Fonofos=0.01 Diazinon=0.06
16 Mar 92	Salt Slough	30	0	0	0				Chlorpyrifos=0.01 Malathion=0.16 Diazinon=0.33(0.7)
16 Mar 92	TID 3	100	100	0	0				Chlorpyrifos=0.04 Diazinon=0.18
23 Mar 92	TID 3	90	0	0	0				
13 Apr 92	Spanish Grant	100	100	80	40				Diazinon=0.03
20 Apr 92	Spanish Grant	50	0	0	0				
4 May 92	Stanislaus R.	100	90	80	80	60	60	60	
4 May 92	Orestimba	0	0	0	0				Chlorpyrifos=0.08(0.8) Fonofos=0.03
4 May 92	Del Puerto	100	100	0	0				Chlorpyrifos=0.02 Diazinon=0.01
4 May 92	Ingram-Hospital	0	0	0	0				Carbaryl=2.0 Chlorpyrifos=0.02 Diazinon=0.01
4 May 92	Spanish Grant	0	0	0	0				Chlorpyrifos=0.07(0.7) Fonofos=0.07 Diazinon=0.01
11 May 92	Orestimba	70	0	0	0				Ethion=0.01 Diazinon=0.18 Chlorpyrifos=0.02 Fonofos=0.02
11 May 92	Del Puerto	100	100	20	0				Chlorpyrifos=0.02 Fonofos=0.03
11 May 92	Ingram-Hospital	0	0	0	0				Carbaryl=2.8 Chlorpyrifos=0.01 Diazinon=0.06
18 May 92	Ingram-Hospital	0	0	0	0				Chlorpyrifos=0.01 Diazinon=0.05 Carbaryl=0.6
25 May 92	Stanislaus R.	100	100	100	100	100	100	70	
25 May 92	Del Puerto	100	100	30	0				Chlorpyrifos=0.01 Diazinon=0.2
22 June 92	Merced R.	100	100	100	80	80	60	50	
22 June 92	Tuolumne R.	100	100	90	70	70	50	40	Diazinon=0.01
22 June 92	TID 3	100	100	100	0				NH_3=1.2
22 June 92	Orestimba	100	0	0	0				Chlorpyrifos=0.02 Fonofos=0.01 Diazinon=0.03
22 June 92	Spanish Grant	0	0	0	0				Chlorpyrifos=0.01 Fonofos=0.01 Diazinon=0.22 Ethion=0.05(?) Diazinon=0.01

[1]Value in brackets is the number of pesticide LC_{50} units.

Table 17. Water samples collected in the study which tested toxic to *Ceriodaphnia* and contained toxic amounts of un-ionized ammonia. Ammonia is reported in terms of *Ceriodaphnia* LC_{50} units. The number of LC_{50} units of insecticide in each sample is also reported.

Date	Location	Survival (day^{-1})				Ammonia (LC_{50} units)	Pesticide (LC_{50} units)
4 Mar 91	TID 5	0	0	0	0	1.9	
19 Mar 91	TID 5	0	0	0	0	7.2	0.5
4 Apr 91	TID 5	80	10	10	10	1.4	
4 Apr 91	TID 3	100	50	10	0	1.2	0.6
25 Nov 91	TID 6	50	0	0	0	1.0	
18 Dec 91	TID 5	30	20	0	0	1.6	
5 Jan 92	TID 5	80	60	40	40	7.2	
13 Jan 92	TID 6	0	0	0	0	0.9	
13 Jan 92	TID 5	100	90	30	0	2.8	
3 Feb 92	TID 5	100	20	0	0	1.4	0.5
3 Feb 92	Del Puerto	0	0	0	0	2.1	4.4
10 Feb 92	TID 6	0	0	0	0	5.6	3.0
10 Feb 92	TID 5	0	0	0	0	4.9	0.6
24 Feb 92	TID 5	0	0	0	0	1.4	0.9

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Table 18. Water samples collected in the study which contained toxic concentrations of un-ionized ammonia but did not test toxic in bioassays. Ammonia concentrations are reported in terms of *Ceriodaphnia* LC_{50} units.

Date	Location	Ammonia (LC_{50} units)
6 Sept 91	TID 5	0.6
9 Oct 91	TID 5	0.9[1]
13 Nov 91	TID 5	0.9[2]
25 Nov 91	TID 5	0.7
11 Dec 91	TID 5	0.6
23 Dec 91	TID 5	0.6
2 Mar 92	TID 6	1.2[3]

[1]Total ammonia in both duplicate samples was 6.0 mg/l.
[2]Total ammonia in both duplicate samples was 7.0 mg/l.
[3]Total ammonia in both duplicate samples was 8.0 mg/l.

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Table 19. Pesticide and ammonia concentration in water samples collected from the San Joaquin River at Laird Park. All samples were analyzed for carbamate and organophosphorus pesticides and for ammonia. Samples tested non toxic in bioassays unless noted otherwise. No carbamate insecticides were detected.

	Insecticides (ppb)					
Date	Diazinon	Chlorpyrifos	Parathion	Fonofos	Malathion	Ammonia
4-24-91[1]	0.06	0.07				
5-15-91[2]	0.01	0.01		0.01		
5-28-91	0.06	0.02	0.03	0.02		
6-12-91[3,4]						
9-6-91	0.01					
9-26-91	0.01					
10-24-91	0.01					
10-30-91	0.01					
11-13-91	0.01					
12-18-91			0.01			
12-23-91			0.01			
1-15-92	0.02		0.02			
1-13-92	0.01					
1-20-92	0.01	0.01				0.53
1-28-92[1]	0.04	0.02				
2-3-92	0.06	0.01				
2-10-92	0.07					
2-19-92	0.10	0.02	0.01			
2-24-92	0.08	0.01				
3-9-92[3]	0.04	0.04				
3-16-92	0.07	0.01			0.08	
3-23-92	0.14	0.01			0.01	
3-30-92	0.03	0.01				
4-6-92[3]	0.02			0.01		
4-13-92	0.02	0.02				
4-20-92	0.02	0.03				
4-27-92	0.03	0.02				
5-4-92	0.02	0.02				
5-11-92[6]		0.02				
5-18-92	0.04	0.01				
5-25-92	0.02					
6-1-92	0.02	0.01				
6-15-92		0.01				
6-22-92	0.02	0.01				

[1]Lagrangian Survey. [2]Extraction not done for two months, chemical concentrations may be low. [3]Sample tested toxic to <u>Ceriodaphnia</u>. Chemical cause of toxicity not known. [4]Carbamate bottle broken, organophosphates=nd. [5]Organophosphate bottle broken, carbamates=nd. [6]Disyston = 0.06 ppb.

Table 20. Mean baseline pesticide concentrations (ppb) between 27 April and 22 June, 1992, in water bodies tributary to the San Joaquin River[1]. Values with the same letter are not statistically different (P>0.05, Kruskall-Wallis and Dunn mean separation test).

Site	Diazinon	Chlorpyrifos	Fonofos
Merced	2/ (7) a	0.006 a	2/ a
Tuolumne	0.011 (8) c	0.008 b	2/ a
Stanislaus	2/ (7) a	0.006 a	2/ a
TID 6	2/ (7) a	0.058 c d	2/ a
TID 5	0.008 (8) b	0.015 c	2/ a
TID 3	0.011 (6) b c	0.008 b	2/ a
Orestimba	0.150 (8) d	0.034 c	0.020 b
Del Puerto	0.064 (8) d	0.020 c	0.011 b
Ingram-Hospital	0.254 (8) d	0.011 c	2/ a
Spanish Grant	0.179 (8) d	0.071 d	0.030 b
Salt Slough	0.044 (8) d	2/ a	2/ a

[1]Non-detections were assigned, for computational purposes, a value of one half the reporting limit (0.005). [2]Site with no pesticide detection. [3]Mean (sample size).

Table 21. Comparisons of the precent frequency of toxicity of water samples collected in the San Joaquin River watershed during 1988-90 and 1991-92. The 1988-90 data are from Foe and Connor (1991) while the 1991-92 values are from the present study.

	Percent frequency of toxicity		
Site	1988-90	1991-92	
Salt Slough	8.3	10.0	
SJR[1] @ Hills Ferry	25.0	4.3	NS[3]
SJR @ Laird Park	41.7	4.3	P<0.05
SJR @ Airport Way	8.3	4.2	
TID[2] 5	75.0	26.8	P<0.05
Orestimba Ck	41.6	44.7	
Merced R.	16.7	15.0	
Tuolumne R.	8.3	5.0	
Stanislaus R.	0.0	10.8	NS

[1]San Joaquin River
[2]Turlock Irrigation District
[3]Chi-sqaure test

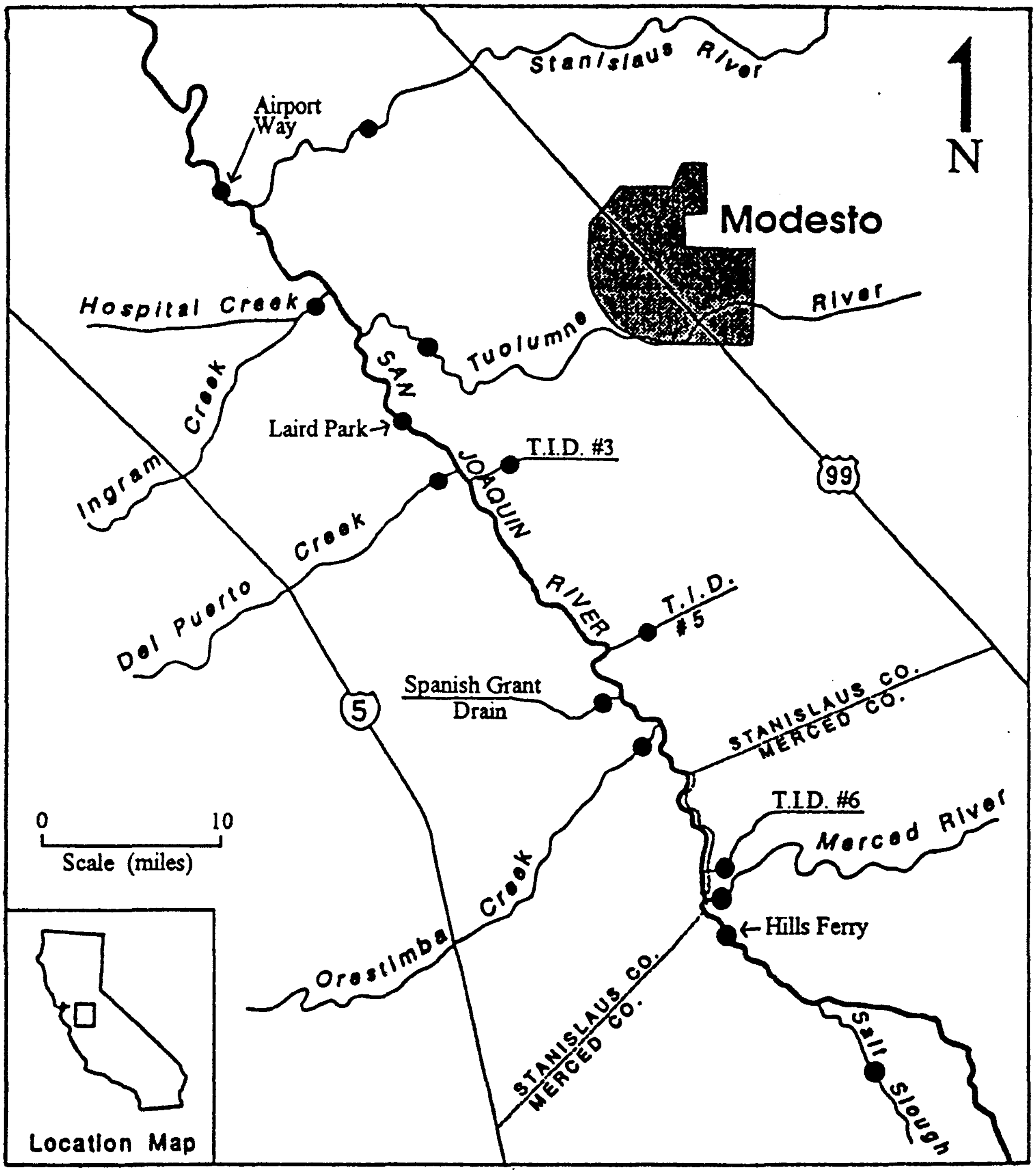

Figure 1. Map of San Joaquin Basin study sites.

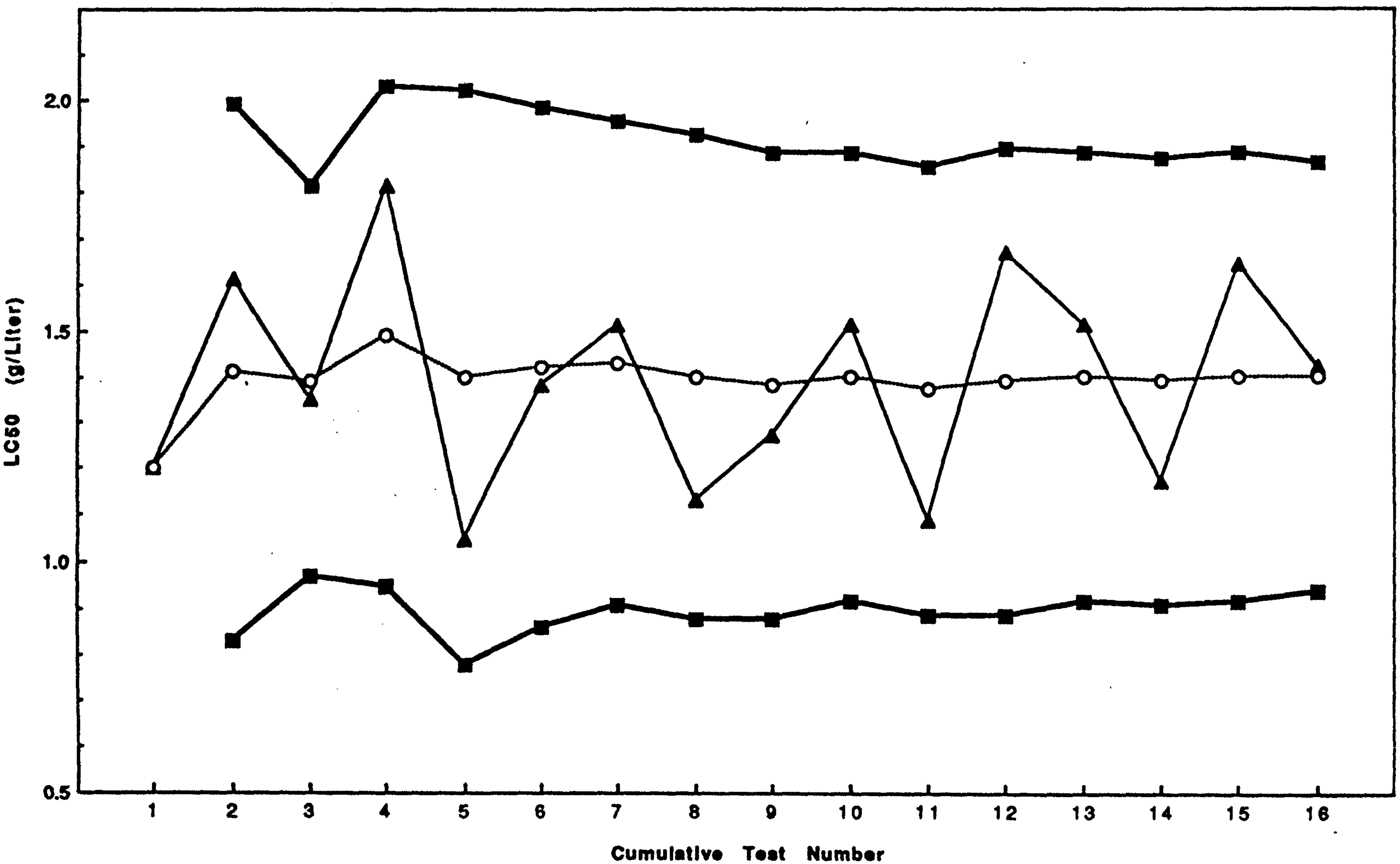

Figure 2. Control chart for the 96 hour *Ceriodaphnia* sodium chloride reference toxicant testing. Individual monthly LC_{50} values are plotted as triangles, the long-term LC_{50} mean as open circles, and the upper and lower 95 percent confidence limits of the long-term mean as solid squares. No individual LC_{50}value ever exceeded either the upper or lower control value.

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APPENDIX A

ESTIMATED UNIMPAIRED FLOWS FOR SAN JOAQUIN BASIN

Table 1. Comparison of seasonal and annual unimpaired flows (acre-feet) for the San Joaquin River for water years 1983[1]-1985 and 1991-92. Data is from the San Joaquin River input-output model described in Kratzer *et al.* (1987). 1983 was classified as wet, 1984 as normal, 1985 as dry, and both 1991-92 as critically dry water year types.

Irrigation Season (March-September)					
	1983[2]	1984	1985	1991	1992
East-side tribs	10,032,810(94.9)	1,060,020(64.6)	685,286(57.5)	264,957(51)	280,670(49.3)
Salt Slough	164,971(1.6)	108,798(6.6)	124,007(10.4)	58,176(11.2)	45,393(8.0)
Mud Slough	31,420(0.3)	23,524(1.4)	50,856(4.3)	10,409(2.0)	8,361(1.5)
Groundwater	68,220(0.6)	81,408(5.0)	42,021(3.5)	18,139(3.5)	46,066(8.1)
Surface return flows[3]	266,959(2.5)	358,907(21.9)	281,207(23.6)	162,237(31)	181,299(31.8)
Subsurface return flows	8,152(0.1)	9,308(0.6)	7,561(0.6)	5,983(1.2)	7,532(1.3)
Total for Basin	10,572,590(100)	1,641,965(100)	1,190,938(100)	519,901(100)	569,321(100)

Non-irrigation season (September-March)					
	1983	1984	1985	1991	1992
East-side Tributaries	4,597,785(95.8)	4,584,949(95.3)	984,716(86.6)	158,421(75.5)	253,346(74.2)
Salt Slough	61,923(1.3)	52,332(1.1)	34,588(3.0)	28,426(13.5)	29,359(8.6)
Mud Slough	87,640(1.8)	70,195(1.5)	45,107(4.0)	922(0.9)	7,989(2.3)
Groundwater	12,720(0.3)	34,214(0.7)	27,122(2.4)	6,202(3.0)	30,690(9.0)
Surface return flows	37,294(0.8)	64,659(1.3)	43,053(3.8)	13,144(6.3)	17,337(5.1)
Subsurface return flows	2,052(0.0)	2,826(0.)	2,843(0)	1,823(0.9)	2,811(0.8)
Total for Basin	4,799,414(100)	4,809,176(100)	1,137,430(100)	209,938(100)	341,533(100)

[1]The 1987 water year is defined as the time interval from 1 October 1987 to 30 September 1988
[2]Flow in acre-feet water(%)
[3]Surface return flows from agriculturally dominated natural creeks and constructed drains.

Table 1. (Continued)

	Full year				
	1983	1984	1985	1991	1992
East-side Tributaries	14,630,650(95.2)	5,644,969(87.5)	1,670,002(71.7)	423,378(58)	534,016(58.6)
Salt Slough	226,894(1.5)	161,130(2.5)	158,596(6.8)	86,602(11.9)	74,752(8.2)
Mud Slough	119,060(0.8)	93,719(1.5)	95,964(4.1)	12,331(1.7)	16,350(1.8)
Groundwater	80,940(0.5)	115,622(1.8)	69,143(3.0)	24,341(3.3)	76,756(8.4)
Surface return flows	304,253(2.0)	423,566(6.6)	324,259(13.9)	175,381(24.0)	198,635(21.8)
Subsurface return flows	10,203(0.1)	12,135(0.2)	10,405(0.4)	7,806(1.1)	10,343(1.1)
Total for Basin	15,372,000(100)	6,451,140(100)	2,328,368(100)	729,839(100)	910,853(100)

[1]The 1987 water year is defined as the time interval from 1 October 1987 to 30 September 1988
[2]Flow in acre-feet water(%)
[3]Surface return flows from agriculturally dominated natural creeks and man constructed drains.

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APPENDIX B

BIOASSAY WATER QUALITY DATA

Table 1. Bioassay water quality measurement

Date: 25 February 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Sl	7.9	8.1	2580/2000	2020	7.2	7.0	<2.0	27
SJR[6] @ Laird Park	8.0	8.3	2160/1876	1925	7.6	7.0	<2.0	17
SJR @ Airport Way	8.1	8.3	1136	1180	8.1	6.0	<2.0	
Merced R	7.8	8.2	374	420	7.7	7.2	<2.0	
Tuolumne R	7.9	8.2	300	337	7.6	7.0	<2.0	
Stanislaus R.	7.9	8.1	157	181	8.2	7.0	<2.0	
TID[7] 6	8.2	8.3	1251	1271	9.6	7.1	<2.0	
TID 5	8.7	8.7	2050	2100	8.8	7.4	<2.0	
TID 5 - chemical duplicate	8.7	8.7	2060	2110	8.8	7.0	<2.0	
TID 3	8.0	8.6	1046	1080	7.9	7.9	<2.0	
Orestimba Ck	8.4	8.6	1366	1360	8.3	7.2	<2.0	
Del Puerto Ck	used for water chemistry duplicate							
Ingram-Hospital Cks	8.6	8.6	2050	2070	8.8	7.0	<2.0	
Spanish Grant Combined Drain	8.4	8.4	2160/1925	1930	8.2	6.8	<2.0	17
Laboratory control	8.4	8.3	217	239	8.6	7.2	<2.0	
Dilution control								

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 4 March 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.1	8.6	2010	1996	8.8	8.2	<2.0	
SJR @ Laird Park	8.0	8.4	1427	1454	8.8	7.9	<2.0	
SJR @ Airport Way	8.0	8.3	1082	1090	8.4	8.2	<2.0	
SJR @ Airport Way - chemical duplicate	8.2	8.7	1076	1089	8.4	7.8	<2.0	
Merced R.	7.6	8.0	120	133	8.6	8.0	<2.0	
Tuolumne R.	7.8	8.3	262	269	8.5	8.0	<2.0	
Stanislaus R.	used for water chemistry duplicate							
TID[7] 6	7.9	8.3	167	184	8.8	8.1	<2.0	
TID 5	8.1	8.7	1740	1702	6.8	7.4	15.0	
TID 3	7.8	8.2	387	402	7.4	7.6	2.5	
Orestimba Ck	8.1	8.2	799	803	8.6	8.1	<2.0	
Del Puerto Ck	8.4	8.5	909	938	8.8	7.8	3.5	
Ingram-Hospital Cks	8.2	8.4	1309	1298	8.8	8.1	<2.0	
Spanish Grant Combined Drain	7.9	8.2	795	827	9.0	8.0	<2.0	
Laboratory control	7.4	8.2	167	227	8.6	8.0	<2.0	
Dilution control								

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 19 March 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.2	8.5	2110	2180	8.3	7.2	<2.0	
SJR @ Laird Park	8.2	8.5	1559	1629	8.1	7.4	<2.0	
SJR @ Airport Way	8.2	8.5	1265	1284	8.0	7.4	<2.0	
Merced R.	7.9	8.1	139	151	8.0	7.4	<2.0	
Tuolumne R.	8.1	8.2	260	276	8.0	7.4	<2.0	
Stanislaus R.	8.1	8.0	131	153	8.0	7.2	<2.0	
TID[7] 6	used for water chemistry duplicate							
TID 5	8.1	8.7	1630	1552	6.2	7.5	58.0	
TID 3	8.4	8.4	591	620	6.8	7.8	<2.0	
Orestimba Ck	8.3	8.3	904	944	8.0		<2.0	
Orestimba Ck - chemistry duplicate	8.2	8.2	910	918	8.4		<2.0	
Del Puerto Ck	8.7	8.7	978	982	8.4		<2.0	
Ingram-Hospital Cks	8.5	8.7	1875	1962	8.4	7.8	<2.0	
Spanish Grant Combined Drain	8.3	8.6	1916	1947	7.8	7.9	<2.0	
Laboratory control	7.9	8.0	197	247	8.2	7.4	<2.0	
Dilution control								

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 4 April 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.2	8.4	2300/2060	2070	9.8	8.1	<2.0	14
SJR @ Hills Ferry - chemistry duplicate	8.5	8.8	2440/2080	2030	9.8	8.0	<2.0	21
SJR @ Laird Park	8.0	8.6	1615	1608	9.4	8.0	<2.0	
SJR @ Airport Way	8.0	8.5	1274	1260	9.4	8.0	<2.0	
Merced R.	7.7	8.1	169	217	9.6	8.1	<2.0	
Tuolumne R.	7.9	8.1	277	288	9.4	8.0	<2.0	
Stanislaus R.	7.9	8.2	180	194	9.8	8.1	<2.0	
TID[7] 6	8.4	8.7	1069	1043	8.9	8.1	<2.0	
TID 5	7.9	8.7	1032	1035	8.9	7.8	11.4	
TID 3	8.0	8.9	1136	1072	8.5	7.9	7.0	
Orestimba Ck	No flow							
Del Puerto Ck	8.0	8.9	1505	1458	8.7	8.2	<2.0	
Ingram-Hospital Cks	8.2	8.7	1994	1934	9.7	8.2	<2.0	
Spanish Grant Combined Drain	used for water chemistry duplicate							
Laboratory control	7.9	8.5	267	266	8.6	7.6	<2.0	
Dilution control	8.1	8.4	187	196	8.6	8.3	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{(\text{volume dilution water + volume sample})} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

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Table 1. (Continued).

Date: 18 April 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.1	8.5	2870/2100	2100	8.4	8.0	<2.0	30
SJR @ Laird Park	8.1	8.8	2010	2010	8.4	8.1	<2.0	
SJR @ Airport Way	8.5	8.7	1500	1529	8.8	8.2	<2.0	
Merced R.	8.0	8.5	308	296	8.4	8.1	<2.0	
Tuolumne R.	8.0	8.3	290	278	8.3	7.9	<2.0	
Stanislaus R.	8.0	8.2	170	188	8.5	8.0	<2.0	
TID[7] 6	used for water chemistry duplicate							
TID 5	7.9	8.7	899	916	8.0	7.8	<2.0	
TID 5 - chemistry duplicate	7.9	8.7	900	915	7.9	8.0	<2.0	
TID 3	8.0	8.8	670	684	8.3	8.0	<2.0	
Orestimba Ck	8.1	8.5	1084	1108	8.0	7.8	<2.0	
Del Puerto Ck	8.6	8.8	1806	1848	8.6	8.0	<2.0	
Ingram-Hospital Cks	8.7	8.7	2000	2000	8.5	7.9	<2.0	
Spanish Grant Combined Drain	8.3	8.8	1452	1460	8.3	8.0	<2.0	
Laboratory control	8.1	8.4	177	182	8.6	8.1	<2.0	
Dilution control	7.9	8.4	148	156	8.6	7.9	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

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Table 1. (Continued).

Date: 3 May 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.0	8.4	2980/2000	2050	10.6	8.4	<2.0	38
SJR @ Laird Park	8.1	8.6	1890	1859	9.8	8.4	<2.0	
SJR @ Airport Way	8.0	9.4	400	457	12.0	8.4	<2.0	
Merced R.	7.8	8.2	231	278	1.06	8.2	<2.0	
Tuolumne R.	7.7	7.8	60	78	10.8	8.2	<2.0	
Stanislaus R.	7.6	7.9	102	138	11.6	8.2	<2.0	
TID[7] 6	used for water chemistry duplicate							
TID 5	7.8	8.4	525	547	10.6	8.0	<2.0	
TID 5 - chemistry duplicate	7.9	8.4	525	577	11.2	8.2	<2.0	
TID 3	7.9	8.5	700	720	10.8	8.2	<2.0	
Orestimba Ck	8.3	8.6	1000	1017	11.2	8.0	<2.0	
Del Puerto Ck	8.3	8.6	1510	1534	11.2	8.2	<2.0	
Ingram-Hospital Ck	8.1	8.6	1618	1610	10.6	8.0	<2.0	
Spanish Grant Combined Drain	8.1	8.6	1443	1447	10.4	8.0	<2.0	
Laboratory control	8.1	8.4	300	303	8.6	8.2	<2.0	
Dilution control	7.9	8.3	188	180	8.6	8.0	<2.0	

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 15 May 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.3	8.4	2900/2050	2070	9.3	8.6	<2.0	35
SJR @ Laird Park	8.4	8.6	1743	1749	10.4	8.7	<2.0	
SJR @ Airport Way	8.7	8.5	899	924	10.6	8.7	<2.0	
Merced R.	8.1	8.2	203	228	8.8	8.6	<2.0	
Tuolumne R.	7.9	8.3	220	227	8.8	8.6	<2.0	
Stanislaus R.	7.9	8.2	128	151	9.2	8.7	<2.0	
TID[7] 6	7.8	8.6	1028	1005	8.1	8.4	<2.0	
TID 6 - chemical duplicate	7.8	8.6	1020	1010	8.1	8.3	<2.0	
TID 5	used for water chemistry duplicate							
TID 3	7.9	8.7	684	716	8.7	8.6	<2.0	
Orestimba Ck	8.2	8.3	929	891	9.2	7.9	<2.0	
Del Puerto Ck	8.5	8.4	1496	1505	9.4	7.8	<2.0	
Ingram-Hospital Cks	8.4	8.4	1641	1605	8.9	7.8	<2.0	
Spanish Grant Combined Drain	8.1	8.1	1600	1595	8.7	7.7	<2.0	
Laboratory control	8.1	8.5	287	288	8.7	8.6	<2.0	
Dilution control	7.9	8.3	198	203	8.7	8.5	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

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Table 1. (Continued).

Date: 28 May 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5]
	start	end	start[4]	end	start	end		(%)
SJR[6] @ Hills Ferry	8.0	8.4	2400/2099	2100	8.2	8.0	<2.0	17
SJR @ Laird Park	8.3	8.6	1799	1795	9.0	8.0	<2.0	
SJR @ Airport Way	8.6	8.5	819	865	9.7	7.9	<2.0	
Merced R.	7.9	8.3	335	373	8.7	8.2	<2.0	
Tuolumne R.	7.7	8.2	219	241	8.5	8.0	<2.0	
Stanislaus R.	7.7	8.1	151	172	8.4	8.1	<2.0	
TID 6	7.4	8.5	627	642	10.8	7.8	<2.0	
TID 5	7.8	8.5	781	787	8.2	7.8	<2.0	
TID 3	7.9	8.8	898	836	8.2	7.6	<2.0	
Orestimba Ck	8.4	8.7	1120	1150	8.6	8.0	<2.0	
Del Puerto Ck	8.5	8.7	1707	1709	8.4	7.4	<2.0	
Ingram-Hospital Cks	8.2	8.7	1657	1635	8.5	7.8	<2.0	
Spanish Grant Combined Drain	8.2	8.7	1504	1486	8.8	7.7	<2.0	
Laboratory control	8.1	8.3	223	250	8.7	8.1	<2.0	
Dilution control	7.9	8.3	187	193	8.7	8.0	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 12 June 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	7.9	8.3	2620/2030	1999	8.1	8.2	<2.0	29
SJR @ Laird Park	8.8	8.6	2010	1999	10.6	8.3	<2.0	
SJR @ Airport Way	9.5	8.5	1149	1175	10.8	7.6	<2.0	
Merced R.	8.0	8.7	815	832	8.5	7.7	<2.0	
Tuolumne R.	8.1	8.4	403	438	9.0	7.4	<2.0	
Stanislaus R.	8.1	8.1	142	173	8.4	7.5	<2.0	
TID[7] 6	used for water chemistry duplicate							
TID 5	7.7	8.5	773	788	7.8	7.5	3.0	
TID 3	7.8	8.7	838	849	7.9	7.4	<2.0	
TID 3 - chemistry duplicate	7.6	8.4	916	902	6.4	7.2	<2.0	
Orestimba Ck	8.2	8.6	1076	1085	8.0	7.4	<2.0	
Del Puerto Ck	8.5	8.6	1484	1496	8.6	7.4	<2.0	
Ingram-Hospital Cks	8.9	8.6	1994	1990	8.7	7.4	<2.0	
Spanish Grant Combined Drain	8.0	8.6	1621	1641	7.5	7.4	<2.0	
Laboratory control	8.1	8.4	287	288	8.6	7.4	<2.0	
Dilution control	7.9	8.3	157	169	8.7	7.5	<2.0	

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 26 June 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.2	8.4	2050	2060	8.1	7.4	<2.0	
SJR @ Laird Park	8.6	8.6	1830	1887	10.4	7.6	<2.0	
SJR @ Airport Way	8.3	8.4	935	1015	10.5	7.7	<2.0	
Merced R.	8.3	8.4	415	458	8.9	7.4	<2.0	
Tuolumne R.	8.5	8.5	477	515	9.5	7.4	<2.0	
Stanislaus R.	8.2	8.2	126	176	8.7	7.2	<2.0	
TID[7] 6	7.5	8.7	1044	1054	7.6	7.2	<2.0	
TID 5	7.8	8.6	1110	1140	8.3	7.1	3.0	
TID 3	8.2	8.5	555	619	8.8	7.2	<2.0	
Orestimba Ck	8.3	8.6	1200	1232	8.7	7.2	<2.0	
Del Puerto Ck	used for water chemistry duplicate							
Ingram-Hospital Cks	8.8	8.6	1770	1804	8.6	7.2	<2.0	
Spanish Grant Combined Drain	8.1	8.6	1736	1785	8.4	7.0	<2.0	
Spanish Grant Combined Drain -chemistry duplicate	8.5	8.6	1771	1804	8.9	7.2	<2.0	
Laboratory control	7.9	8.3	241	301	8.6	7.2	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 2 July 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Sl @ HWY 165	8.1	8.4	1336	1318	8.1	7.8	<2.0	
SJR[6] @ Hills Ferry	8.3	8.5	1794	1785	8.1	7.8	<2.0	
SJR @ Laird Park	8.5	8.6	1628	1634	8.9	7.8	<2.0	
SJR @ Airport Way	8.1	8.5	904	952	10.8	7.9	<2.0	
SJR @ Airport Way -chemistry duplicate	8.1	8.6	909	933	8.2	7.9	<2.0	
TID[7] 6	no flow							
TID 5	used for water chemistry duplicate							
TID 3	8.3	8.7	693	715	8.2	7.7	<2.0	
Orestimba Ck	8.3	8.7	1059	1077	8.3	7.8	<2.0	
Del Puerto Ck	8.4	8.6	1513	1523	8.2	7.8	<2.0	
Ingram-Hospital Cks	8.5	8.7	1592	1601	8.0	7.8	<2.0	
Spanish Grant Combined Drain	8.1	8.6	1694	1691	8.4	7.8	<2.0	
Laboratory control	7.4	8.3	249	296	8.6	7.8	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

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Table 1. (Continued).

Date: 15 July 1991								
Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
Salt Sl	8.1	8.5	1680	1741	8.4	7.8	<2.0	
SJR[6] @ Hills Ferry	8.8	8.6	2170	2100	9.4	7.6	<2.0	
SJR @ Laird Park	8.7	8.5	1640	1714	9.8	7.6	<2.0	
SJR @ Airport Way	9.0	8.5	820	944	9.8	7.6	<2.0	
TID[7] 6	7.6	8.4	730	801	6.6	7.4	<2.0	
TID 5	used for water chemistry duplicate							
TID 3	7.7	8.6	748	754	6.6	7.6	<2.0	
TID 3 - chemistry duplicate	8.0	8.6	757	797	8.0	7.8	<2.0	
Orestimba Ck	8.2	8.3	968	1014	8.3	7.8	<2.0	
Del Puerto Ck	8.3	8.5	1065	1098	8.3	8.0	<2.0	
Ingram-Hospital Cks	8.4	8.6	1350	1392	7.8	7.8	<2.0	
Spanish Grant Combined Drain	8.2	8.4	1169	1250	8.1	7.6	<2.0	
Laboratory control	7.8	8.2	331	326	8.6	8.0	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 30 July 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Sl	7.9	8.2	1184	1190	7.8	8.2	<2.0	
SJR[6] @ Hills Ferry	8.1	8.4	1723	1748	7.9	8.1	<2.0	
SJR @ Laird Park	8.4	8.5	1514	1532	8.1	8.3	<2.0	
SJR @ Airport Way	8.6	8.4	883	924	8.6	8.1	<2.0	
TID[7] 6	no flow							
TID 5	8.0	8.4	868	889	7.8	8.0	<2.0	
TID 3	8.1	8.4	503	530	7.8	8.0	<2.0	
Orestimba Ck	8.3	8.4	1283	1284	7.8	7.7	<2.0	
Del Puerto Ck	8.3	8.5	1213	1235	8.1	8.0	<2.0	
Ingram-Hospital Cks	used for water chemistry duplicate							
Spanish Grant Combined Drain	8.1	8.5	1353	1373	7.8	8.2	<2.0	
Spanish Grant Combined Drain -chemistry duplicate	8.1	8.4	1337	1351	7.6	8.0	<2.0	
Laboratory control	8.1	8.3	198	268	8.4	8.0	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 16 August 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt S1	7.6	8.2	1151	1245	8.6	7.9	<2.0	
SJR[6] @ Hills Ferry	8.1	8.2	1495	1492	8.6	7.6	2.0	
SJR @ Laird Park	8.2	8.5	1384	1396	8.6	7.6	<2.0	
SJR @ Airport Way	8.6	8.3	949	978	9.8	7.7	<2.0	
TID[7] 6	7.9	8.4	522	544	8.3	8.0	<2.0	
TID 5	7.9	8.4	757	766	8.5	7.5	<2.0	
TID 3	7.9	8.6	662	667	8.4	7.4	<2.0	
Orestimba Ck	used for water chemistry duplicate							
Del Puerto Ck	8.1	8.5	993	1002	8.6	7.3	<2.0	
Ingram-Hospital Cks	8.2	8.3	1311	1325	8.0	7.4	<2.0	
Spanish Grant Combined Drain	8.0	8.5	1035	1144	8.4	7.5	<2.0	
Spanish Grant Combined Drain - chemistry duplicate	8.2	8.5	1029	1068	8.7	7.6	<2.0	
Laboratory control	8.2	8.3	191	220	8.4	7.4	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 6 September 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Sl	8.2	8.7	1581	1621	9.1	7.9	<2.0	
SJR[6] @ Hills Ferry	8.4	8.6	2380/2090	2070	8.4	8.5	<2.0	17
SJR @ Laird Park	8.7	8.8	1581	1648	8.2	7.9	<2.0	
SJR @ Airport Way	9.3	8.5	944	996	10.2	8.1	<2.0	
TID[7] 6	7.5	8.7	2040	681[9]	6.3	8.3	2.5	
TID 5	7.9	8.7	878	905	8.4	8.0	5.0	
TID 3	7.8	8.8	818	839	7.6	8.0	<2.0	
Orestimba Ck	used for water chemistry duplicate							
Del Puerto Ck	8.2	8.6	1616	1678	8.2	8.5	4.0	
Ingram-Hospital Cks	8.2	8.4	942	960	8.1	8.1	<2.0	
Spanish Grant Combined Drain	8.6	8.6	1535	1447	8.5	8.3	<2.0	
Spanish Grant Combined Drain - chemistry duplicate	8.4	8.6	1589	1617	8.6	8.0	<2.0	
Laboratory control	7.9	8.5	213	226	8.4	8.2	<2.0	
Dilution control	8.0	8.4	185	185	8.4	8.6		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

[9] Sample discarded before EC could be rerun

Table 1. (Continued).

Date: 18 September 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Sl @ HWY 165	8.3	8.7	1290	1561	8.7	8.1	<2.0	
SJR[6] @ Hills Ferry	8.3	8.7	2020	2440	8.4	7.9	<2.0	
SJR @ Laird Park	8.4	8.8	1431	1691	9.1	8.0	<2.0	
SJR @ Airport Way	9.0	8.7	1008	1305	9.6	7.9	<2.0	
TID[7] 6	7.4	8.8	567	714	7.1	8.0	<2.0	
TID 5	8.1	8.9	926	1143	8.1	8.0	<2.0	
TID 3	no flow							
Orestimba Ck	8.3	8.8	1042	1227	8.1	8.1	<2.0	
Orestimba Ck - chemistry duplicate	8.2	8.8	1020	1219	8.0	8.1	<2.0	
Del Puerto Ck	7.9	8.8	1532	1791	7.9	7.8	<2.0	
Ingram-Hospital Cks	8.1	8.8	1495	1763	8.0	8.1	<2.0	
Spanish Grant Combined Drain	7.9	8.8	1223	1513	8.0	8.1	<2.0	
Laboratory control	8.1	8.6	199	293	8.4	7.9	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 26 September 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Sl	7.7	[9]	1998	[9]	8.6	8.6	<2.0	
SJR[6] @ Hills Ferry	8.2	8.1	2090	2060	8.7	8.6	<2.0	
SJR @ Laird Park	8.6	8.6	1533	1564	9.8	8.5	<2.0	
SJR @ Airport Way	8.9	8.6	1099	1128	10.2	8.5	<2.0	
TID[7] 6	no flow							
TID 5	8.3	8.5	528	602	8.4	8.4	<2.0	
TID 3	used for water chemistry duplicate							
Orestimba Ck	8.0	8.6	1155	1173	8.5	8.5	<2.0	
Del Puerto Ck	8.0	8.6	1528	1522	8.5	8.2	<2.0	
Ingram-Hospital Cks	8.0	8.7	1647	1679	8.4	8.4	<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.0	8.7	1676	1661	8.4	8.4	<2.0	
Spanish Grant Combined Drain	7.9	8.5	1414	1585	8.5	8.4	<2.0	
Laboratory control	7.9	8.3	201	228	8.5	8.3	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

[9] Spilled before could take water quality readings

Table 1. (Continued).

Date: 9 October 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	7.5	8.7	2200/1999	2020	9.1	7.9	3.0	17
SJR @ Laird Park	8.1	8.8	1560	1679	9.7	8.0	<2.0	
SJR @ Airport Way	8.5	8.8	1100	1170	10.2	8.0	<2.0	
Merced R.	7.9	8.5	321	334	8.9	7.9	<2.0	
Tuolumne R.	7.9	8.7	443	447	9.2	8.0	<2.0	
Stanislaus R.	8.0	8.3	103	117	9.1	7.8	<2.0	
TID[7] 6	7.5	8.9	724	721	8.6	7.9	<2.0	
TID 5	used for water chemistry duplicate							
TID 3	7.7	8.8	1010	1027	8.8	7.0	6.0	
TID 3 - chemistry duplicate	7.7	8.8	1004	966	8.8	7.7	6.0	
Orestimba Ck	8.1	8.8	1010	1034	9.1	7.8	<2.0	
Del Puerto Ck	7.9	8.7	1224	1254	9.0	7.8	<2.0	
Ingram-Hospital Cks	8.2	8.8	1560	1587	9.1	7.8	<2.0	
Spanish Grant Combined Drain	8.0	8.7	1201	1237	8.8	7.8	<2.0	
Laboratory control	8.0	8.5	194	210	8.6	7.9		
Dilution control	8.1	8.5	194	231	8.7	7.6		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 24 October 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.0	8.5	2670/2040	2090	9.0	8.4	<2.0	25
SJR @ Laird Park	7.9	8.7	1577	1623	8.9	8.1	<2.0	
SJR @ Airport Way	7.9	8.5	8.6	848	9.0	8.2	<2.0	
Merced R.	7.6	8.2	211	238	9.0	8.3	<2.0	
Tuolumne R.	7.5	8.2	180	195	8.7	8.2	<2.0	
Stanislaus R.	7.6	8.0	8.2	999	8.9	8.1	<2.0	
TID[7] 6	used for water chemistry duplicate							
TID 5	7.7	8.4	500	535	8.9	8.4	<2.0	
TID 5 - chemistry duplicate	7.8	8.4	506	526	8.7	8.3	<2.0	
TID 3	no flow							
Orestimba Ck	8.1	8.7	971	1021	8.5	8.5	<2.0	
Del Puerto Ck	8.1	8.5	744	783	8.9	8.4	<2.0	
Ingram-Hospital Cks	8.2	8.4	1540	1520	8.9	8.0	<2.0	
Spanish Grant Combined Drain	8.6	8.7	1038	1085	9.2	8.4	<2.0	
Laboratory control	8.3	8.4	188	214	8.6	8.4		
Dilution control	8.1	8.3	153	161	8.6	8.4		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
Date: 30 October 1991								
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.0	8.5	1671	1664	9.6	8.4	3.0	
SJR @ Laird Park	7.8	8.4	1041	1157	9.5	8.4	<2.0	
SJR @ Airport Way	7.7	8.3	660	750	9.5	8.4	<2.0	
Merced R.	7.6	7.8	128	185	9.2	8.2	<2.0	
Tuolumne R.	7.5	8.0	180	201	9.2	8.4	<2.0	
Stanislaus R.	7.4	7.8	80	112	9.3	8.4	<2.0	
TID[7] 6	no flow							
TID 5	7.6	8.4	500	500	9.6	8.4	<2.0	
TID 3	no flow							
Orestimba Ck	used for water chemistry duplicate							
Del Puerto Ck	8.1	8.5	1734	1601	9.8	8.4	<2.0	
Ingram-Hospital Cks	no flow							
Spanish Grant Combined Drain	8.0	8.2	788	806	9.5	8.4	<2.0	
Spanish Grant Combined Drain - chemistry duplicate	7.9	8.1	779	803	9.4	8.4	<2.0	
Laboratory control	7.9	7.8	181	245	8.4	8.4		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 13 November 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.0	8.5	2010	2090	8.0		<2.0	
SJR @ Laird Park	7.8	8.4	1104	1161	7.8		<2.0	
SJR @ Airport Way	7.8	8.3	773	816	7.8		<2.0	
Merced R.	7.4	7.7	100	118	7.6		<2.0	
Tuolumne R.	7.7	8.1	203	226	7.9		<2.0	
Stanislaus R.	7.7	7.9	89	106	7.7		<2.0	
TID[7] 6	used for water chemistry duplicate							
TID 5	7.9	8.7	1148	1217	7.6		7.0	
TID 5 -chemistry duplicate	7.9	8.7	1140	1204	7.5		7.0	
TID 3	8.6	8.8	806	850	8.8		<2.0	
Orestimba Ck	8.1	8.3	637	678	7.7		<2.0	
Del Puerto Ck	8.2	8.7	1470	1483	7.7		<2.0	
Ingram-Hospital Cks	8.2	8.5	1088	1137	7.6		<2.0	
Spanish Grant Combined Drain	8.3	8.4	950	982	7.7		<2.0	
Laboratory control	7.6	8.2	209	199	8.4			

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 25 November 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.0	8.4	2070	2120	8.4	6.8	<2.0	
SJR @ Laird Park	7.7	8.4	1262	1404	8.3	6.6	<2.0	
SJR @ Airport Way	7.8	8.3	861	906	8.5	6.8	<2.0	
Merced R.	7.5	7.9	84	158	8.4	6.6	<2.0	
Tuolumne R.	7.8	7.9	221	243	8.2	6.8	<2.0	
Stanislaus R.	7.7	7.8	95	119	8.4	6.8	<2.0	
TID[7] 6	8.2	8.5	1493	1499	8.2	5.8	12.0	
TID 5	7.9	8.4	1293	1184	7.7	6.4	10	
TID 3	no flow							
Orestimba Ck	8.0	8.4	878	930	8.2	6.4	<2.0	
Orestimba Ck - chemistry duplicate	8.0	8.4	882	949	8.0	6.6	<2.0	
Del Puerto Ck	8.0	8.3	961	987	8.2	6.6	<2.0	
Ingram-Hospital Cks	8.2	8.4	1671	1677	8.1	6.6	<2.0	
Spanish Grant Combined Drain	used for water chemistry duplicate							
Laboratory control	7.9	8.2	191	237	8.4	6.6	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] Volume dilution water / (volume dilution water + volume sample) X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
Date: 4 December 1991								
SJR[6] @ Hills Ferry	7.9	8.5	1980	2050	8.3	8.0	<2.0	
SJR @ Laird Park	7.7	8.4	1154	1209	8.4	8.0	<2.0	
SJR @ Airport Way	7.7	8.4	838	894	8.7	7.9	3.0	
Merced R.	7.7	7.8	117	137	8.6	8.0	<2.0	
Tuolumne R.	7.7	8.2	238	264	8.6	8.0	<2.0	
Stanislaus R.	7.7	8.1	141	163	8.5	8.0	<2.0	
TID[7] 6	used for water chemistry duplicate							
TID 5	7.8	8.4	1047	1100	8.1	7.6	3.0	
TID 3	no flow							
Orestimba Ck	8.1	8.2	814	922	8.5	7.6	<2.0	
Del Puerto Ck	8.1	8.4	1520	1551	8.2	7.2	4.0	
Ingram-Hospital Cks	8.2	8.5	1472	1481	8.5	8.1	<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.1	8.1	1477	1471	8.6	8.0	<2.0	
Spanish Grant Combined Drain	8.2	8.3	912	1014	8.8	8.2	<2.0	
Laboratory control	7.9	8.3	187	208	8.4	8.1		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 11 December 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.0	8.3	2280/1887	1898	9.4	8.8	<2.0	25
SJR @ Laird Park	7.7	8.3	1208	1244	9.5	8.9	<2.0	
SJR @ Airport Way	7.8	8.3	866	910	9.7	8.8	<2.0	
Merced R.	7.4	7.9	116	135	9.5	8.9	<2.0	
Tuolumne R.	7.9	8.1	249	278	9.8	8.9	<2.0	
Stanislaus R.	7.8	8.0	142	169	10.0	8.9	<2.0	
TID[7] 6	8.5	8.7	894	923	10.8	7.6	<2.0	
TID 5	7.8	8.3	1011	1026	8.7	7.3	10	
TID 3	8.3	8.4	772	789	9.5	7.4	<2.0	
Orestimba Ck	8.7	8.3	1072	1070	9.8	7.5	<2.0	
Del Puerto Ck	used for water chemistry duplicate							
Ingram-Hospital Cks	8.2	8.6	1398	1526	9.9	7.6	<2.0	
Spanish Grant Combined Drain	8.2	8.4	1386	1324	9.8	7.6	<2.0	
Spanish Grant Combined Drain -chemistry duplicate	8.2	8.6	1358	1408	10.1	7.6	<2.0	
Laboratory control	7.9	8.2	188	157	8.2	8.7		
Dilution control	7.8	8.1	133	149	8.2	8.7		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
Date: 18 December 1991								
SJR[6] @ Hills Ferry	7.7	8.2	2670/2090	2110	7.9	8.0	<2.0	25
SJR @ Laird Park	7.6	8.3	1363	1350	7.9	7.8	<2.0	
SJR @ Airport Way	7.6	8.3	932	938	8.1	7.9	<2.0	
Merced R.	7.4	7.6	89	116	8.1	8.0	<2.0	
Tuolumne R.	7.8	8.0	242	288	8.0	7.8	<2.0	
Stanislaus R.	7.6	8.0	171	180	8.1	7.9	<2.0	
TID[7] 6	used for water chemistry duplicate							
TID 5	7.7	8.5	972	982	7.5	7.3	20	
TID 3	7.8	8.5	1023	1020	7.7		<2.0	
TID 3 - chemistry duplicate	8.0	8.7	1041	975	8.2		<2.0	
Orestimba Ck	no flow							
Del Puerto Ck	8.1	8.3	1254	1324	7.8	7.6	<2.0	
Ingram-Hospital Cks	no flow							
Spanish Grant Combined Drain	8.2	8.4	1561	1553	8.1		<2.0	
Laboratory control	8.1	8.3	204	211	8.4	8.1		
Dilution control	7.8	8.0	127	156	8.4	7.9		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 23 December 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.1	8.4	2700/2090	2070	9.6	7.8	<2.0	25
SJR @ Laird Park	8.0	8.4	1390	1432	9.4	7.8	<2.0	
SJR @ Airport Way	8.0	8.4	984	1031	9.7	7.6	<2.0	
Merced R.	7.6	7.6	86	105	9.6	7.9	<2.0	
Tuolumne R.	8.0	8.2	240	267	10.1	7.8	<2.0	
Stanislaus R.	7.9	8.0	141	163	9.8	7.7	<2.0	
TID[7] 6	8.4	8.7	831	848	9.7	7.0	<2.0	
TID 5	7.8	8.6	835	855	8.5	7.2	6.0	
TID 3	no flow							
Orestimba Ck	no flow							
Del Puerto Ck	8.2	8.3	1475	1533	9.2	7.7	<2.0	
Ingram-Hospital Cks	8.2	8.3	1526	1566	9.2	7.8	<2.0	
Spanish Grant Combined Drain	8.2	8.5	1622	1633	8.7	7.0	<2.0	
Laboratory control	7.9	8.2	218	228	8.2	7.6		
Dilution control	7.9	8.1	157	161	8.3	7.6		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 5 January 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	7.9	8.4	3000/2010	2100	8.5	7.9	<2.0	33
SJR @ Laird Park	7.7	8.4	1230	1340	8.4	7.8	<2.0	
SJR @ Airport Way	7.9	8.4	980	1020	8.6	7.8	<2.0	
Merced R.	7.4	7.8	188	195	8.6	7.9	<2.0	
Merced R. - chemistry duplicate	7.8	8.2	225	253	8.5	7.9	<2.0	
Tuolumne R.	used for water chemistry duplicate							
Stanislaus R.	7.7	8.0	124	158	8.6	7.8	<2.0	
TID[7] 6	8.2	8.5	760	801	8.3	7.3	<2.0	
TID 5	7.8	8.6	920	956	7.8	6.9	70.2	
TID 3	7.9	8.0	161	180	8.5	8.0	<2.0	
Orestimba Ck	8.0	7.9	285	341	8.8	7.8	<2.0	
Del Puerto Ck	7.7	7.8	354	427	8.5	7.9	<2.0	
Ingram-Hospital Cks	7.8	8.0	618	659	8.2	7.9	<2.0	
Spanish Grant Combined Drain	8.3	8.2	1034	1091	8.6	7.8	<2.0	
Laboratory control	8.1	8.3	167	188	8.2	7.6		
Dilution control	8.0	8.2	124	139	8.2	7.7		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 13 January 1992								
Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
SJR[6] @ Hills Ferry	7.9	8.4	2650/2010	2040	9.6	8.3	3.0	25
SJR @ Laird Park	7.8	8.5	1399	1442	9.4	8.5	<2.0	
SJR @ Airport Way	7.7	8.4	1065	1056	9.2	8.2	<2.0	
Merced R.	7.2	7.6	262	195	9.5	8.5	<2.0	
Tuolumne R.	7.7	8.1	259	282	9.7	8.3	<2.0	
Stanislaus R.	7.6	8.0	165	157	9.4	8.2	<2.0	
TID[7] 6	8.0	8.7	1146	1159	8.6	7.5	7.0	
TID 5	7.7	8.4	867	879	9.0	9.6	40	
TID 3	no flow							
Orestimba Ck	no flow							
Del Puerto Ck	7.6	8.2	535	584	9.0	7.4	<2.0	
Ingram-Hospital Cks	used for water chemistry duplicate							
Spanish Grant Combined Drain	no flow							
Laboratory control	8.0	8.3	164	184	8.4	8.6		
Dilution control	8.0	8.2	164	162	8.3	8.2		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 20 January 1992								
Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
SJR[6] @ Hills Ferry	7.9	8.3	2930/2070	2040	9.3	7.8	<2.0	35
SJR @ Laird Park	7.8	8.4	1505	1657	9.1	7.4	3.0	
SJR @ Airport Way	7.8	8.3	1117	1352	9.3	7.6	<2.0	
Merced R.	7.3	7.8	113	196	9.5	7.4	<2.0	
Tuolumne R.	7.6	8.1	245	288	9.5	7.8	<2.0	
Stanislaus R.	7.7	8.1	148	205	9.7	7.4	<2.0	
TID[7] 6	8.1	8.6	850	804	8.9	8.7	<2.0	
TID 6 -chemistry duplicate	8.0	8.6	850	803	8.8	8.5	<2.0	
TID 5	7.8	8.6	1378	1301	5.7	7.4	60	
TID 3	8.2	8.6	885	892	10.3	8.5	<2.0	
Orestimba Ck	no flow							
Del Puerto Ck	used for water chemistry duplicate							
Ingram-Hospital Cks	8.0	8.6	1612	1672	9.6	7.1	<2.0	
Spanish Grant Combined Drain	no flow							
Laboratory control	7.9	8.1	194	360	8.2	7.4		
Dilution control	7.9	8.1	129	216	8.3	7.4		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
Date: 3 February 1992								
SJR[6] @ Hills Ferry	8.0	8.2	3220/1960	1983	9.8	7.9	<2.0	46
SJR @ Laird Park	7.8	8.5	1520	1594	9.4	8.2	<2.0	
SJR @ Airport Way	7.8	8.4	1091	1134	9.6	8.1	<2.0	
Merced R.	7.7	7.9	104	127	10.0	8.1	<2.0	
Tuolumne R.	7.9	8.0	230	262	10.2	7.6	<2.0	
Stanislaus R.	7.8	7.9	145	166	10.1	8.0	<2.0	
TID[7] 6	8.4	8.6	1289	1230	10.4	8.0	<2.0	
TID 5	7.9	8.4	910	1030	9.4	7.6	20.0	
TID 3	no flow							
Orestimba Ck	8.2	8.5	1033	1194	9.6		<2.0	
Del Puerto Ck	8.3	8.4	1020	1054	8.1		30.0	
Ingram-Hospital Cks	8.6	8.7	1671	1850	10.2		<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.6	8.6	1693	1867	9.8		<2.0	
Spanish Grant Combined Drain	used for water chemistry duplicate							
Laboratory control	8.4	8.3	260	209		7.8		
Dilution control	8.2	8.0	139	118		7.8		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 10 February 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	8.0	8.0	2910/1896	1919	9.0	8.9	4.0	42
SJR @ Laird Park	7.8	8.2	1475	1503	9.0	9.4	<2.0	
SJR @ Airport Way	7.8	8.2	1063	1118	9.4	9.2	<2.0	
Merced R.	7.8	7.9	141	140	9.5	8.9	<2.0	
Merced R. - chemistry duplicate	7.7	7.9	146	174	9.3	9.1	<2.0	
Tuolumne R.	7.7	7.8	208	241	9.3	8.8	<2.0	
Stanislaus R.	used for water chemistry duplicate							
TID[7] 6	7.9	8.4	1327	1324	4.6	7.2	80	
TID 5	7.8	8.4	1111	1119	7.1	7.7	70	
TID 3	9.1	8.0	144	180	9.6	8.3	<2.0	
Orestimba Ck	8.0	7.8	193	316	9.2	8.0	<2.0	
Del Puerto Ck	7.8	8.1	494	560	9.3	8.3	<2.0	
Ingram-Hospital Cks	8.0	8.1	768	801	8.7	7.8	<2.0	
Spanish Grant Combined Drain	8.1	8.5	1536	1960	8.8	8.4	<2.0	
Laboratory control	8.2	8.2	241	211	8.4	9.1		
Dilution control	8.1	8.0	148	150	8.4	8.9		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 17 February 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	6.7	8.1	490	524	10.2	9.2	<2.0	
SJR @ Laird Park	no sample							
SJR @ Airport Way	7.1	8.0	467	513	10.2	9.8	<2.0	
SJR @ Airport Way - chemistry duplicate	7.7	8.1	467	494	8.0	9.6	<2.0	
Merced R.	7.2	7.7	104	128	10.4	9.2	<2.0	
Tuolumne R.	7.2	8.0	150	200	10.2	10.4	<2.0	
Stanislaus R.	7.3	7.9	117	148	10.4	9.1	<2.0	
TID[7] 6	7.5	8.4	731	748	8.6	9.4	<2.0	
TID 5	7.5	8.2	447	473	10.0	9.8	3.0	
TID 3	7.8	7.9	146	174	10.6	9.8	<2.0	
Orestimba Ck	7.8	8.3	294	327	10.8	9.4	<2.0	
Del Puerto Ck	8.6	8.6	700	814	10.8	10.4	<2.0	
Ingram-Hospital Cks	8.2	8.4	1126	1335	10.6	10.8	<2.0	
Spanish Grant Combined Drain	7.8	8.5	1607	1733	10.5	9.2	<2.0	
Laboratory control	8.0	8.3	197	214	8.6	9.4		
Dilution control	7.9	8.1	164	150	8.6	10.6		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 24 February 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	7.7	8.4	1763	1838	10.6	8.4	<2.0	
SJR @ Laird Park	7.8	8.4	1137	1202	10.8	8.5	<2.0	
SJR @ Airport Way	7.7	8.3	835	888	10.4	8.5	<2.0	
Merced R.	7.7	7.9	126	154	10.6	8.6	<2.0	
Tuolumne R.	7.5	8.1	229	260	10.4	8.5	<2.0	
Stanislaus R.	7.5	8.1	171	199	10.6	8.5	<2.0	
TID[7] 6	8.3	8.8	1138	1169	10.2	7.8	<2.0	
TID 5	7.8	8.4	1301	1289	10.0	10.0	20	
TID 3	7.7	8.7	1186	1154	7.1	10.6	<2.0	
Orestimba Ck	used for water chemistry duplicate							
Del Puerto Ck	8.7	8.9	1065	1189	10.8	7.9	<2.0	
Del Puerto Ck - chemistry duplicate	8.3	8.8	1149	1217	10.2	7.8	<2.0	
Ingram-Hospital Cks	8.1	8.4	1222	1261	10.6	9.9	<2.0	
Spanish Grant Combined Drain	8.1	8.6	2810/2010	2140	10.8	7.8	<2.0	35
Laboratory control	7.9	8.2	248	212	8.4	8.4		
Dilution control	7.9	8.0	143	177	8.4	8.0		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 2 March 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	7.8	8.3	2780/1985	1925	10.0	6.9	<2.0	35
SJR[6] @ Hills Ferry	7.9	8.3	2500/1935	1835	10.5	7.1	<2.0	29
SJR @ Laird Park	no sample collected							
SJR @ Airport Way	7.9	8.4	1205	1206	10.2	6.6	<2.0	
Merced R.	7.7	7.9	133	142	10.4	5.8	<2.0	
Tuolumne R.	7.7	7.9	249	276	10.5	6.4	<2.0	
Stanislaus R.	7.7	7.9	160	174	10.4	8.5	<2.0	
TID[7] 6	8.2	8.8	1172	1181	9.1	8.4	8.0	
TID 6 - chemistry duplicate	7.8	8.7	1170	1168	9.2	8.5	8.0	
TID 5	used for water chemistry duplicate							
TID 3	8.5	8.6	768	786	10.8	8.4	<2.0	
Orestimba Ck	no flow							
Del Puerto Ck	9.0	8.9	1154	1326	10.8	9.0	<2.0	
Ingram-Hospital Cks	8.4	8.5	2100/1864	1910	10.7	8.8	<2.0	17
Spanish Grant Combined Drain	8.2	8.4	2940/2000	2040	10.8	8.8	<2.0	
Laboratory control	8.1	8.2	197	200	8.6	8.2		
Dilution control	8.1	8.2	129	133	8.6	8.2		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 9 March 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hills Ferry	7.7	8.5	2440/1704	1698	14.0	7.6	<2.0	35
SJR @ Laird Park	7.9	8.5	2060/1575	1599	14.0	7.8	<2.0	29
SJR @ Airport Way	7.6	8.4	1010	1048	12.3	8.8	<2.0	
Merced R.	7.4	8.1	133	174	10.6	7.7	<2.0	
Tuolumne R.	7.4	7.9	187	199	10.6	7.0	<2.0	
Tuolumne R. - chemistry duplicate	7.5	8.1	174	189	10.4	7.7	<2.0	
Stanislaus R.	used for water chemistry duplicate							
TID[7] 6	8.1	8.9	1041	1134	12.0	8.5	<2.0	
TID 5	7.7	8.6	1142	1102	12.1	7.2	5.0	
TID 3	9.6	7.9	286	318	12.8	7.3	<2.0	
Orestimba Ck	7.9	8.5	706	1033	12.7	8.7	<2.0	
Del Puerto Ck	8.9	9.0	1026	1097	12.7	8.8	<2.0	
Ingram-Hospital Cks	8.3	8.2	2050/1544	1501	18.8	7.3	<2.0	
Spanish Grant Combined Drain	8.2	8.7	2360/1746	1921	18.4	8.7	<2.0	
Laboratory control	8.1	8.4	188	199	8.4	7.7		
Dilution control	8.0	8.2	163	132	8.4	7.9		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

C-034321

C-034321

Table 1. (Continued).

Date: 16 March 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	7.7	8.4	2430/2020	1940	8.6	8.2		25
SJR[6] @ Hills Ferry	7.9	8.3	2630/2000	2130	8.7	7.4		29
SJR @ Laird Park	8.0	8.4	1618	1727	8.8	7.3		
SJR @ Airport Way	8.0	8.4	1239	1317	8.9	7.4		
Merced R.	7.8	7.8	126	173	8.9	7.3		
Tuolumne R.	7.8	8.0	258	322	8.9	7.4		
Stanislaus R.	7.8	7.9	175	215	8.9	7.4		
TID[7] 6	7.8	8.6	1418	1508	6.4	7.1		
TID 5	7.8	8.6	1435	1497	5.9	7.0		
TID 5 - chemistry duplicate	8.5	8.5	1402	1417	9.8	7.4		
TID 3	8.3	8.5	934	938	10.4	7.0		
Orestimba Ck	used for water chemistry duplicate							
Del Puerto Ck	8.9	8.8	1195	1271	8.6	7.3		
Ingram-Hospital Cks	8.4	8.6	2000	2010	8.8	7.7		
Spanish Grant Combined Drain	8.3	8.2	2150/1980	1915	9.8	7.4		12
Laboratory control	7.7	7.8	230	228	8.6	7.4		
Dilution control	7.6	7.4	190	130	8.6	7.6		

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

C-034322

C-034322

Table 1. (Continued).

Date: 23 March 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	7.7	8.5	1880	2160	8.9	8.0		
SJR[6] @ Hills Ferry	8.0	8.6	2170/1730	1670	9.2	8.0		
SJR @ Laird Park	8.1	8.7	1568	1630	9.5	7.7		
SJR @ Airport Way	8.0	8.5	1217	1268	9.4	8.1		
Merced R.	7.8	8.1	123	143	9.6	8.0		
Tuolumne R.	7.8	8.3	219	245	9.6	7.9		
Stanislaus R.	7.8	8.0	95	117	9.8	7.2		
TID[7] 6	8.2	8.9	944	960	9.2	8.5		
TID 5	7.9	8.7	1020	1134	8.4	8.3		
TID 3	8.4	8.6	557	587	10.2	7.1		
Orestimba Ck	8.3	8.2	922	940	9.8	7.4		
Del Puerto Ck	8.6	8.6	780	804	10.2	7.4		
Ingram-Hospital Cks	8.1	8.1	276	305	9.4	7.3		
Spanish Grant Combined Drain	7.9	8.3	1284	1286	9.2	7.2		
Laboratory control	8.4	8.2	210	208	8.4	7.8		
Dilution control	8.3	8.1	152	153	8.4	7.8		

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 30 March 1992								
Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
Salt Slough	used for water chemistry duplicate							
SJR[6] @ Hills Ferry	8.1	8.5	2260/1846	1853	9.9	8.7		25
SJR @ Hills Ferry - chemistry duplicate	7.7	8.4	2330/1812	1842	9.6	8.7		29
SJR @ Laird Park	8.1	8.6	1656	1700	10.	8.5		
SJR @ Airport Way	8.1	8.5	1103	1192	10.	8.4		
Merced R.	7.8	8.1	124	153	10.2	8.6		
Tuolumne R.	8.0	8.3	252	281	10.2	8.2		
Stanislaus R.	7.8	8.1	94	118	10.4	8.5		
TID[7] 6	8.4	8.8	898	941	10.2	8.6		
TID 5	7.9	8.7	1070	1080	9.6	8.7		
TID 3	7.6	8.9	957	970	6.9	7.8		
Orestimba Ck	7.8	8.4	1052	1142	8.0	8.0		
Del Puerto Ck	8.5	8.5	784	849	10.4	8.5		
Ingram-Hospital Cks	8.3	8.7	1615	1751	10.1	8.6		
Spanish Grant Combined Drain	8.3	8.6	1218	1239	10.6	8.9		
Laboratory control	8.1	8.4	197	207	8.6	8.4		
Dilution control	8.0	8.2	149	167	8.6	8.4		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 6 April 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	7.8	8.4	2800/1960	2020	9.2	8.5		35
SJR[6] @ Hills Ferry	8.1	8.4	2720/1999	1985	9.1	8.5		32
SJR @ Laird Park	8.2	8.7	1790	1831	9.5	8.3		
SJR @ Airport Way	8.3	8.5	1002	1044	10.4	8.5		
Merced R.	7.7	8.1	150	172	9.8	8.3		
Tuolumne R.	8.0	8.2	242	271	9.7	8.0		
Stanislaus R.	7.9	8.0	96	123	9.8	8.2		
TID[7] 6	8.8	8.6	562	601	10.0	7.4		
TID 5	7.9	8.5	816	887	10.1	8.0		
TID 3	used for water chemistry duplicate							
Orestimba Ck	8.2	8.3	986	834	8.9	8.1		
Del Puerto Ck	8.5	8.5	1178	1202	10.0	7.6		
Ingram-Hospital Cks	8.3	8.2	1999	1970	9.9	8.2		
Ingram-Hospital Cks - chemistry duplicate	8.3	8.5	1968	2030	9.6	8.2		
Spanish Grant Combined Drain	8.4	8.5	1338	1389	10.1	8.2		
Laboratory control	8.0	8.4	187	212	8.4	8.6		
Dilution control	7.9	8.2	164	141	8.4	7.9		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 13 April 1992								
Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
Salt Slough	7.9	8.5	2540/1778	1820	10.2	9.2	<2.0	35
SJR[6] @ Hills Ferry	8.1	8.6	2740/1922	1971	10.3	9.3	<2.0	35
SJR @ Laird Park	8.1	8.8	1950	1965	10.2	9.2	<2.0	
SJR @ Airport Way	8.1	8.6	827	890	10.7	9.1	<2.0	
Merced R.	7.7	9.0	156	184	10.4	8.6	<2.0	
Tuolumne R.	7.9	8.2	252	271	10.3	8.7	<2.0	
Stanislaus R.	7.8	8.4	96	114	10.5	8.5	<2.0	
TID[7] 6	7.8	8.5	468	462	10.4	8.5	<2.0	
TID 6 - chemistry duplicate	7.9	8.4	486	491	10.2	8.7	<2.0	
TID 5	used for water chemistry duplicate							
TID 3	8.7	8.3	195	203	10.7	8.6	<2.0	
Orestimba Ck	8.3	8.6	888	860	10.0	8.6	<2.0	
Del Puerto Ck	8.4	8.6	1276	1297	10.4	8.3	<2.0	
Ingram-Hospital Cks	8.2	8.7	1925	1900	10.0	8.7	<2.0	
Spanish Grant Combined Drain	8.3	7.3	718	763	10.3	8.0	<2.0	
Laboratory control	8.0	8.4	198	213	8.6	8.9		
Dilution control	8.2	8.2	134	142	8.6	8.9		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 20 April 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	8.0	8.5	2080	2140	9.6	9.0	<2.0	
SJR[6] @ Hills Ferry	8.2	8.5	2540/1856	1867	10.2	8.9	<2.0	35
SJR @ Laird Park	8.1	8.7	1738	1758	10.1	8.7	<2.0	
SJR @ Airport Way	8.3	8.4	755	810	10.4	8.9	<2.0	
Merced R.	7.9	8.2	170	195	10.0	8.6	<2.0	
Tuolumne R.	8.1	8.0	234	260	10.2	8.6	<2.0	
Stanislaus R.	7.8	7.9	88	110	10.2	8.9	<2.0	
TID[7] 6	8.2	8.5	711	796	10.4	7.8	<2.0	
TID 5	7.9	8.5	378	453	10.0	7.7	<2.0	
TID 3	used for water chemistry duplicate							
Orestimba Ck	8.3	8.7	1200	1310	10.3	7.8	<2.0	
Del Puerto Ck	8.3	8.7	1658	1691	10.4	7.8	<2.0	
Ingram-Hospital Cks	8.4	8.5	1626	1702	10.6	7.7	<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.5	8.8	1618	1678	10.6	7.8	<2.0	
Spanish Grant Combined Drain	8.2	8.5	1345	1393	10.3	8.2	<2.0	
Laboratory control	8.4	8.4	193	211	9.0	8.9		
Dilution control	8.3	8.2	130	147	9.8	8.8		

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] Volume dilution water / (volume dilution water + volume sample) X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 27 April 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	7.9	8.3	2160/1652	1618	9.4	8.4	<2.0	29
SJR[6] @ Hills Ferry	8.1	8.3	2900/2030	2010	10.2	8.4	<2.0	35
SJR @ Laird Park	8.4	8.7	1753	1794	12.2	8.4	<2.0	
SJR @ Airport Way	8.5	8.3	533	565	10.8	8.2	<2.0	
Merced R.	8.0	8.4	312	333	10.4	8.4	<2.0	
Tuolumne R.	7.8	7.9	128	145	10.4	8.2	<2.0	
Stanislaus R.	7.9	8.0	89	110	10.4	8.2	<2.0	
TID[7] 6	7.9	8.3	513	543	10.3	7.8	<2.0	
TID 5	7.9	8.3	655	712	10.1	7.6	<2.0	
TID 3	8.2	8.7	978	1013	10.8	7.6	<2.0	
Orestimba Ck	8.4	8.6	1041	1088	10.4	9.6	<2.0	
Del Puerto Ck	8.4	8.7	1368	1403	10.6	7.8	<2.0	
Ingram-Hospital Cks	8.5	8.7	1782	1802	8.8	7.5	<2.0	
Spanish Grant Combined Drain	8.1	8.3	1328	1378	8.9	8.7	<2.0	
Laboratory control	8.4	8.4	197	209	8.6	8.2		
Dilution control	7.0	8.0	127	146	8.8	8.7	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 4 May 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	8.2	8.2	2530/1896	1734	10.1	8.7	<2.0	35
SJR[6] @ Hills Ferry	8.3	8.5	2650/1722	1822	10.4	9.1	<2.0	
SJR @ Laird Park	8.4	8.5	1843	1847	12.0	8.6	<2.0	
SJR @ Airport Way	8.1	8.2	447	482	10.6	8.8	<2.0	
Merced R.	7.9	8.2	196	214	10.0	8.4	<2.0	
Tuolumne R.	7.7	7.9	57	78	10.1	8.6	<2.0	
Stanislaus R.	7.9	7.9	114	146	9.6	8.6	<2.0	
TID[7] 6	8.6	8.7	538	565	10.3	8.6	<2.0	
TID 5	8.2	8.6	594	626	9.8	8.4	<2.0	
TID 3	7.6	8.7	732	734	6.9	8.6	<2.0	
Orestimba Ck	8.3	8.4	896	908	9.6	9.4	<2.0	
Del Puerto Ck	8.4	8.6	1386	946	10.0	8.4	<2.0	
Ingram-Hospital Cks	8.5	8.7	1733	1666	9.9	9.4	<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.4	8.7	1748	1784	10.6	9.2	<2.0	
Spanish Grant Combined Drain	7.8	8.4	1343	1344	8.6	9.3	<2.0	
Extra sample	used for water chemistry duplicate							
Laboratory control	8.3	8.4	196	220	10.1	8.6	<2.0	
Dilution control	8.4	8.3	132	155	10.1	8.7	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 11 May 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	8.1	8.2	2560/1832	1862	10.8	7.3	<2.0	35
SJR[6] @ Hills Ferry	8.3	8.4	2800/1931	1902	10.9	7.1	<2.0	38
SJR @ Laird Park	8.4	8.7	1699	1939	12.4	7.1	<2.0	
SJR @ Airport Way	8.7	8.2	610	490	12.4	7.5	<2.0	
Merced R.	7.9	8.0	186	227	10.5	7.2	<2.0	
Tuolumne R.	7.7	7.9	81.6	77.0	10.3	7.1	<2.0	
Tuolumne R. - chemistry duplicate	7.9	8.1	95	142	10.3	7.5	<2.0	
Stanislaus R.	used for water chemistry duplicate							
TID[7] 6	7.5	8.4	291	320	8.6	8.8	<2.0	
TID 5	8.0		1051		10.5		<2.0	
TID 3	7.6		870		8.3		<2.0	
Orestimba Ck	8.2	8.5	928	994	10.3	9.6	<2.0	
Del Puerto Ck	8.5	8.6	1484	1546	10.7	8.7	<2.0	
Ingram-Hospital Cks	8.4	8.3	1432	1458	10.1	12.0	<2.0	
Spanish Grant Combined Drain	8.2	8.6	1420	1421	10.1	10.8	<2.0	
Laboratory control	8.5	8.4	190	219	9.4	7.4	<2.0	
Dilution control	8.4	8.2	129	129	9.6	7.5	<2.0	

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 18 May 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	8.2	8.3	2300/1800	1726	9.4	9.3	<2.0	29
SJR[6] @ Hills Ferry	9.0	7.9	2890/2040	2070	16.0	9.4	<2.0	35
SJR @ Laird Park	8.8	8.7	1785	1844	14.2	9.4	<2.0	
SJR @ Airport Way	8.7	8.3	558	594	10.5	9.4	<2.0	
Merced R.	used for chemistry duplicate							
Tuolumne R.	7.9	8.4	286	321	8.5	9.3	<2.0	
Tuolumne R. - chemistry duplicate	8.0	8.2	297	318	9.3	9.0	<2.0	
Stanislaus R.	7.8	8.0	87	108	8.6	9.2	<2.0	
TID[7] 6	8.2	8.5	520	585	8.8	9.3	<2.0	
TID 5	8.0	8.6	659	683	7.9	8.7	3.0	
TID 3	8.4	8.6	600	645	9.6	8.6	<2.0	
Orestimba Ck	8.5	8.7	1048	1090	8.8	8.4	<2.0	
Del Puerto Ck	8.4	8.7	1490	1090	8.7	8.4	<2.0	
Ingram-Hospital Cks	8.5	8.5	1538	1579	8.7	7.8	<2.0	
Spanish Grant Combined Drain	8.1	8.5	1500	1508	8.2	8.7	<2.0	
Laboratory control	7.5	8.3	204	201	7.9	9.4	<2.0	
Dilution control	7.6	8.2	135	145	8.3	9.4	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] Volume dilution water / (volume dilution water + volume sample) X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 25 May 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	8.1	8.4	2480/1919	1918	10.8	9.6	<2.0	29
SJR[6] @ Hills Ferry	8.4	8.5	2680/1885	1912	12.4	10.0	<2.0	35
SJR @ Laird Park	9.1	8.8	1530	1598	18.9	9.9	<2.0	
SJR @ Airport Way	9.3	8.6	904	958	18.7	9.8	<2.0	
Merced R.	7.9	8.1	203	226	10.6	9.8	<2.0	
Tuolumne R.	8.0	8.4	307	356	10.8	9.8	<2.0	
Stanislaus R.	8.0	8.0	102	125	10.6	9.7	<2.0	
TID[7] 6	sample used for chemistry duplicate							
TID 5	8.1	8.5	693	729	10.7	9.8	<2.0	
TID 3	8.6	8.3	530	652	12.5	8.9	<2.0	
Orestimba Ck	8.4	8.7	1115	1149	10.5	9.8	<2.0	
Del Puerto Ck	8.6	8.6	1240	1264	12.2	9.4	<2.0	
Ingram-Hospital Cks	8.5	8.6	1530	1590	12.1	9.7	<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.6	8.6	1517	1510	12.2	9.9	<2.0	
Spanish Grant Combined Drain	8.2	8.6	1272	1286	10.4	9.4	<2.0	
Laboratory control	8.3	8.4	183	199	9.9	9.7	<2.0	
Dilution control	8.3	8.4	129	197	9.9	9.9	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
Date: 1 June 1992								
Salt Slough	8.4	8.4	2490/1957	1942	12.6	8.0	<2.0	29
SJR[6] @ Hills Ferry	8.8	8.4	2820/2000	2010	16.1	8.2	<2.0	35
SJR @ Laird Park	9.4	8.4	1620	1678	20.0	8.2	<2.0	
SJR @ Airport Way	9.4	8.4	806	857	18.7	8.2	<2.0	
Merced R.	8.0	8.2	805	819	10.7	8.0	<2.0	
Tuolumne R.	8.4	8.4	385	418	12.4	8.3	<2.0	
Stanislaus R.	7.9	7.8	109	126	10.8	8.2	<2.0	
TID[7] 6	7.4	8.1	313	342	7.5	11.8	<2.0	
TID 5	8.1	8.5	557	598	10.8	10.3	<2.0	
TID 3	used for water chemistry duplicate							
Orestimba Ck	8.4	8.7	1126	1144	10.8	10.1	<2.0	
Del Puerto Ck	8.8	8.6	1542	1592	12.1	10.2	<2.0	
Ingram-Hospital Cks	8.7	8.9	1548	1607	12.0	10.0	<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.7	8.6	1557	1603	12.1	10.2	<2.0	
Spanish Grant Combined Drain	8.3	8.5	1498	1605	10.6	12.2	<2.0	
Laboratory control	8.4	8.2	191	205	10.5	8.3	<2.0	
Dilution control	8.5	8.2	126	146	10.5	8.2	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 15 June 1992								
Site	pH start	pH end	EC[1] start[4]	EC[1] end	DO[2] start	DO[2] end	NH_3-N[3]	dilution[5] (%)
Salt Slough	8.2	8.4	2180/1680	1710	12.3	7.9	<2.0	29
SJR[6] @ Hills Ferry	8.6	8.6	2490/1819	1920	14.3	8.1	<2.0	35
SJR @ Laird Park	9.0	8.2	1526	1620	16.9	8.8	<2.0	
SJR @ Airport Way	9.0	8.1	842	903	16.1	7.9	<2.0	
Merced R.	8.1	8.4	468	504	12.4	7.8	<2.0	
Tuolumne R.	8.1	8.5	375	424	12.0	8.0	<2.0	
Stanislaus R.	7.8	7.9	98	132	10.8	7.6	<2.0	
TID[7] 6	7.9	8.4	480	516	10.9	8.0	<2.0	
TID 5	8.2	8.5	709	787	10.9	7.9	<2.0	
TID 3	used for water chemistry replicate							
Orestimba Ck	8.3	8.4	1068	1138	12.0	8.0	<2.0	
Del Puerto Ck	8.8	8.4	1481	1526	12.0	8.0	<2.0	
Ingram-Hospital Cks	8.5	8.4	1642	1739	10.7	7.9	<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.5	8.4	1653	1713	10.8	7.7	<2.0	
Spanish Grant Combined Drain	8.5	8.4	1508	1656	10.7	7.7	<2.0	
Laboratory control	8.3	8.3	188	211	10.2	7.9	<2.0	
Dilution control	8.2	8.0	130	161	10.3	7.8	<2.0	

[1] Electrical conductivity (µmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District

Table 1. (Continued).

Date: 22 June 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
Salt Slough	8.2	7.9	1679	1163	12.8	9.4	<2.0	
SJR[6] @ Hills Ferry	8.7	8.2	2260/1647	1706	16.8	8.8	<2.0	35
SJR @ Laird Park	9.5	8.6	1130	1397	20.8	9.6	<2.0	
SJR @ Airport Way	9.5	8.4	880	985	20.8	9.8	<2.0	
Merced R.	8.0	8.1	220	266	14.1	9.4	<2.0	
Tuolumne R.	8.3	8.4	380	439	14.2	10.0	<2.0	
Stanislaus R.	8.3	8.1	123	151	14.3	8.0	<2.0	
TID[7] 6	8.0	8.6	524	576	12.5	7.9	<2.0	
TID 5	7.9	8.3	413	478	12.8	8.0	<2.0	
TID 3	7.9	8.4	609	634	10.4	8.1	9.0	
Orestimba Ck	8.3	8.4	1171	1225	14.1	10.5	<2.0	
Del Puerto Ck	8.7	8.5	1264	1402	14.1	7.9	<2.0	
Ingram-Hospital Cks	8.8	8.4	1394	1528	12.3	8.0	<2.0	
Ingram-Hospital Cks - chemistry duplicate	8.8	8.5	1431	1607	12.3	8.0	<2.0	
Spanish Grant Combined Drain	8.4	8.3	1333	1468	14.1	10.8	<2.0	
Extra sample	used for water chemistry duplicate							
Laboratory control	8.4	8.4	186	226	12.8	7.9	<2.0	
Dilution control	8.1		123		12.8		<2.0	

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.

[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District

Table 2. Bioassay water quality measurements for Lagrangian survey conducted on 23-26 April 1991.

Date: Lagrangian Survey 23 to 26 April 1991								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hwy 165[8]	8.1	8.5	2000	2000	7.8	8.2	<2.0	
Salt Slough @ Hwy 165[8]	8.0	8.5	2080	2100	7.5	8.2	<2.0	
Mud Slough @ Kesterson[8]	8.3	8.6	3760/2180	2200	7.7	8.2	<2.0	50
Los Banos[8]	8.4	8.8	2870/2010	2040	7.7	8.1	<2.0	35
Newman Wasteway[8]	7.9	8.6	970	1050	7.7	8.0	<2.0	
Merced River[8]	7.9	8.2	201	292	7.7	8.0	<2.0	
SJR @ Hills Ferry[8]	8.4	8.5	1626	1601	7.6	8.0	<2.0	
SJR @ Fremont Ford[8]	8.1	8.5	2210/1920	1980	7.5	8.1	<2.0	12
TID 5[7]	7.3	7.9	605	606	8.6	8.4	3.0	
SJR @ West Main	8.0	8.5	1589	1662	8.8	8.8	<2.0	
Del Puerto Ck	8.5	8.7	1560	1586	9.0	8.8	<2.0	
Stanislaus River	7.9	8.2	180	183	9.0	8.8	<2.0	
SJR @ Maze Blvd	8.0	8.3	768	802	9.1	8.7	<2.0	
SJR @ Airport Way	8.4	8.4	702	732	9.0	8.8	<2.0	
Orestimba Ck	8.5	8.7	870	905	9.1	8.8	<2.0	
Tuolumne River	7.8	8.1	106	120	9.2	8.8	<2.0	
SJR @ Laird Park	8.1	8.7	1585	1627	9.0	8.8	<2.0	
Ingram Hospital Cks	8.2	8.6	1553	1589	9.0	8.8	<2.0	
Laboratory control #1	8.1	8.4	307	360	8.4	8.0	<2.0	
Dilution Control #1	7.3	8.1	154	155	8.4	8.2	<2.0	
Laboratory Control #2	8.2	8.5	244	250	8.2	8.8	<2.0	

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.
[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}}$ X 100 [6] San Joaquin River [7] Turlock Irrigation District
[8] Laboratory and dilution control #1 apply

Table 3. Water quality measurements for Lagrangian survey conducted on 28-30 January 1992.

Date: Lagrangian Survey 28-30 January 1992								
Site	pH		EC[1]		DO[2]		NH_3-N[3]	dilution[5] (%)
	start	end	start[4]	end	start	end		
SJR[6] @ Hwy 165[8]	7.9	8.3	1290	1304	10.1	8.0	<2.0	
Salt Slough @ Hwy 165[8]	7.9	8.2	3040/2010	2330	10.1	8.1	<2.0	39
Mud Slough @ Kesterson	7.9	8.5	3230/1980	2100	9.8	8.2	<2.0	44
Los Banos	8.2	8.5	4860/1999	2300	10.6	8.0	<2.0	54
Newman Wasteway	7.7	8.6	1093	1150	9.2	7.9	<2.0	
Merced River[8]	7.6	7.6	105	126	10.6	7.9	<2.0	
SJR @ Hills Ferry[8]	8.0	8.0	1340	1300	10.4	8.0	<2.0	
SJR @ Fremont Ford[8]	8.0	8.1	3100/2010	2010	10.2	8.0	<2.0	42
TID 5[7]	7.8	7.8	1650	1625	7.0	4.6	<2.0	
SJR @ West Main	7.6	8.1	1470	1548	9.5	8.1	<2.0	
Stanislaus River	7.6	7.8	144	165	10.2	8.0	<2.0	
SJR @ Maze Blvd	7.7	8.2	1107	1243	10.0	7.9	<2.0	
SJR @ Airport Way	7.7	8.2	992	1068	10.0	7.9	<2.0	
Tuolumne River	7.8	7.9	231	288	10.2	7.9	<2.0	
SJR @ Laird Park	7.7	8.4	1426	1555	10.4	7.9	<2.0	
Ingram Hospital Cks	8.1	8.4	1491	1542	10.2	8.0	<2.0	
Laboratory control #1	8.1	8.1	188	200	8.1	8.1	<2.0	
Dilution Control #1	8.0	7.6	196	197	8.2	7.6	<2.0	
Laboratory Control #2	8.2	8.3	193	214	8.2	7.9	<2.0	
Dilution Control #2	8.3	8.1	124	133	7.8	8.0	<2.0	

[1] Electrical conductivity (μmhos/cm). [2] Dissolved oxygen (mg/l). [3] Ammonia (mg/l) [4] EC (before/after) dilution.
[5] $\frac{\text{Volume dilution water}}{\text{(volume dilution water + volume sample)}} \times 100$ [6] San Joaquin River [7] Turlock Irrigation District
[8] Laboratory control and dilution control #1 apply

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APPENDIX C

LOCATION OF SAMPLING SITES

Table 1. Description of sampling sites employed in the San Joaquin study, 1991-92. All samples were collected from the bank or by wading into the River. River miles are from U.S. Army Corps of Engineers (1984 a, b)

LOCATION	DESCRIPTION
SALT SLOUGH	Sample collected from the north side of the Slough at the Landers Avenue Bridge (Highway 165). Salt Slough enters the San Joaquin River at River mile 129.
SAN JOAQUIN RIVER AT HILLS FERRY ROAD	Sample collected from the west bank of the River about 0.5 miles upstream of its confluence with the Merced River at an abandoned tallow factory. River Mile 118.5
MERCED RIVER	Sample collected from the north bank of the River at the George J. Hatfield State Park. The confluence of the Merced and San Joaquin Rivers is at River mile 118.
TURLOCK IRRIGATION DISTRICT LATERAL NO. 6	Sample collected about 200 yards west of where the drain crosses under Central Avenue. TID 6 discharges at River mile 115.5.
ORESTIMBA CREEK	Sample collected at River Road bridge. The Creek discharges to the San Joaquin River at River mile 109.
SPANISH GRANT COMBINED DRAIN	Sample collected at intersection of Marshall and River Roads by trespassing through an abandoned dairy, up onto the eastern flood control levee of the San Joaquin and across a field to where three drains combine and discharge to the drain. The drain discharges at River mile 105.
TURLOCK IRRIGATION DISTRICT LATERAL No. 5	Sample collected from Drain at Carpenter Road bridge. The drain enters the River at mile 103.5
TURLOCK IRRIGATION DISTRICT LATERAL No. 3.	Sample collected at the Jennings Road bridge. The lateral discharges at River mile 93.5

Table 1. (Continued).

LOCATION	DESCRIPTION

DEL PUERTO CREEK Sample collected from south bank at end of Loquat Road. Del Puerto flows into the San Joaquin at River mile 93.0.-

SAN JOAQUIN RIVER AT LAIRD PARK Sample collected off east bank upstream of the confluence of lower Lateral No. 2 at Laird Park. River mile 90.5

TUOLUMNE RIVER Sample collected on north side of River at Shiloh Road bridge. The confluence of the Tuolumne and the San Joaquin Rivers is at River mile 83.8

INGRAM-HOSPITAL CREEKS Sample collected off Dairy Road by trespassing through dairy and onto the Creek's north levee bank road. Sample collected where levee Road makes an abrupt turn north. Ingram-Hospital Creek discharges at River mile 81.

STANISLAUS RIVER Sample collected off north bank of River at Caswell State Park. The Stanislaus River discharges to the San Joaquin River at River mile 75.0 .

APPENDIX D

SUMMARY OF BIOASSAY MORTALITY AND AMMONIA AND PESTICIDE CONCENTRATIONS

C-034342

Table 1. Summary of bioassay, pesticide and ammonia data by survey date. Shading indicates sites testing toxic. Toxicity is defined as a statistically lower survival rate ($P<0.05$, Fisher Exact Test) than in the laboratory control.

Date: 25 February 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100		
SJR[2] @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	100	100	100		
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	90	90	90	90		
TID[3] 6	100	100	100	100		
TID 5	100	100	100	100		
TID 5- bioassay duplicate	90	90	90	90		
TID 3	100	100	100	100		
Orestimba Creek	90	90	40	20	parathion=0.24(3.4) carbamates=nd	P=3.4
Del Puerto Creek	used for bioassay duplicate					
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 4 March 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	80	80	80		
SJR @ Airport Road- bioassay duplicate	100	100	100	100		
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	used for bioassay duplicate					
TID[3] 6	100	100	100	100		
TID 5	0	0	0	0	organophosphates=nd=carbamates NH_3=3.56(1.9)	N=1.9
TID 3	0	0	0	0	chlorpyrifos=0.12(1.2) malathion=0.01 NH_3=0.23 diazinon=0.19 parathion=0.37(5.3) carbamates=nd	P=6.5
Orestimba Creek	0	0	0	0	carbaryl=1.7 diazinon=0.02 parathion=0.31(4.4)	P=4.4
Del Puerto Creek	30	0	0	0	diazinon=0.1 m.parathion=0.02 fonofos=0.03 parathion=0.13(1.9) carbamates=nd NH_3=0.54	P=1.9
Ingram Hospital Creek	60	0	0	0	diazinon=0.02 parathion=0.12(1.7) fonofos=0.06 carbamates=nd	P=1.7
Spanish Grant Combined Drain	40	0	0	0	diazinon=0.02 parathion=0.09(1.3) fonofos=0.01 carbamates=nd	P=1.3
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 19 March 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	90	90		
SJR @ Laird Park	80	80	80	80		
SJR @ Airport Road	90	90	90	90		
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	100	100	100	100		
TID[3] 6	used for bioassay duplicate					
TID 5	0	0	0	0	chlorpyrifos=0.05(0.5) malathion=0.01 diazinon=0.03 carbamates=nd NH_3=13.75(7.2)	N=7.2 P=0.5
TID 3	0	0	0	0	chlorpyrifos=0.23(2.3) diazinon=0.04 carbamates=nd	P=2.3
Orestimba Creek	60	0	0	0	parathion=0.02 diazinon=0.3(0.6) chlorpyrifos=0.05(0.5) carbamates=nd	P=1.1
Orestimba Creek- bioassay duplicate	60	0	0	0		
Del Puerto Creek	40	0	0	0	chlorpyrifos=0.12(1.2) diazinon=0.03 parathion=0.02 carbamates=nd	P=1.2
Ingram Hospital Creek	0	0	0	0	chlorpyrifos=0.57(5.7) parathion=0.01 diazinon=0.02 fonofos=0.01 carbamates=nd	P=5.7
Spanish Grant Combined Drain	0	0	0	0	chlorpyrifos=0.47(4.7) parathion=0.04(0.6) diazinon=0.02 carbamates=nd	P=5.3
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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C-034345

Table 1. (Continued).

Date: 4 April 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	90	90	90		
SJR @ Hills Ferry Road- bioassay duplicate	100	100	100	100		
SJR @ Laird Park	100	90	90	90		
SJR @ Airport Road	100	100	100	100		
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	100	100	100	100		
TID[3] 6	70	70	70	70		
TID 5	80	10	10	10	chlorpyrifos=0.02 malathion=0.01 diazinon=0.04 carbamates=nd NH_3=2.7(1.4)	N=1.4
TID 3	100	50	10	0	chlorpyrifos=0.06(0.6) diazinon=0.02 carbamates=nd NH_3=2.25(1.2)	N=1.2 P=0.6
Orestimba Creek	no flow					
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	90	90	90		
Spanish Grant Combined Drain	used for bioassay duplicate					
Laboratory control	100	100	100	90		
Dilution control	90	90	90	90		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 18 April 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	80	70		
SJR @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	100	90	90		
Merced River	100	100	100	100		
Tuolumne River	100	100	80	80		
Stanislaus River	100	90	50	50	organophosphates=nd=carbamates	
TID[3] 6	used for bioassay duplicate					
TID 5	100	100	100	100		
TID 5- bioassay duplicate	100	100	100	100		
TID 3	100	100	100	100		
Orestimba Creek	50	0	0	0	diazinon=0.02 chlorpyrifos=0.15(1.5) carbamates=nd	P=1.5
Del Puerto Creek	100	90	90	80		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	90	80	60	chlorpyrifos=0.11(1.1) diazinon=0.01 carbamates=nd	P=1.1
Laboratory control	100	90	90	90		
Dilution control	100	100	90	80		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 3 May 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	100	100	90		
Merced River	100	100	100	100		
Tuolumne River	100	100	80	80		
Stanislaus River	100	100	100	100		
TID[3] 6	used for bioassay duplicate					
TID 5	100	100	100	100		
TID 5- bioassay duplicate	100	100	100	100		
TID 3	100	100	100	100		
Orestimba Creek	100	100	100	100		
Del Puerto Creek	90	90	90	90		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	100	90	90		
Laboratory control	100	100	100	100		
Dilution control	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. *Unionized ammonia as NH_3*. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 15 May 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100	chlorpyrifos=0.01[5] diazinon=0.01 fonofos=0.01 carbamates=nd	
SJR @ Airport Road	80	80	80	80	chlorpyrifos=0.01[5] diazinon=0.01 carbamates=nd	
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	100	100	100	100		
TID[3] 6	100	100	100	100		
TID 6- bioassay duplicate	100	100	100	100		
TID 5	used for bioassay duplicate					
TID 3	100	100	100	100		
Orestimba Creek	0	0	0	0	chlorpyrifos=0.12(1.2) fonofos=0.01 diazinon=0.01 carbamates=nd	P=1.2
Del Puerto Creek	100	20	0	0	chlorpyrifos=0.02 fonofos=0.09 diazinon=0.04 parathion=0.01 carbaryl=1.6	
Ingram Hospital Creek	0	0	0	0	chlorpyrifos=0.01 fonofos=0.06 carbaryl=8.4(0.7) diazinon=0.03	P=0.7
Spanish Grant Combined Drain	0	0	0	0	chlorpyrifos=0.22(2.2) fonofos=0.01 diazinon=0.02 parathion=0.01 carbamates=nd	P=2.2
Laboratory control	100	100	100	100		
Dilution control	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.
[5]Organophosphate samples not extracted for two months. Reported values may be low.

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Table 1. (Continued).

Date: 28 May 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	90	90	90		
SJR @ Laird Park	100	80	80	80	chlorpyrifos=0.02 fonofos=0.02 diazinon=0.06 parathion=0.03 carbamates=nd	
SJR @ Airport Road	100	100	80	80		
Merced River	90	90	90	90		
Tuolumne River	90	90	90	90		
Stanislaus River	100	100	100	100		
TID[3] 6	100	50	0	0	chlorpyrifos=0.15(1.5) carbamates=nd	P=1.5
TID 5	100	100	100	100		
TID 3 sample bottle dropped						
Orestimba Creek	100	100	100	100		
Del Puerto Creek	0	0	0	0	chlorpyrifos=0.01 fonofos=0.12 carbamates=nd diazinon=0.42(0.8) parathion=0.72(10.3)	P=11.1
Ingram Hospital Creek	0	0	0	0	chlorpyrifos=0.02 fonofos=0.01 diazinon=0.03 parathion=0.91(9.1) carbamates=nd	P=9.1
Spanish Grant Combined Drain	0	0	0	0	chlorpyrifos=0.21(2.1) fonofos=0.20(0.7) diazinon=0.05 parathion=0.01 carbamates=nd	P=2.8
Laboratory control	100	100	100	100		
Dilution control	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 12 June 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	0	0	0	0	chlorpyrifos=0.01 diazinon=0.01 carbamates=nd	
SJR @ Laird Park	20	0	0	0	organophosphates=nd carbamates=bottle broken	
SJR @ Airport Road	100	90	90	90	isofenfos=0.074(?) diazinon=0.01 carbamates=nd	
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	60	60	60	60	chlorpyrifos=0.01 diazinon=0.02 fonofos=0.01 carbamates=bottle broken	
TID[3] 6	used for bioassay duplicate					
TID 5	100	100	100	100	NH_3=0.46	
TID 3	100	100	100	100		
TID 3- bioassay duplicate	90	90	90	90		
Orestimba Creek	100	100	100	100		
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	100	70	10	chlorpyrifos=0.08(0.8) diazinon=0.02 fonofos=0.03 carbamates=nd	P=0.8
Laboratory control	100	100	100	100		
Dilution control	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). (?) indicates no toxicity data. [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 26 June 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	100	100	100		
Merced River	90	90	90	90		
Tuolumne River	100	100	100	100		
Stanislaus River	90	90	90	90		
TID[3] 6	90	90	90	90		
TID 5	100	100	100	100	NH_3=0.59	
TID 3	100	100	100	100		
Orestimba Creek	100	100	100	100		
Del Puerto Creek	used for bioassay duplicate					
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	100	100	100		
Spanish Grant Combined Drain-bioassay duplicate	100	100	90	90		
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 2 July 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	90	90	80[5]		
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	90	90	90		
SJR @ Airport Road	100	100	100	100		
SJR @ Airport Road- bioassay duplicate	100	100	100	100		
TID[3] 5	used for bioassay duplicate					
TID 3	100	100	100	100		
Orestimba Creek	100	100	100	100		
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.
[5]One animal accidentally killed by laboratory personnel.

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Table 1. (Continued).

Date: 15 July 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	90	90	90		
SJR[2] @ Hills Ferry Road	100	100	90	90		
SJR @ Laird Park	100	100	90	90		
SJR @ Airport Road	100	100	100	100		
TID[3] 6	90	90	60	60	chlorpyrifos=0.01 carbamates=nd	
TID 5	used for bioassay duplicate					
TID 3	100	100	100	100		
TID 3- bioassay duplicate	100	100	100	100		
Orestimba Creek	90	90	90	90		
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	90	90	90	90		
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 30 July 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100		
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	100	100	100		
TID[3] 5	100	100	100	100		
TID 3	90	90	90	90		
Orestimba Creek	0	0	0	0	chlorpyrifos=0.72(7.2) carbamates=nd	P=7.2
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	used for bioassay duplicate					
Spanish Grant Combined Drain	90	90	90	90		
Spanish Grant Combined Drain-bioassay duplicate	100	100	100	100		
Laboratory control	90	90	90	90		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 16 August 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	90	90	90	90		
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	100	100	100		
TID[3] 6	90	90	90	90		
TID 5	100	100	100	100		
TID 3	100	100	100	100		
Orestimba Creek	used for bioassay duplicate					
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	80	80	80		
Spanish Grant Combined Drain-bioassay duplicate	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 6 September 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_5 units[4]
Salt Slough	100	100	100	100		
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100	diazinon=0.01 carbamates=nd	
SJR @ Airport Road	100	100	100	100		
TID[3] 6	100	90	90	90	NH_3=0.59	
TID 5	100	100	100	100	NH_3=1.19(0.6)	N=0.6
TID 3	100	100	100	100		
Orestimba Creek	used for bioassay duplicate					
Del Puerto Creek	100	90	90	90	diazinon=0.01 NH_3=0.78	
Ingram Hospital Creek	0	0	0	0	chlorpyrifos=0.33(3.3) diazinon=0.01 carbamates=bottle broken	P=3.3
Spanish Grant Combined Drain	100	100	100	100		
Spanish Grant Combined Drain-bioassay duplicate	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 18 September 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100		
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	90[5]	90	90		
SJR @ Airport Road	100	100	100	100		
TID[3] 6	100	100	100	100		
TID 5	100	100	100	100		
TID 3	no flow					
Orestimba Creek	100	100	100	100		
Orestimba Creek- bioassay duplicate	100	100	100	100		
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	90	90	90	90		
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.
[5]One animal accidentally killed by laboratory personnel.

Table 1. (Continued).

Date: 26 September 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	80	80	80	80		
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	90	90	90	90	diazinon=0.01 carbamates=nd	
SJR @ Airport Road	100	100	100	100		
TID[3] 6	no flow					
TID 5	90	90	90	90		
TID 3	used for bioassay duplicate					
Orestimba Creek	100	100	100	100		
Del Puerto Creek	90	90	90	90		
Ingram Hospital Creek	90	90	90	90		
Ingram Hospital Creek- bioassay duplicate	100	100	100	100		
Spanish Grant Combined Drain	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

Table 1. (Continued).

Date: 9 October 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100	NH_3=0.71	
SJR @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	100	100	100		
Merced River	90	80	80	70	organophosphates=nd=carbamates	
Tuolumne River	100	100	100	100		
Stanislaus River	100	100	100	80	organophosphates=nd=carbamates	
TID[3] 6	100	100	100	100		
TID 5	used for bioassay duplicate					
TID 3	90	90	90	90	NH_3=1.67(0.9)	N=0.9
TID 3- bioassay duplicate	100	90	90	90	NH_3=1.67(0.9)	N=0.9
Orestimba Creek	100	100	100	100		
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]*San Joaquin River.* [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

Table 1. (Continued).

Date: 24 October 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	90		
SJR @ Laird Park	100	100	100	100	diazinon=0.01 carbamates=nd	
SJR @ Airport Road	100	100	100	100		
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	100	100	100	100		
TID[3] 6	used for bioassay duplicate					
TID 5	100	100	100	100		
TID 5- bioassay duplicate	100	100	100	100		
TID 3	no flow					
Orestimba Creek	100	100	90	90		
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	0	0	0	0	methomyl=3.2(0.6) fonofos=0.05 diazinon=0.19	P=0.6
Spanish Grant Combined Drain	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

Table 1. (Continued).

Date: 30 October 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100	NH_3=0.46	
SJR @ Laird Park	100	100	100	100	diazinon=0.01 carbamates=nd	
SJR @ Airport Road	100	100	100	100		
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	100	100	100	100		
TID[3] 6	no flow					
TID 5	100	100	100	100		
TID 3	no flow					
Orestimba Creek	used for bioassay duplicate					
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	no flow					
Spanish Grant Combined Drain	100	100	100	100		
Spanish Grant Combined Drain-bioassay duplicate	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

Table 1. (Continued).

Date: 13 November 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_5 units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100	diazinon=0.01 carbamates=nd	
SJR @ Airport Road	100	100	100	100		
Merced River	100	100	100	100		
Tuolumne River	100	90	90	90		
Stanislaus River	100	90	90	90		
TID[3] 6	used for bioassay duplicate					
TID 5	100	100	100	100	NH_3=1.66(0.9)	N=0.9
TID 5- bioassay duplicate	100	100	100	100	NH_3=1.66(0.9)	N=0.9
TID 3	100	100	100	100		
Orestimba Creek	100	100	100	100		
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	100	100	100	100		
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 25 November 1991						
Station	4 Day Survival (%)				Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100		
SJR @ Laird Park	100	100	100	100		
SJR @ Airport Road	100	100	100	100		
Merced River	100	100	100	100		
Tuolumne River	100	100	100	100		
Stanislaus River	100	100	100	100		
TID[3] 6	50	0	0	0	organophosphates=nd=carbamates NH_3=1.84(1.0)	N=1.0
TID 5	100	100	100	100	NH_3=1.33(0.7)	N=0.7
TID 3	no flow					
Orestimba Creek	100	100	100	100		
Orestimba Creek- bioassay duplicate	100	100	100	100		
Del Puerto Creek	100	100	100	100		
Ingram Hospital Creek	100	100	100	100		
Spanish Grant Combined Drain	used for bioassay duplicate					
Laboratory control	100	100	100	100		
Dilution control						

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; *nd=no detections*. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 4 December 1991									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Laird Park	100	100	100	100	100	100	100		
SJR @ Airport Road	100	100	100	100	100	100	70	NH_3=0.40	
Merced River	100	100	100	100	100	100	60		
Tuolumne River	100	100	100	90[5]	90	90	90		
Stanislaus River	100	100	100	100	100	80	80		
TID[3] 6	used for bioassay duplicate								
TID 5	100	100	100	100				NH_3=0.40	
TID 3	no flow								
Orestimba Creek	100	100	100	100					
Del Puerto Creek	100	100	100	100				NH_3=0.53	
Ingram Hospital Creek	0	0	0	0				diazinon=0.31(0.6) fonofos=0.28(1.0) methomyl=2.6(0.5)	P=2.1
Ingram Hospital Creek- bioassay duplicate	0	0	0	0					
Spanish Grant Combined Drain	100	100	100	100					
Laboratory control	100	100	100	100	100	100	100		
Dilution control									

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel.

Table 1. (Continued).

Date: 11 December 1991									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	90		
SJR @ Laird Park	100	100	100	100	100	100	100		
SJR @ Airport Road	100	100	90	90	90	90	90		
Merced River	100	100	100	80	80	80	80		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	90	90	90	90	90	90	90		
TID[3] 6	100	100	80	80					
TID 5	100	90	90	90				NH_3=1.13(0.6)	N=0.6
TID 3	100	100	100	100					
Orestimba Creek	70	50	50	50				organophosphates=bottle broken carbamates=nd	
Del Puerto Creek	used for bioassay duplicate								
Ingram Hospital Creek	90	90	90	90					
Spanish Grant Combined Drain	100	100	100	100					
Spanish Grant Combined Drain-bioassay duplicate	100	100	100	100					
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	90	90		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

Table 1. (Continued).

Date: 18 December 1991									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	90		
SJR @ Laird Park	100	100	100	100	100	100	100	parathion=0.01 carbamates=nd	
SJR @ Airport Road	100	100	90	90	90	90	90		
Merced River	100	100	90	90	90	90	90		
Tuolumne River	100	100	100	100	90[5]	90	90		
Stanislaus River	90	90	90	90	90	90	90		
TID[3] 6	used for bioassay duplicate								
TID 5	30	20	0	0				chlorpyrifos=0.01 NH_3=3.06(1.6) diazinon=0.08 carbamates=nd	N=1.6
TID 3	100	100	100	100					
TID 3- bioassay duplicate	100	100	100	100					
Orestimba Creek	no flow								
Del Puerto Creek	0	0	0	0				parathion=2.1(30) carbamates=nd	P=30
Ingram Hospital Creek	no flow								
Spanish Grant Combined Drain	100	100	70	70					
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.
[5]One animal accidentally killed by laboratory personnel.

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Table 1. (Continued).

Date: 23 December 1991									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	90	90	90	90	90		
SJR @ Laird Park	100	100	100	100	100	90	90	parathion=0.01 carbamates=nd	
SJR @ Airport Road	100	90	90	90	90	90	90		
Merced River	100	100	100	100	100	100	100		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	100	100	90[5]	90	90	90	90		
TID[3] 6	100	90	90	90					
TID 5	100	100	100	100				NH_3=1.17(0.6)	N=0.6
TID 3	no flow								
Orestimba Creek	no flow								
Del Puerto Creek	40	40	0	0				chlorpyrifos=0.01 diazinon=0.01 parathion=0.24(3.4) carbamates=nd	P=3.4
Ingram Hospital Creek	100	100	0	0				diazinon=0.01 parathion=0.16(2.3) carbamates=nd	P=2.3
Spanish Grant Combined Drain	100	100	100	70					
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel.

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Table 1. (Continued).

Date: 5 January 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	90	90	90	90	90	90	90		
SJR @ Laird Park	100	100	100	100	100	100	100	diazinon=0.02 parathion=0.02 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	100		
Merced River	100	100	100	100	100	100	100		
Merced River- bioassay duplicate[5]	100	100	100	100	100	100	100		
Tuolumne River	used for bioassay duplicate								
Stanislaus River	100	100	100	100	100	100	100		
TID[3] 6	100	100	100	100					
TID 5	80	60	40	40				chlorpyrifos=0.01 diazinon=0.05 carbamates=nd NH_3=13.69(7.2)	N=7.2
TID 3	20	0	0	0				chlorpyrifos=0.02 diazinon=0.20 parathion=0.10(1.4) carbamates=nd	P=1.4
Orestimba Creek	100	100	100	100					
Del Puerto Creek	0	0	0	0				chlorpyrifos=0.01 fonofos=0.01 diazinon=0.12 parathion=0.51(7.3) carbamates=nd	P=7.3
Ingram Hospital Creek	0	0	0	0				parathion=0.12(1.7) methomyl=5.4(0.6) diazinon=0.16 fonofos=0.09	P=2.3
Spanish Grant Combined Drain	0	0	0	0				DEF=0.01(?) parathion=0.29(4.1) diazinon=0.08 carbamates=nd	P=4.1
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). (?) indicates no toxicity data. [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

Table 1. (Continued).

Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Date: 13 January 1992									
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	NH_3=0.40	
SJR @ Laird Park	100	100	100	100	100	100	100	diazinon=0.01 carbamates=nd	
SJR @ Airport Road	100	100	90	90	90	90	80		
Merced River	100	100	100	100	100	100	100		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	100	100	100	100	100	80[5]	80		
TID[3] 6	0	0	0	0				chlorpyrifos=0.24(2.4) diazinon=0.02 parathion=0.05(0.7) carbamates=nd NH_3=1.66(0.9)	N=0.9 P=3.1
TID 5	100	90	30	0				chlorpyrifos=0.01 DEF=0.01(?) diazinon=0.17 carbamates=nd NH_3=5.32(2.8)	N=2.8
TID 3	no flow								
Orestimba Creek	no flow								
Del Puerto Creek	0	0	0	0				diazinon=0.2 parathion=0.46(6.6) carbamates=nd	P=6.6
Ingram Hospital Creek	used for bioassay duplicate								
Spanish Grant Combined Drain	no flow								
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	90	90		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). (?) indicates no toxicity data. [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel.

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Table 1. (Continued).

Date: 20 January 1992									
Station	*Ceriodaphnia* Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	90	80					
SJR @ Laird Park	100	100	100	100				chlorpyrifos=0.01 diazinon=0.01 carbamates=nd NH_3=0.53	
SJR @ Airport Road	100	100	60	60				chlorpyrifos=0.01 diazinon=0.04 carbamates=nd	
Merced River	90	90	70	50				chlorpyrifos=0.01 diazinon=0.08 carbamates=nd	
Tuolumne River	100	100	20	20				chlorpyrifos=0.02 diazinon=0.03 carbamates=nd	
Stanislaus River	100	100	50	50				diazinon=0.02 carbamates=nd	
TID 6	0	0	0	0				chlorpyrifos=0.17(1.7) parathion=0.01 diazinon=0.02 carbamates=nd	P=1.7
TID 6- bioassay duplicate[6]	0	0	0	0					
TID 5	0	0	0	0				chlorpyrifos=0.01 diazinon=0.09 carbamates=nd NH_3=11.7(6.1)	N=6.1
TID 3	0	0	0	0				chlorpyrifos=1.6(16) diazinon=0.09 carbamates=nd	P=16
Orestimba Creek	no flow								
Ingram Hospital Creek	100	90	80	80					
Spanish Grant Combined Drain	no flow								
Laboratory control	100	100	90	60[5]					
Dilution control	100	70	50	40[5]					

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]Poor control survival invalidates bioassay results. Toxicity subsequently traced to the use of a new type of plastic wrap in the laboratory. [6]Del Puerto Creek used for bioassay duplicate.

Table 1 (Continued).

Date: 3 February 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100	90	90	90		
SJR @ Laird Park	100	100	100	100	100	100	100	chlorpyrifos=0.01 diazinon=0.06 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	100		
Merced River	100	100	100	100	100	100	100		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	100	100	100	100	100	100	100		
TID[3] 6	100	30	0	0				chlorpyrifos=0.05(0.5) parathion=0.01 diazinon=0.11 carbamates=nd	P=0.5
TID 5	100	20	0	0				chlorpyrifos=0.01 diazinon=0.26(0.5) carbamates=nd NH_3=2.66(1.4)	N=1.4 P=0.5
TID 3	no flow								
Orestimba Creek	100	100	100	90					
Del Puerto Creek	0	0	0	0				chlorpyrifos=0.01 malathion=0.01 carbamates=nd diazinon=2.6(5.0)) parathion=0.22(3.1) NH_3=3.99(2.1)	N=2.1 P=8.1
Ingram Hospital Creek	100	100	100	100					
Ingram Hospital Creek- bioassay duplicate	100	100	100	100					
Spanish Grant Drain	used for bioassay duplicate								
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

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Table 1. (Continued).

Date: 10 February 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	NH_3=0.21	
SJR @ Laird Park	100	100	100	100	90	90	90	diazinon=0.07[6]	
SJR @ Airport Road	100	100	100	100	100	100	100		
Merced River	100	100	100	100	100	100	100		
Merced River- bioassay duplicate[7]	100	100	100	100	100	100	100		
Tuolumne River	100	100	100	100	90	90	80		
TID[3] 6	0	0	0	0				chlorpyrifos=0.12(1.2) diazinon=0.91(1.8) carbamates=nd NH_3=10.64(5.6)	N=5.6 P=3.0
TID 5	0	0	0	0				chlorpyrifos=0.04 diazinon=0.29(0.6) carbamates=nd NH_3=9.31(4.9)	N=4.9 P=0.6
TID 3	0	0	0	0				chlorpyrifos=0.73(7.3)[8] diazinon=2.6(5.2)	P=12.5
Orestimba Creek	60	0	0	0				chlorpyrifos=0.02[8] parathion=0.01 diazinon=0.26(0.5)	P=0.5
Del Puerto Creek	0	0	0	0				chlorpyrifos=0.03[8] malathion=0.28 diazinon=1.3(2.6) parathion=0.07(1.0)	P=3.6
Ingram Hospital Creek	80	0	0	0				chlorpyrifos=0.01 fonofos=0.02 diazinon=0.24(0.5) parathion=0.02 carbamates=nd	P=0.5
Spanish Grant Combined Drain	100	90	30	10				chlorpyrifos=0.08(0.8) parathion=0.12(1.7) diazinon=0.02[6]	P=2.5
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel. [6]No samples submitted for carbamate analysis. [7]Stanislaus River used for bioassay duplicate. [8]Carbamate=nd.

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Table 1. (Continued).

Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1,6]	Sum of LC_{50} units[4]
Date: 17 February 1992									
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Laird Park	no sample (see Lagrangian run, 19 February 1992)								
SJR @ Airport Road	20	0	0	0	0	0	0	chlorpyrifos=0.02 parathion=0.01 diazinon=0.28(0.6)	P=0.6
Merced River	30	0	0	0	0	0	0	chlorpyrifos=0.05(0.5) parathion=0.03 diazinon=0.32(0.6)	P=1.1
Tuolumne River	100	100	100	50	10	0	0	chlorpyrifos=0.03 diazinon=0.35(0.7)	P=0.7
Stanislaus River	100	100	100	90[7]	90	90	90	diazinon=0.06	
TID[3] 6	0	0	0	0				chlorpyrifos=0.04 malathion=0.01 diazinon=0.35(0.7) parathion=0.01	P=0.7
TID 5	0	0	0	0				chlorpyrifos=0.08(0.8) parathion=0.01 diazinon=0.5(1.0) NH_3=0.28	P=1.8
TID 3	0	0	0	0				chlorpyrifos=0.17(1.7) malathion=0.02 diazinon=0.82(1.6) parathion=0.02	P=3.3
Orestimba Creek	20	0	0	0				diazinon=0.38(0.8) parathion=0.04(0.6)	P=1.4
Del Puerto Creek	100	100	100	100					
Ingram Hospital Creek	100	100	100	100					
Spanish Grant Combined Drain	40	0	0	0				diazinon=0.06 parathion=0.01	
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100					

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]San Joaquin River was backing up into the El Solyo Drain. [6] No samples submitted for carbamate analysis.[7] One animal accidentally killed by laboratory personnel.

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Table 1. (Continued).

Date: 24 February 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1,5]	Sum of LC_{50} units[4]
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Laird Park	100	100	100	90	90	80	80	chlorpyrifos=0.01 diazinon=0.08 carbamates=nd	
SJR @ Airport Road	90	90	80	80	80	80	80		
Merced River	100	100	100	100	100	100	100		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	100	100	100	100	100	100	90		
TID[3] 6	100	100	100	100				chlorpyrifos=0.01 diazinon=0.02	
TID 5	0	0	0	0				chlorpyrifos=0.02 parathion=0.02 diazinon=0.45 (0.9) NH_3=2.66 (1.4)	N=1.4 P=0.9
TID 3	0	0	0	0				chlorpyrifos=0.03 diazinon=0.23	
Orestimba Creek	used for bioassay duplicate								
Del Puerto Creek	100	100	100	100					
Del Puerto Creek- bioassay duplicate									
Ingram Hospital Creek	100	0	0	0				chlorpyrifos=0.01 parathion=0.01 diazinon=0.2	
Spanish Grant Combined Drain	100	100	100	80					
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]No carbamate analyis conducted

C—034374

Table 1. (Continued).

Date: 2 March 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100	100	100	100		
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Laird Park	no sample								
SJR @ Airport Road	100	100	100	100	100	90	90		
Merced River	100	100	100	100	100	100	100		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	100	100	100	100	100	100	100		
TID[3] 6	100	100	100	100				NH_3=2.23(1.2)	N=1.2
TID 6- *bioassay duplicate*	100	100	100	100				NH_3=1.90(1.0)	N=1.0
TID 5	used for bioassay duplicate								
TID 3	80	0	0	0				chlorpyrifos=0.04 diazinon=0.33(0.7)	P=0.7
Orestimba Creek	no flow								
Del Puerto Creek	100	100	100	100					
Ingram Hospital Creek	100	100	100	100					
Spanish Grant Combined Drain	100	100	100	100					
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

C-034375

Table 1. (Continued).

Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Date: 9 March 1992									
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Laird Park	100	90	90	40	0	0	0	chlorpyrifos=0.04 diazinon=0.04 carbamates=nd	
SJR @ Airport Road	100	100	100	90	40	0	0	chlorpyrifos=0.03 diazinon=0.04 carbamates=nd	
Merced River	100	100	100	100	100	80	40	chlorpyrifos=0.01=parathion diazinon=0.04 carbamates=nd	
Tuolumne River	100	100	100	100	100	100	100		
Tuolumne River- bioassay duplicate[6]	100	100	100	100	100	100	100		
Stanislaus River	used for bioassay duplicate								
TID[3] 6	100	100	100	90					
TID 5	0	0	0	0				chlorpyrifos=0.08(0.8) diazinon=0.08 carbamates=nd NH_3=0.98	P=0.8
TID 3	0	0	0	0				chlorpyrifos=0.12(1.2) parathion=0.01 diazinon=0.27(0.5)	P=1.7
Orestimba Creek	100	90	90	80					
Del Puerto Creek	100	100	100	100					
Ingram Hospital Creek	0	0	0	0				chlorpyrifos=0.01 fonofos=0.01 diazinon=0.06	
Spanish Grant Combined Drain	100	100	100	90					
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	90	90	90	90		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

C-034376

Table 1. (Continued).

Date: 16 March 1992									
Station	Ceriodaphnia dubia Survival (%) by day[8]							Pesticide (ppb) and ammonia (mg/l) detections[1,5]	Sum of LC_{50} units[4]
Salt Slough	30	0	0	0				chlorpyrifos=0.01[7] malathion=0.16 diazinon=0.33(0.7)	P=0.7
SJR[2] @ Hills Ferry Road	100	100	100	20				chlorpyrifos=0.01[7] malathion=0.16 diazinon=0.38(0.8)	P=0.8
SJR @ Laird Park	100	100	100	100				chlorpyrifos=0.01[7] malathion=0.08 diazinon=0.07	
SJR @ Airport Road	100	80	80	80					
Merced River	100	100	100	80					
Tuolumne River	100	90	90	90					
Stanislaus River	100	100	100	100					
TID[3] 6	100	100	100	100					
TID 5	100	100	100	100					
TID 5- bioassay duplicate	100	100	90	90					
TID 3	100	100	0	0				chlorpyrifos=0.04 diazinon=0.18 carbamates=nd	
Orestimba Creek	used for bioassay duplicate								
Del Puerto Creek	100	100	70	70					
Ingram Hospital Creek	80	10	0	0				chlorpyrifos=0.06(0.6) diazinon=0.02 carbamates=nd	P=0.6
Spanish Grant Combined Drain	100	100	100	100					
Laboratory control	100	100	100	100					
Dilution control	100	100	100	90					

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]Refrigerator broke. Samples held incidentally for 72 hours without refrigeration at about 20 °C. [7]carbamates=nd. [8]Bioassay testing terminated at 96 hours to treat laboratory for fungal outbreak in water baths.

Table 1. (Continued).

Date: 23 March 1992									
Station	Ceriodaphnia dubia Survival (%) by day[4]							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100	100	100	100		
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Laird Park	100	100	100	100	100	100	90	chlorpyrifos=0.01 malathion=0.01 diazinon=0.14	
SJR @ Airport Road	100	100	100	100	100	100	100		
Merced River	100	100	100	100	100	90[6]	90		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	100	100	100	100	90	80	80		
TID[3] 6	100	100	100	100					
TID 5	100	100	100	100					
TID 3	90[5]	0	0	0					
Orestimba Creek	0	0	0	0				chlorpyrifos=0.29(2.9) malathion=0.18 diazinon=0.1 carbamates=nd	P=2.9
Del Puerto Creek	0	0	0	0				chlorpyrifos=0.02 fonofos=0.54(2.0) diazinon=0.13 malathion=0.01 carbamates=nd	P=2.0
Ingram Hospital Creek	0	0	0	0				chlorpyrifos=0.05(0.5) fonofos=0.02 diazinon=0.29(0.6) malathion=0.42 carbamates=nd parathion=0.04(0.6)	P=1.7
Spanish Grant Combined Drain	0	0	0	0				chlorpyrifos=0.06(0.6) parathion=0.11(1.1) carbofuran=0.8 diazinon=0.06	P=1.7
Laboratory control	100	100	100	100	90	90	90		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]Refrigerator froze sample--no analysis. [6]Animal accidentally killed by laboratory personnel.

Table 1. (Continued).

Date: 30 March 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	used for bioassay duplicate								
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Hills Ferry Road- bioassay duplicate	100	100	100	100	100	100	100		
SJR @ Laird Park	100	100	100	100	100	100	100	chlorpyrifos=0.01 diazinon=0.03 carbamates=nd	
SJR @ Airport Road	100	100	100	90	90	90	90		
Merced River	100	100	100	90	90	90	90		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	100	90	70	70	70	70	70		
TID[3] 6	100	100	100	100					
TID 5	100	100	100	100					
TID 3	100	100	100	100					
Orestimba Creek	100	100	100	100					
Del Puerto Creek	100	100	100	100					
Ingram Hospital Creek	100	100	100	100					
Spanish Grant Combined Drain	100	100	100	100					
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

Table 1. (Continued).

Date: 6 April 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100	100	100	100		
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Laird Park	100	90	90	90	80	80	70	diazinon=0.02 fonofos=0.01 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	100		
Merced River	100	100	100	100	100	100	100		
Tuolumne River	100	100	100	100	100	100	100		
Stanislaus River	100	100	100	100	90[5]	90	90		
TID[3] 6	40	0	0	0				chloropyrifos=0.14(1.4) diazinon=0.01 carbamates=nd	P=1.4
TID 5	100	100	100	100					
TID 3	used for bioassay duplicate								
Orestimba Creek	100	100	100	100					
Del Puerto Creek	100	100	70	10				diazinon=0.02 fonofos=0.52(1.9) carbamates=nd	P=1.9
Ingram Hospital Creek	100	100	100	100					
Ingram Hospital Creek- bioassay duplicate	100	100	100	100					
Spanish Grant Combined Drain	100	100	100	100					
Laboratory control	100	100	100	100	100	100	90[5]		
Dilution control	100	100	100	100	90[5]	90	90		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel.

C-034380

C-034380

Table 1. (Continued).

Date: 13 April 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	90	90	90	90	90	0	chlorpyrifos=0.12(1.2) diazinon=0.01 carbamates=nd	P=1.2
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100		
SJR @ Laird Park	100	100	100	100	100	100	100	chlorpyrifos=0.02 diazinon=0.02 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	100		
Merced River	100	100	100	100	100	100	0	chlorpyrifos=0.13(1.3) fonofos=0.01 diazinon=0.01 carbamates=nd	P=1.3
Tuolumne River	100	100	100	100	100	100	80		
Stanislaus River	100	100	100	100	100	100	90		
TID[3] 6	100	100	80	80					
TID 6- bioassay duplicate	100	100	100	100					
TID 5	used for bioassay duplicate								
TID 3	100	100	90	90					
Orestimba Creek	100	100	100	100					
Del Puerto Creek	100	100	100	100					
Ingram Hospital Creek	100	100	100	100					
Spanish Grant Combined Drain	100	100	60	40				diazinon=0.03 carbamates=nd	
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

C-034381

C-034382

Table 1. (Continued).

Date: 20 April 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100	90	90	90		
SJR[2] @ Hills Ferry Road	100	100	90[5]	90	90	90	90		
SJR @ Laird Park	100	100	100	100	100	100	100	chlorpyrifos=0.03 diazinon=0.02 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	100		
Merced River	100	100	100	100	100	100	100		
Tuolumne River	100	100	100	90[5]	90	90	90		
Stanislaus River	100	100	100	100	100	100	100		
TID[3] 6	100	100	100	100					
TID 5	100	100	100	100					
TID 3	used for bioassay duplicate								
Orestimba Creek	100	100	90	70				chlorpyrifos=0.02 fonofos=0.21(0.8) diazinon=0.01 carbamates=nd	P=0 8
Del Puerto Creek	100	100	100	100					
Ingram Hospital Creek	100	100	90	90					
Ingram Hospital Creek- bioassay duplicate	100	100	80	80					
Spanish Grant Combined Drain	50	0	0	0				organophosphates=nd=carbamates	
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	60	60	60	60	60		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel.

C—034382

C-034383

Table 1 (Continued).

Date: 27 April 1992

Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100	100	100	100	diazinon=0.17	
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	chlorpyrifos=0.01 diazinon=0.07	
SJR @ Laird Park	100	100	100	100	90	90	90	chlorpyrifos=0.02 diazinon=0.03 carbamates=nd	
SJR @ Airport Road	100	100	80	80	80	80	70	chlorpyrifos=0.01	
Merced River	100	100	100	100	100	100	100	chlorpyrifos=0.01	
Tuolumne River	100	100	100	90	90	90	90	chlorpyrifos=0.01	
Stanislaus River	100	100	100	100	90[5]	90	90		
TID[3] 6	100	100	90	90				chlorpyrifos=0.01	
TID 5	100	100	100	100				chlorpyrifos=0.02 diazinon=0.01	
TID 3	100	90	80[5]	80				organophosphates=nd	
Orestimba Creek	100	10	0	0				chlorpyrifos=0.09 (0.9) fonofos=0.06 diazinon=0.01 carbamates=nd	P=0.9
Del Puerto Creek	100	100	100	100				chloryprifos=0.03 diazinon=0.02	
Ingram Hospital Creek	100	90	90	70				chlorpyrifos=0.01 diazinon=0.02	
Spanish Grant Combined Drain	0	0	0	0				chlorpyrifos=0.19 (1.9) diazinon=0.02 parathion=0.01 fonofos=0.06 carbamates=nd	P=1.9
Laboratory control	100	100	100	100	100	100	90		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. No carbamate analysis conducted. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel.

C-034383

Table 1. (Continued).

Date: 4 May 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	80	70	70	70	70	diazinon=0.06 carbamates=nd	
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	diazinon=0.06	
SJR @ Laird Park	100	100	100	100	100	100	100	chlorpyrifos=0.02 diazinon=0.02 carbamates=nd	
SJR @ Airport Road	100	100	90	90	90	90	80	chlorpyrifos=0.01 carbamates=nd	
Merced River	100	100	100	90[4]	90	90	90	chlorpyrifos=0.01	
Tuolumne River	100	100	100	100	80	70	70	chlorpyrifos=0.01 carbamates=nd	
Stanislaus River	100	90	80	80	60	60	60	organophosphates=nd=carbamates	
TID[3] 6	100	100	100	100				chlorpyrifos=0.01	
TID 5	100	100	100	100				chlorpyrifos=0.01 diazinon=0.01	
TID 3	100	100	100	100				chlorpyrifos=0.01 diazinon=0.03	
Orestimba Creek	0	0	0	0				chlorpyrifos=0.08(0.8) fonofos=0.03 ethion=0.05(?) diazinon=0.01 carbamates=nd	P=0.8
Del Puerto Creek	100	100	0	0				chlorpyrifos=0.02 diazinon=0.01 carbamates=nd	
Ingram Hospital Creek	0	0	0	0				chlorpyrifos=0.02 diazinon=0.01 carbaryl=2.0	
Ingram Hospital Creek- bioass. duplicate	0	0	0	0					
Spanish Grant Combined Drain	0	0	0	0				chlorpyrifos=0.07(0.7) fonofos=0.07 diazinon=0.01 carbamates=nd	P=0.7
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	90[5]	90	90	90		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Carbamate analysis not conducted unless indicated otherwise. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel.

Table 1. (Continued).

Date: 11 May 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100	100	100	100	diazinon=0.02	
SJR[2] @ Hills Ferry Road	100	100	100	90	80	80	80	chlorprifos=0.02 diazinon=0.02	
SJR @ Laird Park	100	100	100	100	100	100	90	chlorpyrifos=0.02 disyston=0.06(?) carbamates=nd	
SJR @ Airport Road	100	100	100	100	90	90	90	chlorpyrifos=0.01 diazinon=0.01	
Merced River	100	100	100	100	100	100	100	organophosphates=nd	
Tuolumne River	100	100	90	90	90	90	90	chlorpyrifos=0.01	
Tuolumne River- bioassay duplicate	100	100	100	100	100	100	100		
Stanislaus River	used for bioassay duplicate								
TID[3] 6	100	70	60	50				chlorpyrifos=0.07(0.7) carbamates=nd	P=0.7
TID 5	100	100	100	100				chlorpyrifos=0.05(0.5) diazinon=0.01	P=0.5
TID 3	90	90	90	90				chlorpyrifos=0.01 diazinon=0.01	
Orestimba Creek	70	0	0	0				chlorpyrifos=0.02 fonofos=0.02 ethion=0.01(?) diazinon=0.18 carbamates=nd	
Del Puerto Creek	100	100	20	0				chlorpyrifos=0.02 fonofos=0.03 diazinon=0.22 carbamates=nd	
Ingram Hospital Creek	0	0	0	0				chlorpyrifos=0.01 diazinon=0.06 carbaryl=2.8	
Spanish Grant Combined Drain	0	0	0	0				chlorpyrifos=0.04 fonofos=0.03 diazinon=1.2(2.4) carbamates=nd	P=2.4
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Carbamate analysis not conducted unless indicated otherwise. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

C-034385

Table 1. (Continued).

Date: 18 May 1992

Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections[1]	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100	100	100	90	diazinon=0.03	
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	diazinon=0.02	
SJR @ Laird Park	100	100	100	100	100	100	100	chlorpyrifos=0.01 diazinon=0.04 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	90	diazinon=0.05	
Merced River	used for bioassay duplicate								
Tuolumne River	100	100	100	100	100	100	100	diazinon=0.02	
Tuolomne River- bioassay duplicate	100	100	100	100	100	100	100		
Stanislaus River	100	100	100	100	100	100	90[5]	organophosphates=nd	
TID[3] 6	100	100	100	100				organophosphates=nd	
TID 5	100	100	100	100				NH_3=0.59	
TID 3	100	100	100	100				chlorpyrifos=0.01	
Orestimba Creek	100	100	100	90				chlorpyrifos=0.01 diazinon=0.07	
Del Puerto Creek	100	100	100	100				chlorpyrifos=0.01 diazinon=0.01	
Ingram Hospital Creek	0	0	0	0				chlorpyrifos=0.01 diazinon=0.05 carbaryl=0.6	
Spanish Grant Combined Drain	100	70	0	0				chlorpyrifos=0.05(0.5) fonofos=0.04 diazinon=0.08 carbamates=nd	P=0.5
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	90[5]	90	90	90		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Carbamate analysis not conducted unless indicated otherwise. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]One animal accidentally killed by laboratory personnel.

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Table 1. (Continued).

Date: 25 May 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections	Sum of LC_{50} units[4]
Salt Slough	100	100	100	100	100	100	100	diazinon=0.04	
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	diazinon=0.03	
SJR @ Laird Park	100	100	100	90	90	90	80	diazinon=0.02 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	80	diazinon=0.06	
Merced River	100	100	100	100	100	100	100	organophosphates=nd	
Tuolumne River	100	100	100	100	100	100	100	chlorpyrifos=0.01 diazinon=0.03	
Stanislaus River	100	100	100	100	100	100	70	organophosphates=nd	
TID[3] 6	used for bioassay duplicate								
TID 5	100	100	100	100				chlorpyrifos=0.01	
TID 3	100	100	100	100				organophosphates=nd	
Orestimba Creek	0	0	0	0				chlorpyrifos=0.01 fonofos=0.01 diazinon=0.88 (1.8) carbamates=nd	P=1.8
Del Puerto Creek	100	100	30	0				chlorpyrifos=0.01 diazinon=0.2 carbamates=nd	
Ingram Hospital Creek	0	0	0	0				chlorpyrifos=0.01 diazinon=1.8 (3.6) carbamates=nd	P=3.6
Ingram Hospital Creek- bioassay duplicate	0	0	0	0					
Spanish Grant Combined Drain	100	100	100	70				chlorpyrifos=0.03 diazinon=0.07 fonofos=0.02	
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	90	90	90		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. No carbamate analysis conducted unless indicated otherwise. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

C-034387

C-034388

Table 1. (Continued).

Date: 1 June 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections	Sum of LC_{50} units[1]
Salt Slough	100	100	100	100	100	100	100	diazinon=0.02	
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	diazinon=0.02	
SJR @ Laird Park	100	100	100	100	100	100	100	chlorpyrifos=0.01 diazinon=0.02 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	100	diazinon=0.01	
Merced River	100	100	100	100	100	100	100	organophosphates=nd	
Tuolumne River	100	100	100	100	100	100	100	diazinon=0.01	
Stanislaus River	100	100	100	100	100	100	100	organophosphates=nd	
TID[3] 6	0	0	0	0				chlorpyrifos=0.25(2.5) carbamates=nd	P=2.5
TID 5	100	100	100	100				chlorpyrifos=0.01[5]	
TID 3	used for bioassay duplicate								
Orestimba Creek	100	100	100	100				diazinon=0.02 fonofos=0.02	
Del Puerto Creek	100	100	100	100				chlorpyrifos=0.02 diazinon=0.02 fonofos=0.01	
Ingram Hospital Creek	100	100	100	100				diazinon=0.07	
Ingram Hospital Creek- bioassay duplicate	100	100	100	100					
Spanish Grant Combined Drain	0	0	0	0				chlorpyrifos=0.17(1.7) diazinon=0.02 carbamates=nd	P=1.7
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. Carbamate analysis not conducted unless indicated otherwise. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]Data may be unreliable as surrogate recovery was out of bounds.

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Table 1. (Continued).

Date: 15 June 1992

Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections	Sum of LC_{50} units[4]
Salt Slough	100	100	90	90	90	90	90	organophosphates=nd	
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	organophosphates=nd	
SJR @ Laird Park	100	100	100	100	100	100	100	chlorpyrifos=0.01 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	100	organophosphates=nd	
Merced River	100	100	100	80	80	80	80	organophosphates=nd	
Tuolumne River	100	100	90	90	90	90	90	chlorpyrifos=0.01	
Stanislaus River	100	100	100	100	100	100	100	organophosphates=nd	
TID[3] 6	100	100	100	100				organophosphates=nd	
TID 5	100	100	100	100				organophosphates=nd	
TID 3	used for bioassay duplicate								
Orestimba Creek	100	100	100	100				chlorpyrifos=0.01	
Del Puerto Creek	100	100	100	100				chlorpyrifos=0.01 diazinon=0.01 fonofos=0.03	
Ingram Hospital Creek	100	100	100	100				chlorpyrifos=0.01 diazinon=0.01	
Ingram Hospital Creek- bioassay duplicate	100	100	100	100					
Spanish Grant Combined Drain	100	100	100	100				chlorpyrifos=0.01 diazinon=0.01	
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. No carbamate analysis conducted unless indicated otherwise. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units.

C-034389

C-034390

Table 1. (Continued).

Date: 22 June 1992									
Station	Ceriodaphnia dubia Survival (%) by day							Pesticide (ppb) and ammonia (mg/l) detections	Sum of LC_{50} units[4]
Salt Slough	100	100	100	90[4]	90	90	90	diazinon=0.01	
SJR[2] @ Hills Ferry Road	100	100	100	100	100	100	100	diazinon=0.01	
SJR @ Laird Park	100	90	90	90	90	90	90	chlorpyrifos=0.01 diazinon=0.02 carbamates=nd	
SJR @ Airport Road	100	100	100	100	100	100	100	organophosphates=nd	
Merced River	100	100	100	80	80	60	50	organophosphates=nd=carbamates	
Tuolumne River	100	100	90	70	70	50	40	diazinon=0.01 carbamates=nd	
Stanislaus River	100	90	90	70	70	40	40	chlorpyrifos=0.01 carbamates=nd	
TID[3] 6	100	100	100	100				chlorpyrifos=0.01[5]	
TID 5	100	100	100	100				chlorpyrifos=0.01	
TID 3	100	100	100	0				organophosphates=nd=carbamates NH_3=1.20	
Orestimba Creek	100	0	0	0				chlorpyrifos=0.02 fonofos=0.01 diazinon=0.03 carbamates=nd	
Del Puerto Creek	100	100	100	100				chlorpyrifos=0.04 diazinon=0.02	
Ingram Hospital Creek	100	80	80	80				chlorpyrifos=0.01 diazinon=0.01 carbamates=nd	
Ingram Hospital Creek- bioassay duplicate	100	100	90	90					
Spanish Grant Combined Drain	0	0	0	0				chlorpyrifos=0.01 fonofos=0.01 diazinon=0.02 carbamates=nd	
Laboratory control	100	100	100	100	100	100	100		
Dilution control	100	100	100	100	100	100	100		

[1]Blanks indicate that no pesticide analysis was conducted and that ammonia was less than 2.0 mg/l; nd=no detections. No carbamate analysis conducted unless indicated otherwise. Unionized ammonia as NH_3. Value in parenthesis is the calculated number of 96 hr LC_{50} units (pesticide concentration/LC_{50} value). [2]San Joaquin River. [3]Turlock Irrigation District. [4]P=Sum of pesticide LC_{50} units. N=Ammonia LC_{50} units. [5]Data should be viewed with caution because of low surrogate recovery.

C-034390

APPENDIX E

1990 PESTICIDE USE DATA BY COUNTY

Table 1. Chlorpyrifos use during 1990 (Department of Pesticide Reguluation, 1990). All commodities receiving more than 30 pounds of active ingredient are reported.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Alfalfa	410	20,622	323	16,132	297	13,078
Almonds	1100	66,404	440	25,535	470	36,310
Apples	70	3,081	39	1,643	8	408
Asparagus			21	1,150		
Broccoli			1	80		
Cabbage	4	364				
Cauliflower			6	338		
Cherries			6	42		
Corn	91	7083	44	3345	42	2328
Cotton					15	956
Landscape Maintenace			62	128	17	56
Container Plants	55	33			24	52
Nectarine			1	60		
Nut Crops	2	196				
Peach	17	399	1	30	5	280
Pear	1	50			2	50
Pecan	1	50			2	50
Plum					2	62
Public Health					3	181
Prune			2	57		

Table 1. Chlorpyrifos use continued.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Sorghum			2	117		
Structural	317	3,437	638	5,809	390	3,599
Sugarbeets			284	15,986	45	2,734
Sweet Potato	5	130			21	645
Walnuts	500	30,993	517	39,762	214	14,453
Wheat			12	1,552		
Total						

C-034394

Table 2. Diazinon use during 1990 (Department of Pesticide Reguluation, 1990). All commodities receiving more than 30 pounds of active ingredient are reported.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Alfalfa	40	680	154	4,353	316	6,458
Almonds	536	57,073	319	16,427	403	50,470
Apples	21	509	55	1,705	16	606
Apricots	144	2,943	48	1,445	46	3,644
Beans					5	79
Beets	35	34				
Broccoli			6	40		
Cauliflower	8	410	11	56		
Cherries	8	410	321	9,107		
Corn			79	4,152	10	701
Cucumbers			3	98	1	96
Figs					3	219
Grapes			98	2,810		
Landscape Maintenance			74	462		
Lettuce	20	513				
Melons	44	957			93	2,974
Container Plants	19	97	61	225	7	38
Nectarines			4	86	4	57
Nut Crops	4	120				
Onions	11	76	12	52	2	32

C-034394

Table 2. Diazinon use continued.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Peaches	83	1,691	28	560	4	934
Pears			10	356		
Peppers	8	61				
Plums					17	616
Prunes	1	42			19	1,398
Structural	235	2,226			328	4,947
Sugarbeets	10	299			12	308
Sweet Potatoes					1	39
Swiss Chard	64	36				
Tomato	21	260			14	148
Walnuts	24	966			13	569
Watermelon					7	134
Total						

C-034395

Table 3. Parathion use during 1990 (Department of Pesticide Reguluation, 1990). All commodities receiving more than 30 pounds of active ingredient are reported.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Alfalfa			1	96	7	133
Almonds	415	33,055	122	6,496	781	62,074
Apples	3	40	3	76		
Apricots	320	11,439	8	6,161	20	555
Beans			6	137		
Cherries	17	693	14	856		
Oats			1	72		
Nectarines					5	58
Nut Crops					1	210
Peaches	165	5,301	5	228	142	5,402
Pears			2	83		
Plums	3	83			2	31
Prunes	5	242			19	1,218
Pumpkins	17	231	22	576		
Spinach	25	657				
Squash			3	60		
Swiss Chard	2	105				
Tomatoes	4	120	4	127	1	78
Wheat					2	109
Total						

Table 4. Fonofos use during 1990 (Department of Pesticide Reguluation, 1990). All commodities receiving more than 30 pounds of active ingredient are reported.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Asparagus			26	2,954		
Beans	13	1,259	15	2,200	1	40
Broccoli	1	110				
Corn			40	3,775		
Peppers	14	936	5	293		
Sugarbeets			4	333		
Tomatoes	42	2886	37	3,101	3	183
Total						

C—034397

C-034398

Table 5. Carbaryl use during 1990 (Department of Pesticide Reguluation, 1990). All commodities receiving more than 30 pounds of active ingredient are reported.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Alfalfa	5	429	3	96	5	764
Almonds	8	1,514	5	370	12	535
Apples	4	51	16	521	6	456
Apricots	3	91	2	98	3	243
Beans	14	1,568	9	720		
Beets			18	681		
Boysenberries			2	41	3	45
Citrus					3	207
Cherries			80	4,146		
Corn	98	3,795	149	5,866	61	2,485
Cotton			3	81	3	57
Grapes	72	6,150	67	7,543	16	3,457
Landscape maintenace	8	1,603	16	425	6	177
Lettuce	16	137				
Melons					7	408
Nectarines	5	67	2	46	9	147
Peaches	162	8,683	16	816	105	7,817
Peppers	19	954	9	273	1	70
Pumpkins	4	115				
Rangeland			3	75		

C-034398

Table 5. Carbaryl use continued.

Commodity	Stanislaus County Number of applications	Stanislaus County Pounds applied	San Joaquin County Number of applications	San Joaquin County Pounds applied	Merced County Number of applications	Merced County Pounds applied
Right of Way	3	77				
Small Fruit	2	41				
Sorghum			3	196		
Structural	25	1,794	41	212	55	19,433
Sugarbeets	1	128	89	5,711	11	426
Sunflowers			2	75		
Tomato	117	7,396	160	1,980	24	955
Walnuts			26	982		
Total						

C-034400

Table 6. Methomyl use during 1990 (Department of Pesticide Reguluation, 1990). All commodities receiving more than 30 pounds of active ingredient are reported.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Alfalfa	90	2,433	291	9,296	303	7,568
Apples					8	188
Beans	206	6,576	35	1,423	43	1,525
Beets	89	405	4	141	7	169
Bokchoy	119	124				
Broccoli	9	199			9	192
Cabbage	143	149	10	226		
Cauliflower	57	2,442	15	529	14	509
Celery	35	801	1	31		
Collards	67	101				
Corn	5	137	171	1,065	11	283
Cucumbers			2	47		
Grapes	4	127	18	914	34	1,068
Kale	131	109				
Lettuce	285	646				
Melon	12	672			85	2,194
Mustard	71	84				
N-grms	133	1,986	37	34	16	246
Onions	16	318			3	64
Peaches					1	35

C-034400

Table 6. Methomyl use continued.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Peppers	55	2,034	79	1,519	1	67
Potatoes			7	406		
Pumpkins	9	247	39	1,042		
Right of Way					1	356
Sorghum			2	65	4	216
Spinach	2	68				
Sugarbeets	10	156	55	1,745	271	7,633
Swiss chard	150	136				
Tomatoes	150	5,643	374	8,725	216	7,222
Watermelon			5	310	1	34
Total						

Table 7. Malathion use during 1990 (Department of Pesticide Reguluation, 1990). All commodities receiving more than 30 pounds of active ingredient are reported.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Alfalfa	20	927	42	2,354	168	13,807
Almonds	2	123				
Apricots			1	95		
Asparagus			5	92		
Barley					1	46
Beans	7	412				
Corn			2	74		
Cucumbers			1	36		
Eggplant			3	50		
Figs					2	200
Grapes	4	167	11	349		
Landscape Maintenace			20	170		
Leeks			3	78		
Melon			1	42	6	397
Oats					3	113
Onions			21	969		
Peppers			3	96		
Public Health	3	1,642	4	1,580	5	2,523
Squash			2	56		
Structural Pest Control	50	2,591	75	935	96	42,752

C-034403

Table 7. Malathion use continued.

Commodity	Stanislaus County		San Joaquin County		Merced County	
	Number of applications	Pounds applied	Number of applications	Pounds applied	Number of applications	Pounds applied
Sugarbeets			3	225		
Tomatoes			18	928	6	676
Walnuts	1	98	6	157		
Wheat			6	1,731	1	46
Totals						

C-034403