SACRAMENTO-SAN JOAQUIN DELTA

BIOASSAY MONITORING REPORT: 1994-95

SECOND ANNUAL REPORT TO THE
CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD

Compiled by:

Linda Deanovic, Kristy Cortright, Karen Larsen,
Emilie Reyes, Howard Bailey, David E. Hinton
Aquatic Toxicology Laboratory
University of CA, Davis

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EXECUTIVE SUMMARY

From 1993 to 1995, the Central Valley Regional Water Quality Control Board (CVRWQCB), the State Water Resources Control Board and the University of California at Davis conducted a monitoring program to characterize aquatic toxicity in the Delta. This report summarizes the results of the second year of monitoring. The first year of monitoring is summarized in Deanovic *et al.* (1996).

The Sacramento-San Joaquin Delta, comprising over 700 miles of interconnected waterways encompassing 1153 square miles, provides Californians with drinking water, irrigation water, industrial water and recreational opportunities. Delta waters are used for agriculture within the Delta and also are diverted to irrigate several million acres of Central Valley farmland. Over half of the drinking water for the state is pumped from the Delta. While beneficial to the state, these water uses have disrupted the unique Delta ecosystem and contributed to the degradation of water quality.

Over 280 species of birds and over 50 species of fish inhabit the freshwater portion of the estuary. Many resident aquatic species of the Delta, at various trophic levels, have shown a decline (Herbold *et al.* , 1992; Alpine and Cloern, 1992; Obrebski *et al.*, 1992). Once abundant, native fishes, such as Delta smelt, Sacramento splittail, Sacramento perch, longfin smelt and winter-run Chinook salmon, are now classified as threatened, rare or endangered (SWRCB, 1994). While the causes of the decline are uncertain, a number of factors including water diversions, loss of habitat, introduced exotic organisms and toxic contaminants have been suggested as potential candidates (Bailey *et al.*, 1995; CDFG, 1994; Foe, 1995).

In 1993 and 1994, the CVRWQCB, in conjunction with the Bay Protection Toxic Cleanup Program, conducted the first year of a two-year monitoring program to characterize surface water toxicity in the Sacramento-San Joaquin Delta. Standardized USEPA freshwater bioassay protocols were used to determine the extent, severity and sources of toxicity in the Delta. The organisms used in these laboratory assays include 1) a primary producer, the green algae *Selenastrum capricornutum*, 2) a primary consumer, the zooplankton *Ceriodaphnia dubia,* and 3) a secondary consumer, the fathead minnow *Pimephales promelas.*

During the first year, monthly sampling of twenty-four sites was implemented based on the simplifying assumption that toxicity was either transported into the Delta from the mainstem rivers or was created internally within the Delta. Bioassays were conducted to determine the extent, severity and sources of toxicity.

The following general trends of toxicity were observed during the first year of monitoring. Toxicity to *Ceriodaphnia* occurred most frequently in water samples collected from back sloughs and small upland drainages and less frequently in main river inputs. Adverse effects on *Selenastrum* were observed in samples collected in and around Paradise Cut in the south Delta. Fathead minnow toxicity was detected primarily in samples collected from mainstem rivers. Toxicity associated with rain events in the mainstem rivers also was observed to all three species.

The second year of the monitoring program is summarized in this report. USEPA three species bioassays were used to continue the characterization of the extent, severity and sources of toxicity within the Sacramento-San Joaquin Delta. However, due to budgetary

constraints, more resources were allotted to identifying chemicals responsible for toxicity and samples were tested more extensively with *Ceriodaphnia* and *Selenastrum* than with *Pimephales*.

The following patterns of toxicity were observed during the second year of the monitoring study.

1. Metabolically activated pesticides were identified as the chemical group of compounds primarily responsible for toxicity to *Ceriodaphnia* in 19 out of 21 toxic samples. Chlorpyrifos and diazinon were identified as the two primary toxicants in this pesticide group. In each of these instances, one or both of these metabolically activated pesticides were detected at concentrations exceeding suggested water quality criteria for protecting aquatic life. These samples were collected from Ulatis Creek (1, 13 and 18 September 1994; 7 November 1994; 9 and 21 March 1995), Paradise Cut (12 and 19 July 1994; 9 and 15 March 1995), Duck Slough (21 and 25 March 1995), French Camp Slough (2 and 7 September 1994), and Mosher Slough (4 December 1994; 9 January 1995; 21 and 24 March 1995; 1 May 1995). One sample collected from Ulatis Creek on 4 December 1994 contained both diazinon and chlorpyrifos, however the concentrations were insufficient to account for the majority of toxicity. Carbaryl was primarily responsible for toxicity in a single sample collected from Ryer Island on 31 May 1995. As in the previous year, chronic reproductive toxicity was seen in both Prospect and Duck Slough water samples collected during the summer irrigation season. The compounds responsible for this toxicity were not identified.

2. No toxicity to *Selenastrum* was observed using the EPA criteria for evaluating results. In part, this may have been because the growth in the control water was poor, making it difficult to see statistical differences. However, several samples did show suppressed growth relative to other field samples collected on the same day. Several Toxicity Identification Evaluations were conducted to evaluate potential causes of these growth suppressions. Results of the Toxicity Identification Evaluations suggested that non-polar compounds may have been the cause. Non-polar compounds caused growth suppression in five samples collected in and around Paradise Cut, as well as in samples collected from back sloughs and an island tract drain. Special studies were conducted to determine the cause of low growth in samples collected from Paradise Cut. Results of the special studies suggest that toxicants originate in agricultural runoff, rather than from local NPDES discharges. In contrast to the first year, no growth suppression was observed in samples collected during rain events.

3. Fathead minnow tests were conducted on only three dates due to limited resources. No toxicity to the minnow was detected.

4. As part of a special study, samples were collected from Cache Creek and two of its tributaries following a March rain event. A total of nine samples were collected. Some samples were collected on different days from the same sites. Although not part of the Delta, Cache Creek contributes a significant amount of water to the Yolo Bypass and eventually discharges into the Delta. Toxicity to *Ceriodaphnia* occurred in samples collected at four sites on three rain runoff dates. The cause of toxicity is not known. It should be noted that the majority of the Cache Creek data was not

generated in accordance with the quality assurance plan due to the prolonged sample storage time prior to testing. Nonetheless, the data suggests rain runoff related toxicity in the watershed.

Data collected over two monitoring seasons suggest the majority of compounds causing acute *Ceriodaphnia* mortality are insecticides from agricultural and urban sources. In the previous year's report, three sites were recommended for classification as potential toxic hot spots[1]. In all three cases, acute toxicity to *Ceriodaphnia* was exhibited on more than one occasion and the chemicals causing toxicity were identified. The toxicants identified in water samples from Paradise Cut, French Camp Slough and the San Joaquin River at Vernalis were carbofuran, chlorpyrifos and diazinon, respectively. The Delta has been included on the CVRWQCB 303(d) list because of diazinon, chlorpyrifos and other pollutants.

This year, samples from four sites exhibited toxicity to *Ceriodaphnia* on more than one occasion and in each instance a chemical contributing to toxicity was identified. Additional samples were collected following the detection of toxicity to ascertain the potential duration of toxicity in the field. The results from these follow-up samples suggested that toxicity possibly existed at each of these sites for a sufficient duration and magnitude to impact resident species with similar life cycles and toxicant sensitivities. The conditions under which this toxicity occurred are likely to be repeated in future years. We are recommending that the Regional Board consider the sites listed in the table below for classification as toxic hot spots in addition to those recommended in the previous report:

Sampling Location	Samples exhibiting toxicity	Primary toxicant
Ulatis Creek	9/1, 9/13 and 9/18/94	chlorpyrifos
Paradise Cut	3/9/95and 3/15/95	chlorpyrifos
Duck Slough	3/21/95 and 3/25/95	chlorpyrifos
French Camp Slough	9/2/94 and 9/7/94	chlorpyrifos

Since October 1994 to date, data collected from this and other studies (Bailey *et al.*, 1996a; Lee, in prep) conducted by the UC Davis Aquatic Toxicology Laboratory have demonstrated diazinon to be the primary cause of toxicity on several occasions in Mosher Slough. Although only some TIEs have been conducted on samples collected from Mosher Slough, the samples have caused acute *Ceriodaphnia* mortality and have had concentrations of diazinon above this laboratory's established 96-hour LC_{50} concentrations for *Ceriodaphnia* (0.400 µg/L). For these reasons, the Regional Board also should consider Mosher Slough as a toxic hot spot.

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[1]Toxic hot spots are defined by exceedances in water quality objectives, toxicity associated with a toxic pollutant, exceedances of tissue contamination levels, impairment of resident organisms or degradation of populations associated with toxic pollutants.

The ecological significance of the pesticide detections documented in this study are not known. Further research is needed to address this issue.

INTRODUCTION

The Sacramento-San Joaquin Delta, along with the San Francisco Bay, forms the largest Estuary on the North American West Coast. The three main river inputs into the Delta are the Sacramento, the San Joaquin, and the Mokelumne; together, these provide a combined average unimpaired flow of about twenty-two million acre-feet per year. The Sacramento-San Joaquin Delta, comprising over 700 miles of interconnected waterways and encompassing 1153 square miles, is a valuable resource for the people of California. Delta waters are used for municipal and domestic water supply, with over half of all the drinking water for the State of California being pumped from the Delta. Other major beneficial uses of Delta water include industrial supply, irrigation, navigation, recreation, and wildlife habitat. The Delta is a significant aquatic habitat to over two hundred and eighty species of birds and over fifty species of fish inhabiting the freshwater portion of the Estuary (Herbold *et al.*, 1992).

An appreciable decline of aquatic resources in the Delta has been observed in a number of studies including those by Herbold *et al.* (1992), Alpine and Cloern (1992), and Obrebski *et al.* (1992). Many indigenous fish once abundant in the Delta, such as Delta smelt, Sacramento splittail, Sacramento perch, longfin smelt and winter-run Chinook salmon, are now classified as threatened, rare or endangered (SWRCB, 1994). A decrease of one to two orders of magnitude in phytoplankton and zooplankton production in the Delta also has been observed (Alpine and Cloern, 1992; Obrebski *et al.*, 1992). While the causes of the decline are uncertain, a number of factors including water diversions, loss of habitat, introduced exotic organisms and toxic contaminants have been suggested as potential candidates (Bailey *et al.*, 1995; CDFG, 1994; Foe, 1995).

In 1989, the California Water Code was amended to create the Bay Protection and Toxic Cleanup Program (BPTCP). The three primary goals of the program are to identify toxic hot spots, develop sediment quality objectives and remediate toxic hot spots, either through cleanup efforts, mitigation or prevention (SWRCB, 1993). The BPTCP identifies five conditions that singly or in combination may be used to define a toxic hot spot:

1. exceedances of water quality objectives
2. toxicity associated with a toxic pollutant
3. exceedances of tissue contaminant levels
4. impairment of resident organisms
5. degradation of populations or communities associated with toxic pollutants

The monitoring studies summarized in this and in a previous report by Deanovic *et al.* (1996) were conducted for the BPTC program to identify toxic hot spots. Of particular interest was the identification of sites where bioassays identified water column toxicity. These sites could also be considered toxic hot spots if the chemical causing toxicity could be identified. Water column toxicity could be considered a violation of the Central Valley Regional Water Quality Control Board's (CVRWQCB) narrative toxicity

objective[1] and could be considered a Bay Protection hot spot if the responsible chemical could be identified.

The sources of contaminants in the Delta potentially include National Pollutant Discharge Elimination System (NPDES) discharges, urban runoff, agricultural runoff, and discharges from upstream inactive and abandoned mines. Significant toxicity in the principal tributaries to the Delta, the Sacramento and San Joaquin Rivers, has been documented in previous bioassay and chemical analytical data. Toxicity from pesticides and metals has been demonstrated in the Sacramento River Basin (Connor *et al.*, 1993b; Connor *et al.*, 1994; Foe and Connor, 1991). Pesticides from storm and irrigation runoff of row and orchard crops have been linked to toxicity in the San Joaquin River Basin (Foe and Connor, 1991; Kuivila and Foe, 1995; Foe and Sheipline, 1993; Foe, 1995). Finally, toxicity from metals and pesticides has been observed in runoff from the Cities of Sacramento and Stockton (Connor, 1994; 1995a; 1995b; 1996).

In 1993 and 1994, the CVRWQCB, in conjunction with the BPTCP, conducted the first year of a two-year monitoring program to determine the extent, severity, and sources of toxicity in the Sacramento-San Joaquin Delta. Monthly sampling of twenty-four sites was implemented with the simplifying assumption that toxicity was either transported into the Delta from the Central Valley via the mainstem rivers or was created internally within the Delta. Standardized USEPA three species freshwater bioassay protocols were used to characterize surface water toxicity in the Delta. The USEPA bioassays employ species from three trophic levels: 1) a primary producer, the green algae *Selenastrum capricornutum*, 2) a primary consumer, *Ceriodaphnia dubia* and 3) a secondary consumer, the minnow *Pimephales promelas*.

The following general trends of toxicity were observed in the 1993-1994 study period. The Sacramento River, which contributes approximately 80% of the water entering the Delta, exhibited toxicity to the fish test species more frequently than any other site. This study and others showed that about half of all water samples collected at the Sacramento River at Freeport caused mortality to the fathead minnow (Deanovic *et al.*, 1996; Fox *et al.*, 1996; Brown and Caldwell, 1993). The cause of this reported toxicity is unknown. Toxicity to *Ceriodaphnia* also was associated with storm runoff in January and February rain events in both the Sacramento and San Joaquin Rivers. The fish and invertebrate results are examples of external sources of toxicity entering the Delta. In contrast, water samples collected from back sloughs exhibited toxicity most frequently to the invertebrate bioassay organism. The causes of some of the invertebrate toxicity were identified through Toxicity Identification Evaluations (TIEs) as elevated concentrations of diazinon, chlorpyrifos, and carbofuran. The back slough results are an example of toxicity being produced by agricultural activities within the Delta.

The purpose of this study was to follow-up on the 1993-1994 results. During the second year of monitoring, USEPA three species bioassays again were used to characterize toxicity within the Sacramento-San Joaquin Delta. While the general objectives of the program remained the same, conclusions from the previous year and budgetary constraints resulted in some changes. The objectives were narrowed to focus on the cause

[1]The CVRWQCB's narrative objective states that all waters must be maintained free of toxic substances in concentrations that cause detrimental physiological responses in aquatic organisms.

and extent of toxicity, particularly in back sloughs. Identifying specific chemicals as significant contributors to toxicity through the use of TIEs was a key component of this study. This identification was necessary to meet conditions for recommending toxic hot spots.

MATERIALS AND METHODS

Sampling Sites

All sites sampled as part of this study are presented in Table 1. The location of all sites is illustrated in Figures 1, 2 and 3. The specific location of each site is described in Appendix A. Samples were collected from 21 sites within the Delta. In addition, two smaller special studies were conducted and are described below (Figure 1).

A portion of the Bay Protection Funds was allocated to determine the metal loading patterns to the Delta, with emphasis on storm events. The laboratory took a unique opportunity to evaluate the toxicity of leftover Cache Creek sample water from the metal loading study. These samples were only tested with *Ceriodaphnia*[1]. Although not within the legal boundary of the Delta, Cache Creek may contribute a significant amount of water to the Delta in wet winters via the Yolo Bypass. Samples from four sites within the Cache Creek watershed were used as part of this special study (Figure 2).

In both 1993 and 1994, samples collected from Paradise Cut during the early summer months exhibited suppressed algal growth relative to other samples collected on the same day. In 1993, these growth suppressions were thought to be exacerbated by barriers in the southern Delta. The barriers were designed, in part, to prevent fish entrainment at the State and Federal pumps but, may have decreased tidal dilution and increased water residence times, thereby increasing the concentration of pollutants from local islands. During this study, samples also were collected from 20 additional sites around Paradise Cut to determine the potential source of toxicity to the *Selenastrum*. Figure 3 illustrates the Paradise Cut special study area.

Sample Collection and Storage

Samples were collected from June 1994 through July 1995. All samples were collected as sub-surface grabs at low tide to ensure maximum freshwater composition. Water for bioassays and Toxicity Identification Evaluations (TIEs) was collected in one gallon amber borosilicate glass bottles. Samples were only collected once per sampling event rather than the sampling frequency suggested by EPA as a minimum for NPDES compliance monitoring. EPA allows for one time sub surface grab samples as an alternative procedure for testing in ambient monitoring programs because of cost considerations in collecting samples over a wide geographical area. A single sample also facilitates toxicity identification evaluation procedures, a primary objective of this study.

During rain events, sample collection commenced with the onset of runoff and continued each day for several consecutive days. Whenever possible, a sample was collected as a pre-storm sample to represent pre-runoff conditions. In some instances, a follow-up sample was collected for bioassays from a site exhibiting toxicity to determine the potential duration of toxicity in the field.

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[1] The second test was not conducted in accordance with the quality assurance program as the samples were not tested in bioassays until approximately four weeks after the sample was collected.

To prevent volatilization, all water samples were kept in containers without headspace. During rain events, additional water was collected in one-gallon polyethylene cubitainers for determining total suspended solids (TSS) and turbidity. Samples were collected from back sloughs and main rivers because previous testing suggested these types of waterways might be most impaired. Samples for pesticide analysis were collected in one-liter amber borosilicate glass bottles and were submitted for analysis only when a sample was determined to be toxic. All samples were immediately placed on ice for transport to the laboratory where they were stored at 4°C. If a sample was determined to be toxic, then sub-samples were taken from the bioassay water and placed in one liter polyethylene bottles containing nitric acid for determinations of total recoverable and dissolved (1.0 µm filtered) metal concentrations.

Analytical Chemistry and Water Quality

Dissolved oxygen (DO), hydrogen ion concentration (pH) and electrical conductivity (EC) were measured in the laboratory at the beginning of the test to ensure that all samples would support aquatic life. The following meters were used to obtain these measurements: a YSI model 58 oxygen meter with a model 5700 series probe, a Beckman IS425 pH meter and a YSI model 33 EC meter. Dissolved oxygen and pH also were measured after the first 24 hours of exposure in both the *Ceriodaphnia* and minnow assays. Upon test termination, pH also was recorded for the alga. When mortality was equal to or greater than 30%, total ammonia concentrations only were measured in *Ceriodaphnia* and minnow assays. Ammonium concentrations were measured with an Aquaquant® Ammonium kit. TSS and hardness concentrations were measured within fourteen days of sample collection. TSS was determined by filtering 0.05 to 1.50 liters of water through a glass fiber filter and drying to a constant weight at 103-105° C (Clesceri *et al.*, 1989). Hardness was determined by titrimetric methods (Clesceri *et al.*, 1989). Turbidity was measured using a Hach Model 2100A Turbidimeter. Metal concentrations were analyzed by the California Department of Fish and Game using ultra-clean facilities and graphite furnace atomic absorption spectrophotometry (Goetzl and Stephenson, 1993). Pesticide samples were sent either to the US Geological Survey Central Laboratory at Arvada, CO or to APPL[1], Inc. The organic chemicals analyzed in the USGS 2010 scan by Gas Chromatography/Mass Spectrometry (GC/MS) are listed in Appendix B (Table 1). Pesticide samples sent to USGS were filtered through a 0.7 µm glass fiber filter and extracted with a 6 ml solid phase extraction (SPE) C18 cartridge before submittal to USGS (Zaugg *et al.*, 1995). For samples analyzed by USGS, percent recoveries were not computed in each sample for each analyte. The USGS developed an analytical report that summarizes the mean percent recoveries and the relative percent standard deviation for each of the analytes (Appendix B, Table 1; Zaugg *et al.*, 1995). Percent recoveries for chlorpyrifos, diazinon and malathion are 83, 77, and 90, respectively. Percent recoveries for two carbamate pesticides, carbaryl and carbofuran, are 151 and 108, respectively, and are reported with an E code which cautions the user when the concentrations are only estimates and need to be evaluated carefully (Zaugg et al., 1995). The USGS also included a surrogate spike of terbuthylazine to be used as an internal standard and calculated a running mean for the recovery of this compound. Any data that did not fall within the control limits of the internal standard running mean was

[1]APPL, Inc. 4203 West Swift Fresno, CA 93722 (209) 275-2175.

not reported to our laboratory. Periodic intralaboratory blanks were submitted for analysis and no chemicals were ever detected.

Samples sent to APPL, Inc. were analyzed using liquid liquid extraction and Gas Chromatography (GC) with a Nitrogen-Phosphorous specific detector or a Liquid Chromatographic system with UV and post column derivitization. Similarly, APPL laboratory did not report percent recoveries for each analyte in each sample. Periodic studies were conducted to determine the minimum detection limits, mean percent recoveries and relative percent standard deviation for each analyte (Appendix B, Table 2; Glen Brown, pers. comm.). Percent recoveries for chlorpyrifos, diazinon and malathion were 131, 130 and 105, respectively. Percent recoveries for carbaryl and carbofuran were 94 and 92, respectively. APPL laboratories also uses internal standards (tributylphosphate and triphenylphosphate) which clearly reports any outliers of their running mean for these compounds. In addition, any compounds that are detected, but are below the limit of quantitation, are reported as such and are to be interpreted with caution. Also, our laboratory submitted periodic blanks for analysis and no chemicals were ever detected.

In addition, Millipore and Ohmicron Enzyme-Linked Immunosorbent Assays (ELISA) were used at the UC Davis laboratory to determine diazinon, chlorpyrifos and carbofuran concentrations. These measurements were made on samples that had been allowed to settle for at least 24 hours. The quality assurance plan for ELISA consists of blanks, spikes and periodic duplicates. No chemicals were detected in the blanks. Percent recoveries of spikes ranged from 71-94% for chlorpyrifos and 88-176% for diazinon. The precision[1] between duplicates ranged from 0-55%. Finally, it should be noted that the analyses by ELISA on settled water and by GC/MS (or GC) on filtered samples were not expected to be quantitatively comparable but, nonetheless, were undertaken to provide separate verification of the presence of the compound(s). The manufacturer reports no cross-reactivities between diazinon and chlorpyrifos (Millipore, 1995).

Toxicity Testing Procedures

Prior to exposing test organisms, assay water was shaken in the original container to homogenize the sample. All waters for *Ceriodaphnia* and minnow assays were poured through a 60 μm screen, warmed to 25°C and aerated at a rate of 100 bubbles/minute until the dissolved oxygen decreased below 8.6 mg/L (104% saturation). Before *Selenastrum* cells were introduced to the sample, water was filtered through a Gelman™ type A/E glass fiber filter (nominal pore size 1.0 μm) and allowed to warm to a minimum of 20°C.

Generally, samples used in Toxicity Identification Evaluations (TIEs) were permitted to settle for at least 48 hours. Waters were then siphoned or poured off the top to prevent suspended solids from clogging the SPE columns. Alternatively, some samples were shaken as previously mentioned. However, all waters were handled similarly within a specific TIE. Waters used for TIEs were poured through a 60 μm screen and placed in a

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[1]Precision = the absolute value of $\frac{100x\ (\text{Duplicate 1-Duplicate 2})}{(\text{Duplicate 1 + Duplicate 2})/2}$

25°C environmental chamber for a minimum of two hours before test species were introduced to allow for gas equilibration.

Dilute UC Davis Ecology Institute well water (Dilute EI) served as the laboratory control water in the *Ceriodaphnia* and minnow bioassays. This water was prepared by diluting well water with laboratory glass distilled water (Corning Mega-Pure System, model MP-3A distilling unit) to a total hardness of 89.8 ± 6.4 mg/L as $CaCO_3$ (n=12). Laboratory glass distilled water was used as the algal control water.

Except for periods during rain-related events, bioassays were initiated within 36 hours of water collection. During rainfall events, samples were collected for up to 6 days and were tested simultaneously. All organisms were maintained at 25±1°C. Test procedures generally followed the guidelines given by EPA (1989). Brief summaries of test procedures, including all deviations from the recommended bioassay protocols, are outlined below.

Ceriodaphnia dubia

Two test styles, chronic and TIE, were used during this study. Chronic styled tests were generally used for screening a sample for toxicity. TIE styled tests were used for follow up work on samples that caused mortality in the initial screening and for TIEs. In the *Ceriodaphnia* chronic assay, one 8 to 24-hour-old *Ceriodaphnia* was randomly placed into each of ten 20 ml borosilicate vials containing 15 ml of sample. This 16-hour time frame in which the neonates were born deviates from EPA protocol, however, was permitted in the QA plan to reduce the overall workload. The *Ceriodaphnia* were from an in-house culture. Trout chow (Sterling H. Nelson & Sons, Silver Cup 1) and *Selenastrum* were added as food each day. The yeast and CEROPHYLL® portion of EPA's recommended food protocol were omitted since this laboratory's unreported data has found that animal performance is not statistically different using only trout chow and *Selenastrum*. Every 24 hours, each *Ceriodaphnia* was pipetted into a new vial containing 15 ml of fresh sample. When neonates were present, they were counted and discarded. The test duration was 7 days with endpoints of reproduction (number of offspring/female) and mortality.

TIE styled tests were designed to more cost effectively identify toxicants in samples which initially affected the mortality endpoint. The reproductive endpoint was eliminated. Five neonates (8 to 24 hours old) were placed in each of two to four replicate vials containing approximately 18 ml of sample. Trout chow and *Selenastrum* were added at chronic test concentrations, but only for a four hour period prior to water renewal. Four out of five Phase III TIE tests were conducted for 72 hours with un-fed animals. The fifth Phase III was conducted TIE style as described above. Regardless of the test style, the organisms were pipetted into fresh water every 24 hours until test termination.

Unpublished data from this laboratory suggest that *Ceriodaphnia* are generally more sensitive to some toxicants when tested in a TIE styled test rather than in the chronic styled test. Samples, which may cause chronic mortality in the original screening, can cause acute mortality when tested in a TIE styled test. Several potential reasons for the increased sensitivity exist. First, toxicants that readily adsorb to suspended solids have less sediment to bind to in a TIE style test because the tests are conducted with settled,

rather than shaken, samples. Therefore toxicants may be more bioavailable to the test species. Second, *Ceriodaphnia* are only fed for four hours rather than the full 24-hour period. This decreases the amount of time that the toxicants have to bind to suspended solids (food) and therefore toxicants, again, may be more bioavailable. In addition, the reduced feeding time provides less nutrients to the test species making them more susceptible to toxicants. Third, *Ceriodaphnia* may be crowded in the TIE test conditions, also making them more vulnerable to toxicant effects. Side-by-side comparisons between test styles need to be done with more compounds to verify this hypothesis.

Selenastrum capricornutum

Selenastrum capricornutum cultures were obtained from the University of Texas Starr collection (#1648). To ensure that cells were in exponential growth, an innoculum was transferred to the EPA algal growth media containing Ethylenediamine Tetraacetetate (EDTA) six days prior to the initiation of the test. Four replicate flasks containing 100 ml of filtered sample were inoculated with EPA algal test media (without EDTA) and 10,000 cells/ml. The flasks were maintained under a continuous light source of 400 ± 40 ft-candles on an orbital shaker at 100 rpm and randomized twice daily during the 4-day test to minimize position effects. Upon test termination, cell counts were measured on a Coulter Counter (model ZM) to ascertain algal growth rates.

Pimephales promelas

Fathead minnows were obtained from Aquatox in Hot Springs, AK. Upon arrival, fish were acclimated to laboratory control water for six hours. Ten 48-hr-old larvae were selected randomly and placed in each of three replicate 500 ml glass beakers containing 250 ml of sample. Minnows were fed *Artemia* nauplii three times daily during the 7-day test. Two hundred ml of water was removed from each beaker and renewed with freshly aerated water daily. Dead organisms (both fish and *Artemia*) were removed. At test termination, the surviving fish were euthanized with MS-222 (1.0g/L) and dried to constant weight. Dry weights for each replicate were determined with a Mettler balance (model AE100). The toxicological endpoints evaluated were growth and mortality.

Toxicity Identification Evaluation Procedures

When toxicity was detected, TIEs were conducted to help determine the cause. When 100% mortality occurred within 24 hours in a sample, a series of dilutions of the sample were tested to determine the toxicant's potency. The results of dilution series tests were used to estimate the number of toxic units[1] present in a sample. This estimation was done using linear interpolation.

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[1]A toxic unit is defined as the concentration of a specific chemical present in a sample divided by the 96-hour LC_{50} concentration for the species of interest. An LC_{50} is defined as the concentration of a chemical that causes 50% mortality in 96 hours. Toxic units can be added when multiple toxicants are present (assuming that the individual toxic compounds act additively) to equal the total number of toxic units. The total number of toxic units can be compared to the toxic units observed in the results of a dilutions series test.

USEPA has published TIE procedures for *Pimephales* and *Ceriodaphnia,* but not for *Selenastrum.* However, some preliminary algal TIE procedures were attempted to help evaluate observed growth suppressions. No fish TIEs were conducted. Briefly, Phase I TIEs involve chemical manipulations to either remove or inactivate specific classes of chemicals (see Table 2). After manipulation, the toxicity of a sample was reassessed against that of unmanipulated water in a bioassay to ascertain whether toxicity was reduced. If organism performance improved, then a specific class of chemical was assumed to be at least partially responsible for the toxicity and follow-up TIE work emphasized that group of chemicals. For a detailed description of the Phase I TIE procedure, see EPA manual EPA/600/6-91/003F and Bailey *et al.* (1996b).

All *Ceriodaphnia* and *Selenastrum* Phase I TIEs implicated organic compounds. Hence, most Phase II work focused on this class of chemicals. Phase II *Ceriodaphnia* procedures utilized 6 ml Varian C8 solid phase extraction (SPE) columns to remove non-polar organic chemicals from the ambient water. The chemicals were subsequently eluted with increasing concentrations of methanol[1]. Bioassays were performed on each fraction and on a methanol laboratory control blank to determine whether any fraction retained toxicity. Bailey *et al.* (1996b) and Crepeau (1997) have determined the fraction in which several of the more common insecticides used in the Central Valley elute. Crepeau (1997) also has demonstrated that the elution patterns of compounds could be related to the chemical's octanol-water partitioning coefficients.

When pesticides were suspected, piperonyl butoxide (PBO) was added to samples at 100 to 200 µg/L to help identify the class of insecticide. PBO is reported to decrease the toxicity of metabolically activated insecticides such as diazinon and chlorpyrifos but has no effect on carbofuran (Bailey *et al.*, 1996b), which is in the carbamate class of pesticides. PBO at 200 µg/L is reported to ameliorate about four toxic units of metabolically activated toxicity (Bailey *et al.*, 1996b). See Bailey *et al.* (1996b) and USEPA (1993) for more detailed information on conducting Phase II TIEs. Pesticides identified in the TIE process were confirmed by ELISA and GC/MS analysis.

Finally, in five cases, Phase III TIEs were conducted to ascertain how much of the ambient toxicity could be attributed to the insecticides implicated in the Phase I and II TIEs and in the independent chemical analysis. Phase III TIEs were carried out by comparing bioassay mortality rates in paired dilution series, consisting of the ambient water and amended control water. The latter was amended with insecticides to match concentrations measured in the ambient sample. The concentrations included in the two paired dilution series varied depending on the number of toxic units present in the sample. The NOEC concentration was included in each series. Both dilution series were diluted with laboratory control water. The cause of toxicity was assumed to have been confirmed when the mortality rates were similar in both series.

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[1]The eight methanol:water fractions were 50:50, 70:30, 75:25, 80:20, 85:15, 90:10 and 100:0.

TIE Manipulations

Sample manipulations are described below and are summarized in a flow chart presented in Figures 4a-4e. The TIEs generally followed the flow chart, however, to improve cost and experimental efficiency, several manipulations were commonly omitted from the procedures. Bailey *et al.* (1995) and USEPA (1991) describe procedures used by the laboratory. Brief descriptions of the manipulations are described below.

Six ml Varian C8 Solid Phase Extraction columns were used to remove non-polar organic chemicals from the ambient water samples. C8 SPE columns were used, rather than the C18 SPE recommended by EPA, because a single insecticide elutes in a smaller number of fractions during Phase II testing procedures (Bailey *et al.*, 1996b). The results of Phase II TIEs are more easily interpreted when the number of fractions that a compound elutes in is small. All waters were pumped through the column at a rate of 5 to 10 ml/min. Control blank waters were first pumped through the columns prior to the ambient water samples. Settled ambient samples (1000-1800 ml) were then passed through the column. The first 200 ml of the C8 solid phase extracted water for both the control blank and for the ambient water was discarded to minimize potential artifactual column toxicity. HPLC grade or OPTIMA grade methanol (MeOH) was used for column activation and extraction. Eluates (methanol extractions) were obtained by running 3.0 ml of MeOH through the loaded column at a rate of one ml/min. The concentration at which the eluate was added back in the Phase II TIEs ranged from 3 to 5 times the ambient concentration.

EDTA and sodium thiosulfate were added to ambient water in cases where preliminary Phase I TIE results suggested that toxicity was due to chemicals other than non-polar organic compounds. Concentrations ranged from 1.25 to 50 mg/L and from 7.5 to 60 mg/L, respectively.

Statistical Methods and Definition of Toxicity

Toxicity was defined as a statistically significant difference ($p<0.05$) between a sample and the laboratory control. Bartlett's Test for homogeneity of variance was run on all fish growth and mortality, daphnid reproduction and algal growth data. When the variance was homogeneous, the data was compared to the controls using Analysis of Variance and Dunnett's mean separation tests. If the variance was not homogeneous, then statistical significance was ascertained using Kruskal-Wallis and Dunn's non-parametric multiple comparison tests. *Ceriodaphnia* survival[1] was compared against the control with a Fisher's Exact Test. No statistical analyses were conducted on *Ceriodaphnia* TIE results. T-tests were used for statistical comparisons in the algal TIEs.

Quality Assurance Program

The purpose of the Quality Assurance (QA) Program was to ensure that the data were generated under conditions that accurately reflected the quality of the water sample.

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[1]Acute toxicity was defined as a statistically significant difference in mortality between an ambient water and laboratory control within 96 hours of exposure. Chronic toxicity refers to a statistically significant difference in mortality, growth or reproduction between an ambient water and laboratory control occurring after 96 hours.

Standardized procedures were followed in all aspects of research. The methods followed the QA plan designed specifically for this project (Connor *et al.*, 1993b). Monthly reference toxicant tests, consisting of five to six known concentrations of NaCl in laboratory control water, were conducted for each species. Chronic LC_{50} and EC_{50}[1] concentrations were calculated to ascertain changes in animal sensitivity throughout the time period of the study.

[1]An EC_{50} is defined as the concentration that produces a 50% reduction in sub-lethal endpoints such as growth and reproduction.

RESULTS

NaCl Reference Toxicant Testing

Between test variability was assessed monthly for the thirteen-month study with reference toxicant testing. USEPA (1989) recommends reference toxicant testing to ascertain whether changes in animal sensitivity occurred. A testing endpoint was considered an outlying value if it fell beyond two standard deviations of the cumulative mean. One outlying value each occurred in the *Ceriodaphnia* reproduction and survival tests, the *Selenastrum* and *Pimephales* growth assays and the fish mortality data (Appendix C). The USEPA (1989) suggests that one outlying value may be expected to occur by chance when 20 or more events are compared. Twenty-one to twenty-four data points are presented in the control charts, therefore, quality control measurements are acceptable and indicate that the bioassay data are reliable.

Species Performance

USEPA requires that the test performance of each species in laboratory control water meet specific criteria for a bioassay to be considered acceptable (USEPA, 1989). Screening tests that failed to meet these criteria are presented in the appendix for general information, but are excluded from the text of this report.

For chronic *Ceriodaphnia* tests, USEPA requires organisms in control water to produce a minimum average of 15 neonates/adult, six out of ten organisms to have three broods and mortality not to exceed 20%. Of the 20 surveys conducted, only one failed to meet the above criteria (low reproduction at 9.1 neonates/adult). *Ceriodaphnia* TIE styled test results were considered acceptable when mortality in the laboratory control water did not exceed 20%.

For *Selenastrum*, USEPA requires that the coefficient of variation between the four replicate control flasks be less than or equal to 20% and exhibit an average growth of 200,000 cells/ml or more. Two out of seventeen of the screening studies failed to meet these criteria due to high coefficients of variation (23.6% and 23.8%). USEPA does not specify test criteria for *Selenastrum* TIEs. The coefficients of variation for the six TIEs conducted ranged from 7.7 to 21.6%.

USEPA requires control treatments in the *Pimephales* assay to have a minimum average weight of 0.25 mg/fish and a maximum mortality of 20%. All tests met these criteria.

Water Chemistry and Analytical Chemistry

EC, pH, hardness, TSS and turbidity for routine monitoring and rain events are presented in Appendix D. Unless noted otherwise, all pH, DO, EC and final ammonia concentrations of test waters were within the acceptable physiological limits of the test organism. Final ammonia concentrations for all toxic samples (mortality $\geq$ 30%) ranged from 0.0 to 3.0 mg/L. These concentrations were well below concentrations reported to cause acute toxicity to *Daphnia magna* and *Pimephales promelas* (Henderson *et al.*, 1961; Mount and Norberg, 1984).

The pesticide concentrations obtained from both USGS and APPL Inc. are reported in Appendix E, Tables 3 to 6. ELISA values are reported in water chemistry tables (Appendix D, Tables 1 to 19) and in TIE Tables (Appendix F, Tables 1 to 32).

Bioassay Results

For routine monitoring, rain events and special studies, the results are reported by species in the order of *Ceriodaphnia*, *Selenastrum* and *Pimephales*.

Ceriodaphnia

Routine Monitoring

One hundred seventy two samples were collected and tested with *Ceriodaphnia* during the 13-month study. The results of individual experiments are shown in Appendix G. Twelve samples caused acute mortality (Table 3). Acute toxicity was defined as a statistically significant difference in mortality between a sample and the laboratory control at 96 hours. Of the twelve samples causing acute mortality, four were collected from Mosher Slough, three from Ulatis Creek, and one each from Paradise Cut, Haas Slough, Ryer Island Drain, French Camp Slough, and Duck Slough. Six of these sites are back sloughs, and one is a main agricultural drain on a Delta tract (Table 1). Three additional samples tested chronically toxic. Samples collected from both Sycamore Slough (28 February 1995) and Ulatis Creek (1 September 1994) caused 90% mortality and one sample collected from French Camp Slough (21 March 1995) caused 50% mortality by day seven of the test. Two additional samples were collected from Ulatis Creek on 13 and 18 September 1994 to evaluate duration of toxicity in the field. The sample collected on 13 September caused acute mortality while the sample collected on the 18 September caused chronic toxicity, respectively.

Nine of the 172 samples tested caused reproductive inhibition (Table 4). On 3 September 1994, filtered (0.22 µm and 1 µm filtration) and unfiltered samples collected from Duck Slough were tested in the routine *C. dubia* bioassay. Reproduction improved with decreasing filter pore size suggesting that the toxicant was absorbed to particulate material and was removed by filtration (Appendix G, Table 4).

Toxicity During Rain Events

The daily precipitation and related bioassay data are presented in Appendix H. Precipitation measurements were taken in the City of Stockton. Results of the six rain events and one follow-up test are summarized below.

Sacramento River at Greene's Landing and San Joaquin River at Vernalis: 9-14 January 1995

A total of 2.44 inches of rain fell between 9 and 14 January 1995. The first sample collected from the San Joaquin River at Vernalis prior to the storm was not toxic. During the storm event reproduction decreased significantly in samples collected from the San Joaquin River at Vernalis (10 and 11 January) and from the Sacramento River at Greene's Landing (13 and 14 January) (Appendix H, Table 2).

ELISA analyses detected 0.091 µg/L diazinon in the sample collected at Vernalis on 11 January. Diazinon was not detected at Greene's Landing on 14 January. No GC/MS analysis was conducted. Both values are thought too low to cause the observed reproductive impairment.

San Joaquin River at Vernalis 23-25 January and Old River at Tracy 23 January 1995

A total of 0.92 inches of rain fell from 23 to 25 January 1995. No toxicity to *Ceriodaphnia* was observed (Appendix H, Table 3).

Delta Rain Event 1-11 March 1995

A total of 2.32 inches of rain fell in the Central Valley between 8 and 11 March 1995. One hundred percent mortality occurred within 96 hours in those samples collected from Ulatis Creek, Paradise Cut and Mosher Slough on 9 March 1995 (Appendix H, Table 4). Of the four samples collected from the San Joaquin River at Vernalis between 8 March and 11 March, only the sample collected on 10 March resulted in significantly lower reproduction than the laboratory control. TIEs were conducted on the Ulatis Creek and the Paradise Cut 9 March samples and the results are presented below. No follow-up TIEs were conducted on the 9 March Mosher Slough sample.

No toxicity was observed in any of the samples collected from Sacramento River at Greene's Landing, Ryer Island Drain, French Camp Slough or Duck Slough.

Haas Slough, Sycamore Slough and Ulatis Creek 13 March 1995

A total of 0.35 inches of rain fell on 13 March 1995. No toxicity was observed (Appendix H, Table 5).

San Joaquin at Vernalis 21-24 March 1995

A total of 1.24 inches fell between 21 and 24 March, following 0.51 inches falling on 20 March 1995. No toxicity was observed (Appendix H, Table 6).

Sacramento River at Greene's Landing 22-24 March, Mosher Slough 24 March, Duck Slough, Ulatis Creek and San Joaquin River at Vernalis 25 March 1995

A total of 1.05 inches of rain fell between 22 and 25 March 1995. No toxicity was observed in the samples collected from the Sacramento River at Greene's Landing, Ulatis Creek and the San Joaquin River at Vernalis. One hundred percent mortality within 24 hours occurred in samples collected from Duck and Mosher Sloughs (Appendix H, Table 7). A follow-up sample was collected from Duck Slough six days later which still caused 100% mortality within 24 hours (Appendix H, Table 8). TIEs were conducted on samples collected at both Duck Slough on 25 March and at Mosher Slough on 24 March (see below).

Cache Creek Special Study

Samples were collected from Cache Creek (Figure 2) on one occasion during a rain event and twice during dry periods. Samples were collected primarily from Cache Creek at

Road 102. However, five upstream samples also were taken from Bear Creek (twice), Cache Creek at Rumsey (once) and North Fork Cache Creek (twice).

A seven-day chronic test of a sample collected on 21 March 1995 from Cache Creek at Road 102 resulted in significant reproductive inhibition. No mortality was observed (Appendix I, Table 1). This sample was re-tested later along with several other samples collected following a rain event on 9, 10 and 13 March 1995 (Appendix I, Table 2). In the retest, significant mortality had occurred by day 6 of the test (73.3%).

The remaining samples were collected at the following sites on one or more occasions: Cache Creek at Road 102, Bear Creek, Cache Creek at Rumsey and North Fork Cache Creek. All samples were tested in an eight-day *Ceriodaphnia* mortality test. However, this particular test was set up approximately 4 weeks after some of the samples had been collected which is not in accordance with EPA methods. Also, this test was set up TIE style, rather than the chronic style, due to limited sample availability. Toxicity occurred in samples collected at all four sites on two to three dates for this rain event.

Cache Creek samples collected on 2 May 1995 caused no toxicity to *Ceriodaphnia* in 7-day chronic bioassays (Appendix I, Table 3).

Causes of Toxicity

The primary objective of this study was to identify chemicals causing or contributing to toxicity in individual samples. This information could then be used to recommend toxic hot spots. Abbreviated Toxicity Identification Evaluations (TIEs) were conducted on 21 samples, all of which identified pesticides as the primary toxicants. Twelve of the 21 samples were from routine monitoring tests. Two of the toxic samples were taken during rainfall events and the remaining seven were follow-up samples used to ascertain the potential duration of toxicity in the field. A primary toxicant is considered to be the compound that causes a majority of the observed mortality. Identification of a toxicant does not exclude the possibility that other compounds may be present and also contribute in an additive fashion to the toxicity. It is difficult to account for all of the toxicity by comparing the observed toxic units to the expected toxic units. Even in instances where only one toxic compound is present, the expected toxic units and observed toxic units may not match perfectly because of changing animal sensitivity, analytical variability and matrix effects. Phase III TIEs help considerably because variations in animal sensitivity are eliminated. Each of the TIEs is discussed below briefly and the results are presented in Tables 5 to 25 and in greater detail in Appendix F, Tables 1 to 32. The results from follow-up samples are also presented in Appendix F.

Ulatis Creek

Ulatis Creek is a back slough which receives agricultural runoff from farmland in Solano and Yolo Counties as well as some urban runoff from the City of Vacaville. Seven samples collected from Ulatis Creek tested toxic. Six of the seven samples contained chlorpyrifos at concentrations high enough to account for the majority of toxicity.

One Ulatis Creek sample collected on 1 September 1994 as part of routine monitoring implicated a metabolically activated compound as the primary compound responsible for toxicity (Table 5). In the original screening, 90% mortality to *Ceriodaphnia* occurred on

day 7, suggesting that a toxicant was present below one toxic unit (TU). The sample was re-tested with and without piperonyl butoxide (PBO). The toxicity was reduced with the addition of PBO suggesting a metabolically activated organic compound was responsible for toxicity. GC/MS analysis detected chlorpyrifos at 0.058 µg/L. The laboratory's approximate 96-hour LC_{50} for chlorpyrifos is 0.080 µg/L. The 96-hour LC_{50} can range from 55 to 95 µg/L depending on animal variability and test style. The laboratory's 7-day NOEC[1] is 40 µg/L. The concentration measured in this sample exceeds the laboratory 7-day NOEC and is below the 96-hour LC_{50} which can account for the chronic toxicity that was observed.

A follow-up sample, collected from Ulatis Creek on 13 September 1994, thirteen days after the original screening, was assayed to ascertain the potential duration of toxicity in the field (Table 6). In the follow-up sample, ninety-five percent mortality occurred within 72 hours suggesting that the toxicant was present at concentrations greater than one toxic unit and had increased in the field since the original sample had been collected. In the original sample (collected on 1 September 1994), complete mortality occurred on day 5 (TIE styled test). A Phase I TIE was initiated. The toxicity was alleviated in the sample amended with PBO again suggesting that a metabolically activated compound was responsible. The sample was run through a C8 SPE column, then extracted with eight discrete methanol:water fractions for a Phase II TIE. One hundred percent mortality occurred in the 80% fraction within 48 hours and 40% mortality occurred in the 85% fraction on day 7. Toxicity in these fractions is consistent with the elution pattern of chlorpyrifos (Bailey *et al.*, 1996b; Crepeau, 1997). Typically, the majority of chlorpyrifos will elute in the 80% fraction, causing the mortality rate to be highest in this fraction. More importantly, no toxicity was apparent in any other fraction suggesting that a single toxicant was probably responsible for the mortality. GC/MS analysis detected 0.09 µg/L chlorpyrifos. This concentration exceeded one toxic unit and could account for the majority of toxicity in the bioassay response.

An additional follow-up sample was collected on 18 September 1994 to ascertain the potential duration of toxicity in the field (Table 7). This sample was collected 18 days after the initial detection of toxicity. The initial screening study included a PBO treatment. Seventy-five percent mortality occurred in the ambient sample at day 5 suggesting that the toxicant was present below one toxic unit. No mortality occurred in the PBO treatment suggesting that metabolically activated pesticides were responsible for toxicity. Chlorpyrifos and malathion both require metabolism to activate compounds. Each compound was detected by GC/MS at 0.048 µg/L and 0.025 µg/L, respectively. The chlorpyrifos concentration exceeded the laboratory 7-day NOEC and was below the 96-hour LC_{50} which could account for the chronic toxicity that was observed. The concentration of malathion was less than one tenth of a toxic unit, which was considered negligible.

A sample collected from Ulatis Creek on 7 November 1994, as part of routine monitoring, again implicated chlorpyrifos as the primary toxicant (Table 8). In the initial screening study, 100% mortality occurred within 48 hours suggesting that the toxicant was present at more than one toxic unit. In a Phase I TIE, a C8 solid phase extraction treatment and a PBO treatment were tested. The removal of toxicity in both of these

[1] The NOEC is the no observed effect concentration.

treatments suggested that a non-polar organic compound, specifically a metabolically activated pesticide, was likely responsible. In the Phase II TIE, 100% mortality occurred fastest in the 80% fraction (day 1) which is consistent with the elution pattern of chlorpyrifos. One hundred percent mortality also occurred in the 70% and 75% fractions by day four. Chlorpyrifos was detected at 0.047 µg/L by GC/MS. Malathion was present at 0.061 µg/L by GC/MS and may have contributed to the toxicity detected in the 70% fraction. Crepeau (1997) has shown that malathion elutes in the 70% fraction. This Phase II TIE was conducted at five times the ambient sample concentration that may have concentrated a non-toxic chemical to a toxic concentration. Some toxicity was also present in the 95 and 100% fractions, which may indicate the presence of a third toxicant. Unfortunately, no Phase III TIE was conducted to evaluate this possibility. The chlorpyrifos concentration exceeded the laboratory 7-day NOEC and was approximately at the 96-hour LC_{50} which accounts for the majority of the observed response. The concentration of malathion was less than one tenth of a toxic unit, which was considered negligible.

A follow up sample from Ulatis Creek was collected on 11 November 1994 to determine the potential duration of toxicity in the field, however, this sample was non-toxic.

A Ulatis Creek sample collected on 4 December 1994 as part of routine monitoring, caused 100% mortality to *Ceriodaphnia* in 72 hours suggesting that a toxicant was present at more than one toxic unit (Table 9). Removal of toxicity in samples with the addition of PBO and with solid phase extraction suggested that toxicity was due to a metabolically activated pesticide. When *Ceriodaphnia* mortality in the control water with PBO was high, as was the case with this TIE, similar mortality was expected in the ambient sample amended with PBO. However, the low mortality in the ambient sample with PBO, despite the expected high mortality, suggests that a metabolically activated pesticide was the cause of toxicity. Unreported laboratory tests have demonstrated that PBO toxicity is reduced in the presence of diazinon and chlorpyrifos. Therefore, data generated when PBO toxicity in the blank was apparent was reported. More studies need to be conducted to determine if PBO is generally less toxic in ambient samples due to some matrix effect. In a Phase II TIE, 100% mortality occurred in the 80% and 85% fractions, suggesting the presence of chlorpyrifos. Mortality also was detected in the 90% and 95% fractions (40% and 56%, respectively), which may indicate the presence of another toxicant. Alternatively it must be mentioned that this Phase II TIE was conducted at five times the ambient sample concentration which may have concentrated a non-toxic chemical to a toxic concentration. Chlorpyrifos and diazinon were detected by ELISA at 0.045 µg/L and 0.133 µg/L, respectively. The chlorpyrifos value, however, is below the ELISA detection limit. At these concentrations, chlorpyrifos is present at half a toxic unit and diazinon is present at one third of a toxic unit. Chlorpyrifos and diazinon are known to be additive (Bailey, 1996b). No Phase III or GC analysis was conducted. The combination of chlorpyrifos and diazinon were considered to contribute to toxicity however these two compounds could only account for about half of the observed response.

A sample collected from Ulatis Creek on 9 March 1995, during a rain event, caused 100% *Ceriodaphnia* mortality within 24 hours (Table 10). A dilution series was conducted to determine the potency of the toxicant. The observed response was equivalent to three toxic units based on linear interpolation of the dilution series results.

The addition of PBO alleviated toxicity, suggesting that the toxicant(s) was metabolically activated. Chlorpyrifos was detected at 0.230 µg/L and 0.137 µg/L by ELISA and GC, respectively. Diazinon was detected at 0.293 µg/L and 0.270 µg/L by ELISA and GC, respectively. These values are roughly equivalent to two toxic units of chlorpyrifos and half of a toxic unit of diazinon. This chlorpyrifos concentration could account for the majority of toxicity in the observed response. Diazinon was considered to contribute to the toxicity.

Ulatis Creek was sampled on 21 March 1995 following a rain event. One hundred percent mortality occurred within 24 hours. A dilution series was conducted to determine the potency of the toxicant(s). The observed response was equivalent to three toxic units based on linear interpolation of the dilution series results. PBO alleviated the toxicity implicating a metabolically activated compound. The solid phase extraction sample also removed toxicity suggesting that a non-polar organic compound was present. The sample was analyzed by ELISA and was found to contain chlorpyrifos at 0.134 µg/L (about two toxic units). To confirm the role of chlorpyrifos, a Phase III TIE was conducted. A side-by-side dilution series test was conducted with whole sample and laboratory water spiked with chlorpyrifos. The similarities in mortality in the 100% and 75% dilutions of the ambient and spiked laboratory water confirmed that chlorpyrifos was primarily responsible for toxicity. Mortality was slightly greater in the 50% dilution of the ambient sample suggesting that another toxicant also might be present. Chlorpyrifos and carbofuran were detected in the ambient sample at 0.100 µg/L and at 0.800 µg/L, respectively. These values correspond to about one toxic unit of chlorpyrifos and approximately one third of a toxic unit of carbofuran.

Paradise Cut

Paradise Cut is a back slough located in the southern Delta which receives agricultural runoff and some National Pollutant Discharge Elimination System (NPDES) discharge. Four samples collected from Paradise Cut caused significant mortality. All toxic samples collected from this site implicated chlorpyrifos as the primary toxicant.

A sample collected from Paradise Cut on 12 July 1994, as part of routine monitoring, resulted in complete *Ceriodaphnia* mortality within 24 hours (Table 12). A dilution series was conducted to determine the potency of the toxicant. The observed response was equivalent to six toxic units based on linear interpolation of the dilution series results. With the addition of PBO in the Phase I TIE, toxicity was alleviated until day 3 suggesting that a metabolically activated compound was, at least partially, responsible for toxicity. PBO, at the concentration used in this experiment, will only eliminate up to four toxic units (Bailey *et al.*, 1996b). Therefore, the mortality in the PBO treatment is expected. The toxicity also was alleviated with C8 solid phase extraction and recovered in the eluate added back to control water suggesting that a non-polar organic compound was responsible for toxicity. A Phase II TIE was conducted to help in compound identification. The 80% and 85% fractions had 100% mortality with the mortality occurring slightly sooner in the 80% fraction. No other fraction was found to be toxic suggesting the presence of a single toxicant. Chlorpyrifos is known to elute in the 80% and 85% fractions and was found at 0.444 µg/L by GC/MS and 0.55 µg/L by ELISA. The average of these concentrations exceeded five toxic units and could account for the majority of the toxicity in the observed response.

A follow-up sample was collected from Paradise Cut on 19 July 1994 to ascertain the potential duration of toxicity (Table 13). This second sample was collected seven days after the initial detection of toxicity. Significant mortality occurred by day 5 in the initial screening but 100% mortality did not occur until day 8 in this follow-up sample suggesting that a toxicant was present below one toxic unit. In the Phase I test, PBO alleviated toxicity suggesting that a metabolically activated compound was present. Toxicity also was alleviated in the solid phase extraction treatment and recovered in the eluate added back to laboratory control water suggesting that a non-polar compound was responsible for toxicity. In the Phase II TIE, recovery of toxicity in the 80% fraction implicated chlorpyrifos. In addition, PBO was added to this toxic fraction to confirm that the toxicity was due to a metabolically activated pesticide. Toxicity was reduced, again suggesting a metabolically activated compound. Chlorpyrifos was detected by GC/MS at 0.068 µg/L. The chlorpyrifos concentration exceeded the laboratory 7-day NOEC and was below the 96-hour LC_{50} which could account for the chronic toxicity that was observed.

One hundred percent mortality occurred within 48 hours in a sample collected from Paradise Cut on 9 March 1995 (Table 14) suggesting that a toxicant was present at greater than one toxic unit. This sample was collected during a rain event. The addition of PBO alleviated toxicity suggesting that a metabolically activated pesticide was primarily responsible for toxicity. Chlorpyrifos was detected by ELISA and GC at 0.146 µg/L and 0.230 µg/L, respectively. The average of these concentrations exceeded two toxic units and could account for the observed toxicity.

Six days later, a follow-up sample was collected from Paradise Cut on 15 March 1995 to ascertain the potential duration of toxicity in the field (Table 15). The sample was tested with and without PBO. Due to high mortality in the PBO control treatment, a second test was set up. The first test and the retest had 90 and 100% mortality at 96 hours, respectively. These results suggest that a toxicant was present at more than one toxic unit. PBO alleviated the toxicity suggesting that a metabolically activated compound was responsible for toxicity. Chlorpyrifos was detected at 0.080 µg/L and 0.145 µg/L by GC and ELISA, respectively. Diazinon also was detected by ELISA at 0.125 µg/L, approximately one fourth of a toxic unit. Due to the relatively low concentration of diazinon, a Phase III TIE was set up with only chlorpyrifos. The similarities between both dilution series confirm that chlorpyrifos was the primary toxicant. The higher mortality rates in the 100% and 50% dilutions of the ambient sample suggest, however, that low concentrations of additional toxicant(s) may also have been present. Diazinon may account for this toxicity.

Duck Slough

Duck Slough is a back slough which drains agricultural land in Yolo and Solano Counties. A Duck Slough sample collected on 21 March 1995, as part of a routine monitoring event, implicated chlorpyrifos as the primary toxicant (Table 16). In the initial screening, 100% mortality occurred within 24 hours. In the dilution study, complete mortality occurred in the 12.5% dilution within 96 hours suggesting that the toxicant(s) was present at a minimum of eight toxic units. Chlorpyrifos was detected at 0.490 µg/L and 0.896 µg/L by GC and ELISA, respectively. PBO was added to the 50% and 100% dilutions. Toxicity was completely eliminated in the 50% dilution with PBO.

However, in the 100% dilution, high mortality was only delayed by 24 hours. PBO can only eliminate about four toxic units of pesticide (Bailey *et al.*, 1996b). Alleviation of toxicity in the C8 solid phase extracted sample suggested the presence of a non-polar organic compound. A Phase III TIE was conducted to confirm that toxicity was due to chlorpyrifos. The organisms' responses in both dilution series paralleled one another, suggesting that all of the toxicity was due to chlorpyrifos.

A follow-up sample was collected from Duck Slough on 25 March 1995, four days after the initial sample was collected, to ascertain the potential persistence of toxicity (Table 17). Complete mortality occurred within 24 hours. The observed response approximated eleven toxic units based on linear interpolation of the dilution series results. PBO completely alleviated toxicity in the 25% and 12.5% dilutions. The 50% and 100% dilutions were not tested with PBO. The sample was analyzed for organophosphorous pesticides based on the results of the PBO treatments. Chlorpyrifos was detected at 0.300 µg/L and 0.511 µg/L by GC and ELISA, respectively. No other organophosphorous pesticides were detected. The average of these concentrations was approximately five toxic units and accounted for about half of the observed response.

French Camp Slough

French Camp Slough is a back slough which primarily drains agricultural land located southeast of the City of Stockton. French Camp Slough tested acutely toxic on two occasions. The first was a sample collected on 2 September 1994, as part of routine monitoring, which caused complete mortality within 72 hours (Table 18). These results suggest that a toxicant was present at more than one toxic unit. PBO addition in the Phase I TIE alleviated toxicity, suggesting the presence of a metabolically activated compound. Toxicity was also alleviated with C8 solid phase extraction and recovered in the eluate added back to laboratory control water, suggesting that a non-polar organic compound was responsible for toxicity. In the Phase II TIE, recovery of toxicity in the 80% fraction implicated chlorpyrifos. Alleviation of the toxicity in this fraction with the addition of PBO further implicates a metabolically activated compound such as chlorpyrifos. Chlorpyrifos and malathion were detected by GC/MS at 0.130 µg/L and 0.021 µg/L, respectively. The amount of chlorpyrifos in the sample was approximately 1.5 toxic units and could account for the majority of the observed response. The concentration of malathion was less than one tenth of a toxic unit, which is considered negligible.

The second French Camp Slough sample was collected 5 days later on 7 September 1994 and resulted in 100% mortality within 48 hours (Table 19). A dilution series was conducted only to a 50% dilution, wherein 95% mortality occurred. This suggested that the toxicant was present at approximately two toxic units. When PBO was added to the sample, toxicity was completely alleviated, suggesting that a metabolically activated pesticide was responsible for toxicity. In the Phase II TIE, 100% mortality occurred within 24 hours in the 80% fraction and 65% mortality occurred in the 85% fraction at 72 hours. This elution pattern is consistent with chlorpyrifos. Chlorpyrifos and malathion were detected at 0.096 µg/L and 0.018 µg/L, respectively. The chlorpyrifos concentration exceeded the 96-hour LC_{50} and could account for the majority of the observed response. The concentration of malathion was less than one tenth of a toxic unit, which is considered negligible.

Mosher Slough

Mosher Slough is located in the northern part of the City of Stockton and receives both urban and agricultural inputs. Five samples collected from Mosher Slough caused acute mortality to *Ceriodaphnia*. Toxicity was attributed to diazinon, chlorpyrifos or a combination of the two in four out of five samples.

The Mosher Slough sample collected on 4 December 1994 as part of the routine monitoring resulted in complete *Ceriodaphnia* mortality within 96 hours (Table 20). These results suggest that a toxicant was present at more than one toxic unit. In the Phase I TIE the addition of PBO alleviated toxicity, suggesting the presence of a metabolically activated pesticide(s). Diazinon was detected by ELISA at 0.403 µg/L, roughly equivalent to one toxic unit. This concentration could account for the majority of the observed mortality.

The sample collected from Mosher Slough on 9 January 1995, as part of routine monitoring, also exhibited toxicity (Table 21). In the initial test, 100% mortality occurred within 72 hours, suggesting that a toxicant was present at more than one toxic unit. Addition of PBO in the Phase I TIE completely alleviated toxicity, suggesting the presence of a metabolically activated pesticide(s). Chlorpyrifos and diazinon were detected by ELISA at 0.087 µg/L and 0.422 µg/L, respectively. Together, these two compounds approximated two toxic units and accounted for the observed response.

The Mosher Slough sample collected 21 March 1995 as part of routine monitoring, exhibited 100% *Ceriodaphnia* mortality in 48 hours, the cause of which was only partially determined by subsequent TIE procedures (Table 22). These results suggest that a toxicant was present at more than one toxic unit. A Phase I TIE was set up with a PBO and a C8 solid phase extraction treatment. Alleviation of toxicity in both of these treatments suggested the presence of a metabolically activated pesticide(s). Chlorpyrifos was detected at 0.053 µg/L and 0.050 µg/L by ELISA and GC, respectively. In addition, diazinon was detected at 0.316 µg/L and 0.190 µg/L by ELISA and GC, respectively. The average of these concentrations are approximately one-half of a toxic unit for each chemical and, in combination, can account for about half of the toxicity.

A follow-up sample was collected from Mosher Slough on 24 March 1995 three days after the original sample was collected. Tests conducted on this sample resulted in toxicity which may have been due to the presence of chlorpyrifos (Table 23). One hundred percent mortality occurred in 24 hours in the initial screening. The observed response was equivalent to three toxic units based on linear interpolation of the dilution series results. The addition of PBO reduced the mortality to 20%, suggesting the presence of a metabolically activated OP pesticide(s). Analysis by ELISA detected chlorpyrifos at 0.116 µg/L, which was roughly one and a half toxic units and could account for about half of the observed toxicity. Diazinon also was detected at 0.110 µg/L, about one fourth of a toxic unit.

A sample was collected from Mosher Slough on 1 May 1995 as part of a routine monitoring event. One hundred percent mortality occurred within 48 hours (Table 24) suggesting that a toxicant was present at more than one toxic unit. ELISA detected chlorpyrifos and diazinon at 0.120 µg/L and 0.416 µg/L, respectively. A Phase III TIE was set up to determine the contribution of these two chemicals to the toxicity.

Similarities in both of the dilution series suggest that all of the toxicity was caused by these two compounds.

Ryer Island

Ryer Island is a Delta island which drains agricultural land in Solano County. The Ryer Island sample collected on 31 May 1995 resulted in 100% *Ceriodaphnia* mortality in 24 hours (Table 25). The dilution series experiment did not meet the laboratory criteria for test acceptability due to high mortality in the control. However, linear interpolation estimated 1.5 toxic units, which provides some indication of the toxicant's potency. In a Phase I TIE, the addition of PBO did not alleviate toxicity suggesting that toxicity was not due to a metabolically activated compound(s). However, toxicity was removed by the C8 solid phase extraction, which suggests the presence of a non-polar organic toxicant. Complete mortality occurred in the 50% and 70% fractions. Carbaryl was detected by GC at 7 µg/L.

In order to evaluate if carbaryl could explain the observed toxicity in the Ryer Island sample, carbaryl was spiked into laboratory control water and tested in the laboratory's standard TIE procedures. The laboratory 96-hour LC_{50} was determined to be 4.5 µg/L. In the controlled Phase I TIE, PBO did not alleviate toxicity. In the Phase II TIE, carbaryl eluted in the 50% and 70% fractions. Comparisons between the results of the laboratory LC_{50} studies and the detected concentration of carbaryl in the Ryer Island sample and the controlled carbaryl TIEs and the Ryer Island TIEs suggest that carbaryl was responsible for toxicity. A Phase III TIE was set up to confirm the role of carbaryl. Similarities of time to death in matching dilutions of sample eluate and carbaryl spiked control water indicate that toxicity was due to carbaryl.

A follow up sample from Ryer Island was collected on 4 June 1995 to determine the potential duration of toxicity in the field. However, this sample was non-toxic.

Selenastrum

Routine Monitoring

During routine monitoring, 115 samples were collected and tested with *Selenastrum* (Appendix J, Tables 1-13). No toxicity was detected when cell counts of the individual samples were statistically compared to those of the laboratory control (Table 26). This may be misleading because glass distilled water contains less nutrients compared to ambient waters and this condition in the assay subsequently limits algal growth. It is more useful to compare sites with low cell counts to other sites and try to determine if toxicants are responsible for the low counts. This issue will be addressed in more detail in the discussion section. For each sampling date, the samples showing the lowest cell counts (1/3 of total samples) were examined. Table 27 illustrates general trends in algal performance in the various waterways. Sites that were sampled less than four times are discussed as a separate group. In these cases, no seasonal trends can be established since sites were not sampled for a full year.

Of the sites sampled more than four times, the three with the highest frequency of poor performance were the San Joaquin River at Vernalis, Paradise Cut and Sycamore Slough. Samples collected from the San Joaquin River at Vernalis had low cell counts five out of

ten times. Samples collected from Paradise Cut were impacted five out of 11 times and samples collected from Sycamore Slough were impacted three out of seven times. For Paradise Cut, four of the five low cell counts occurred in four consecutive months (June 1994 through September 1994). Samples collected from Old River at Tracy and Prospect Slough each had low cell counts in four out of ten samples. For samples from Old River at Tracy, three of its four low counts were between July 1994 and September 1994. This is the same time its upstream site, Paradise Cut, had low cell counts.

No patterns can be applied to the sites in which samples were collected four times or less, although samples from several sites did have low growth relative to other samples. Of all the samples collected and tested with *Selenastrum*, the following sites rarely (less than 15% of the times collected) exhibited reduced cell counts relative to other ambient water samples: Sacramento River at Greene's Landing, Lindsay Slough, White Slough, French Camp Slough, Ulatis Creek, Skag Slough, Hog Slough, Upper Jones Tract and Middle Roberts.

Toxicity During Rain Events

Delta Rain event 8-9 March 1995

No apparent algal toxicity was detected in samples collected during the 8-9 March 1995 rain event when compared to the laboratory control. During this storm event, cell counts ranged from 70.3 to 211.8 x 10^4 cells/ml in the ambient waters compared to 49.7 x 10^4 cells/ml in the glass distilled control water (Appendix K, Table 1). A Phase I TIE was conducted on the 9 March samples from Paradise Cut and Ulatis Creek because these two samples had low cell counts relative to other ambient sites. The TIE results are discussed below.

Delta Rain Event 13 and 15 March 1995

During the 13 to 15 March rain event, cell counts ranged from 67.0 to 205.0 x 10^4 cells/ml in the ambient waters compared to 35.0 x 10^4 cells/ml in the glass distilled control water (Appendix K, Table 2). No apparent algal toxicity was observed during this rain event and no TIEs were conducted.

Special Studies

Three tests were conducted as part of a special study to determine the origin of toxicants causing the relatively low cell growth in Paradise Cut samples.

For the first test, additional sites were sampled during one of the routine monitoring events (3 June 1994). These additional sampling sites isolated different agricultural sources as well as an NPDES discharge. The rationale for each site selection is presented in Appendix L, Tables 1-3 along with bioassay results. The results of the first bioassay study suggested that agricultural sources were responsible for the apparent low growth in Paradise Cut. Primary production rates for this subset of samples ranged from 36.6 to 223.2 x 10^4 cells/ml in the ambient waters compared to 86.3 x 10^4 cells/ml in the glass distilled control water. The only sample representing a waterway receiving an NPDES discharge had the highest cell growth in the test. Growth in samples collected from the agricultural areas had cell counts below 80 x 10^4 cells/ml.

Since the first experiment implicated agricultural runoff as the source of compounds causing low cell growth, a second set of samples was collected on 14 June 1994 from all major waterways that drain into Paradise Cut to better isolate the source of toxicity. Primary production rates ranged from 60.5 to 206.9 x 10^4 cells/ml in the ambient waters compared to 86.3 x 10^4 cells/ml in the glass distilled control water. Cell growth was not significantly different from the control in any of the seven sites. However, cell counts in samples from Mac Arthur Blvd. and Stewart's Tract East Drain were lower than in water samples from other sites. The differences in growth between samples collected from the two sides of the tract suggest that a toxic compound was present rather than a wide spread problem caused by ionic imbalances from ground water recharge. TIEs were conducted on water from both locations and results are discussed below.

A third set of samples was collected on 22 June 1994 to look more closely at agricultural inputs. Additional samples were collected from the drains of specific crop types to determine which pesticides used on these crop types might be causing the lower cell growth. Cell counts ranged from 17.5 x 10^4 cells/ml to 208.2 x 10^4 cells/ml. Low cell growth was detected in samples from a tile drain discharging into Paradise Cut and the drain of an alfalfa field.

Causes of Reduced Growth

Ten samples, which had apparent low algal growth relative to others collected on the same day, were passed through a C8 solid phase extraction column to determine if the growth suppression was due to a non-polar organic compound. First, algal growth in laboratory control water before and after passage through a C8 column was compared by t-test to rule out artifactual toxicity due to extraction procedures. If no significant change in growth was detected, then a similar comparison was made for the ambient sample. If a significant improvement was detected in algal growth after solid phase extraction, then reduced growth was attributed to a non-polar organic compound. The following samples showed such an improvement: Paradise Cut (3 June 1994), a lateral waterway in the Paradise Cut Irrigation District (Mac Arthur Blvd., 14 June 1994), Duck Slough (9 January 1995), Victoria Island Drain (9 January 1995) and Ulatis Creek (9 March 1994). Each is discussed in more detail below. The results of these TIEs are summarized in Table 28. Any available organic chemical concentrations for these samples are presented in Appendix E, Table 6.

Paradise Cut (3 June 1994)

A TIE was conducted on a sample collected from Paradise Cut on 3 June 1994, which showed low algal growth relative to the other sites. In the Phase I TIE, the solid phase extracted sample exhibited a 46% growth enhancement, while cell counts decreased by 12% in control water passed through the same cartridge. These results suggest that a non-polar organic compound was responsible for growth reduction in the ambient sample (Appendix M, Table 1).

Mac Arthur Blvd. (14 June 1994)

A sample collected from a lateral waterway within the Paradise Cut Irrigation District at Mac Arthur Blvd. on 14 June 1994 exhibited low algal growth. A Phase I TIE was

initiated (Appendix M, Table 2). Growth in the solid phase extracted sample was enhanced by 313% relative to the ambient sample, while growth decreased by 27% in control water passed through the same cartridge. These results suggest that a non-polar organic compound was responsible for decreased cell growth.

Duck Slough and Victoria Island Drain (9 January 1995)

Samples collected from Duck Slough and Victoria Island Drain on 9 January 1995 exhibited comparatively low growth rates. In the solid phase extracted sample, growth was enhanced by 378% and 220% for Duck Slough and Victoria Island Drain, respectively (Appendix M, Table 3). This compares to a 54% and 46% reduction in growth in control water passed through the respective cartridges. Again, this suggests the decrease in cell growth in both ambient samples was due to a non-polar organic compound.

Ulatis Creek (9 March 1995)

The Ulatis Creek sample collected 9 March 1995 during a rain event did not show a statistically significant growth reduction when compared to the control, but cell counts were lower than in other samples collected on the same date. A Phase I TIE was conducted (Appendix M, Table 4). Growth in the solid phase extracted Ulatis sample was enhanced by 140%, while growth decreased by 34% in control water passed through the same cartridge. These results suggest that a non-polar organic compound was responsible for the reduced cell growth.

Paradise Cut (12 July 1994), Sycamore Slough (28 February 1995), and Stewart's Tract East Drain (14 June 1994)

TIEs also were conducted on samples collected from Paradise Cut on 12 July 1994, 1 March 1995 and 9 March 1995, from Sycamore Slough on 28 February 1995 and from Stewart's Tract East Drain on 14 June 1994 (Appendix M). In these samples, however, we were unable to differentiate between artifactual column enhancement and enhancement due to the removal of a non-polar organic compound(s). The results of these TIEs were inconclusive.

Pimephales

Fathead minnow tests were conducted on only three dates. One was part of routine monitoring and the others were related to rainfall events.

Routine Monitoring

Delta Monitoring 4-5 December 1994

Samples were collected from several sites including the Sacramento River at Greene's Landing, the San Joaquin River at Vernalis, Ulatis Creek, French Camp Slough and Ryer Island. Mortality ranged from 0 to 10%. Growth ranged from 0.313 to 0.333 mg/fish in the ambient waters compared to 0.295 mg/fish in the laboratory control water. None of these values indicated toxicity to the fathead minnow (Appendix N, Table 1).

Toxicity During Rain Events

Delta Rain Event 9-14 January 1995

During the January rain event, fathead minnow growth ranged from 0.281 to 0.330 mg/fish in the ambient samples compared to 0.280 mg/fish in the control (Appendix O, Table 1). None of these values indicated toxicity. No significant minnow mortality occurred in any of the samples collected during this rain event.

Sacramento River at Greene's Landing 1 May 1995

Fathead minnow growth was 0.22 mg/fish in the sample collected from Sacramento River at Greene's Landing compared to 0.25 mg/fish in laboratory control water. No mortality occurred in either treatment (Appendix O, Table 2). These values do not indicate toxicity to the fathead minnow.

DISCUSSION

The data generated during the second year of this study primarily provides information on severity and sources of toxicity to laboratory test organisms in samples collected from the Sacramento-San Joaquin Delta. Toxicological patterns usually emerged as repeated instances of toxicity in samples collected from the same site, or less frequently, as isolated instances affecting several sites geographically related to one another.

Ceriodaphnia Toxicity

During routine monitoring, *Ceriodaphnia* toxicity occurred exclusively in samples collected from back sloughs and an agricultural drain from a Delta island tract. Toxicity in these types of waterway was of particular interest due to longer water residence times and the potential for increased exposure times. Acute toxicity occurred on 12 occasions, some of which were repeated instances of toxicity seen at the same site.

During two rain events (January and March 1995), reproductive toxicity was observed in the mainstem rivers. Otherwise, no toxicity was observed in these water bodies. A few back sloughs were sampled during rain events to determine whether toxicity was present. Acute toxicity to *Ceriodaphnia* occurred in Mosher Slough on two occasions and in Ulatis Creek, Duck Slough and Paradise Cut each on one occasion demonstrating that back sloughs were toxic during the rainy season, as well.

Several samples were collected from Cache Creek because of its significant contribution of water into the Yolo Bypass, which ultimately drains into the Delta. It should be noted that the majority of the Cache Creek data was not generated in accordance with the EPA methods due to the prolonged sample storage time prior to testing. Nonetheless, the data provides a preliminary indication of runoff related toxicity in the watershed. Following a March rain event, toxicity occurred in samples collected at four sites on two or three dates. The cause of *Ceriodaphnia* mortality in these samples is not known. Samples were collected from Cache Creek on 11 March 1995 to determine metal loading. Connor and Clark (1998) reported that Cache Creek is a major source of metals during high flow years. Due to the observed toxicity from this runoff related event and the evidence of high metal loading reported by Connor and Clark, studies should be conducted to determine the magnitude, duration, frequency and source of toxicity during runoff events in the Cache Creek watershed.

Causes of Toxicity and Comparisons to Other Study Results

Toxicity Identification Evaluations (TIEs) were conducted on twenty-one samples collected during the sampling year. Chemical identification was considered successful if TIE results suggested that a chemical or chemical group was present in the sample and that the suspected toxicant(s) were present at a concentration that could explain or contribute to the majority of toxicity. The identification of the primary toxicant does not exclude the possibility that other toxicants may be present in the sample; rather, it simply suggests that the identified compound accounts for a majority of the toxicity. Examples of how diazinon, chlorpyrifos and carbaryl typically react in a Phase I and Phase II TIEs are presented in Table 29. The flow chart presented in the Materials and Methods section (Figures 4a-4e) may be helpful to understand the basis for the TIE conclusions.

Chlorpyrifos

In 19 out of the 21 toxic samples, metabolically activated pesticides were identified as the group of chemical compounds primarily responsible for the toxicity. Chlorpyrifos and diazinon were determined to be two toxicants in this pesticide class. Chlorpyrifos was detected at concentrations exceeding the laboratory 7-day NOEC of 40 µg/L in these 19 samples. Chlorpyrifos was detected at concentrations of approximately one toxic unit or greater in 15 samples. Bailey *et al.* (1996b) reported the 96-hour *Ceriodaphnia* LC_{50} to be 0.060 µg/L. The Department of Fish and Game (1992) conducted two studies and determined the 96-hour *Ceriodaphnia* LC_{50} to be 0.13 µg/L and 0.08 µg/L. The bioassay, TIE and chemical analysis for these samples are consistent with the reported data and implicate chlorpyrifos as a major contributor to the toxicity.

Since toxicity tests employ laboratory organisms, it is important to note that local species have sensitivities similar to *Ceriodaphnia*. *Neomysis mercedis* and *Daphnia magna* are both residents of the Delta. The reported 96-hour LC_{50} of chlorpyrifos is 0.07 µg/L and 0.16 µg/L for *Neomysis mercedis* (Bailey *et al.*, 1995; CDFG, 1992). USEPA (1985) reports *Daphnia magna* reproductive impairment at 0.08 µg/L.

The reported 96-hour LC_{50} values for chlorpyrifos for other non-resident invertebrates are 0.056 µg/L for *Mysisdopsis bahia* (Borthwick and Walsh, 1981) and 0.11 µg/L for the amphipod, *Gammarus lacustris* (Sanders, 1969). Other impairments at these chlorpyrifos concentrations have been reported. The 24-hour LC_{50} for the naiad life stage of the dragonfly, *Pseudoagrion* species is 0.10 µg/L (Karim *et al.*, 1985). McKenney *et al.* (1981) reports a LOEC of 0.004 µg/L for the juvenile *Mysidopsis bahia*. Therefore, the reported 96-hour LC_{50} values for *Ceriodaphnia* appear to be similar to those of other sensitive invertebrates.

Chlorpyrifos has been shown to result in toxicity in tests conducted on other California surface waters. DiGiorgio *et al.* (1995) detected chlorpyrifos in the Colorado River basin between September and December and in the Imperial Valley between August and November. Foe (1995) detected chlorpyrifos 85 times with a mean concentration of 0.07 µg/L, between April 1991 and June 1992 in the San Joaquin River Basin. Bailey *et al.* (1996a) reported that chlorpyrifos concentrations exceeded the laboratory's 96-hour LC_{50} in approximately 25% of the samples collected from storm runoff in the Cities of Sacramento and Stockton between November 1994 and May 1995. Finally, MacCoy *et al.* (1995) detected chlorpyrifos once in the San Joaquin River between November 1991 and April 1994. The primary agricultural uses of chlorpyrifos during the winter and early spring are as a dormant spray on orchards and on alfalfa for weevil control. During the summer irrigation season, chlorpyrifos is used primarily on walnuts, almonds and apples. (Sheipline, 1993).

Diazinon

Diazinon was detected in eight toxic samples. Concentrations in six of these exceeded the laboratory 7-day NOEC of 250 µg/L. Three of the eight contained concentrations approximately equal to the laboratory 96-hour LC_{50} of 425 µg/L. For diazinon, results appear comparable to those of chlorpyrifos. Specifically, diazinon was established as the primary toxicant in one sample (Mosher Slough collected 4 December 1994). The 48-hour *Ceriodaphnia* LC_{50} for diazinon was reported as 0.35 µg/L by Amato *et al.* (1992)

and as 0.50 µg/L by Burkhard and Jenson (1993). Two studies conducted by Bailey *et al.* (1996b) reported 96-hour LC_{50} concentrations of 0.47 µg/L and 0.41 µg/L for *Ceriodaphnia dubia*. Other organisms have the following reported LC_{50} values: 0.21 µg/L for *D. magna*, a Delta resident (Mitchell, 1985), 0.20 µg/L for *Gammarus fasciatus* (Johnson and Finley, 1980) and 0.03 µg/L for *Chironomus tentans* (Morgan, 1976). Therefore, the reported 96-hour LC_{50} values for *Ceriodaphnia* again appear to be similar to those of other sensitive invertebrates.

Other studies (Lee, in prep) conducted by this laboratory have shown the presence of diazinon in Mosher Slough during winter and spring between 1994 and 1997, at concentrations potentially lethal to *C. dubia*. In 1993, Kuivila and Foe (1995) reported a peak concentration of diazinon in the Sacramento River at Freeport of 0.393 µg/L. On one occasion (1 February 1996), diazinon was measured at concentrations exceeding 14 µg/L in the San Joaquin River at Vernalis (this laboratory's unpublished data). In these studies, Sacramento River samples with diazinon concentrations at or above 0.187 µg/L resulted in 100% *C. dubia* mortality within seven days. All samples from the San Joaquin River at Vernalis with diazinon concentrations greater than 0.331 µg/L resulted in 100% *C. dubia* mortality within 48 hours. The Department of Pesticide Regulation also has measured high diazinon concentrations after heavy rains in the San Joaquin River (Ross, 1991b). In the Central Valley, diazinon is primarily applied in the early spring as a dormant spray on stone fruit and almond orchards to control boring insects (Sheipline, 1993).

Diazinon and Chlorpyrifos

Not only is it important to consider chlorpyrifos and diazinon singly, but, the results show they are sometimes present together. For example, two samples, both from Mosher Slough, contained a lethal combination of both diazinon and chlorpyrifos. Each compound was present at approximately one toxic unit. The toxicity of these two compounds is additive (Bailey *et al.*, 1996b). One sample, Ulatis Creek collected on 4 December 1994, had approximately one toxic unit of chlorpyrifos and diazinon collectively, however, these concentrations were too low to account for a significant portion of the toxicity suggesting that another toxic compound may have been driving the toxicity.

Carbaryl

Carbaryl was detected at 7.0 µg/L in a sample collected from Ryer Island on 31 May 1995. Oris *et al.* (1991) reported the 48-hour LC_{50} for *C. dubia* at 11.6 µg/L and reproductive impairment at 7.2 to 10.6 µg/L carbaryl in a 7-day test.

The carbaryl concentration detected in the Ryer Island Drain sample was above the concentrations known to affect three organisms residing in the Delta. The 48-hour LC_{50} for *D. magna* is 1.25 µg/L (DiGiorgio *et al.*, 1995). Bailey and Liu (1980) reported the 48-hour LC_{50} of carbaryl for *Daphnia pulex* at 6.4 µg/L. Significant growth and reproduction suppression occurred in *Daphnia ambigua* when exposed to 5 µg/L carbaryl during its juvenile stage (Hanazato, 1993). Hanazato (1993) also found that daphnids exposed to carbaryl concentrations equal to or greater than 3 µg/L died before reaching their fifth instar.

Additional information about the toxicity of carbaryl to other aquatic organisms has been reported in other studies. Karnak and Collins (1974) reported the 24-hour EC_{50} (immobilization) for the larval stage of the midge, *Chironomus tentans,* at 7.0 µg/L. The 96-hour LC_{50} values for other invertebrates include 7.0 µg/L for the amphipod *Gammarus pseudolimnaeus* (Woodward and Mauck, 1980). The 96-hour LC_{50} of carbaryl to naiads of the stonefly *Pteronarcys californica*, *Pteronarcella badia* and *Claassenia sabulosa* were reported at 4.8, 1.7 and 5.6 µg/L, respectively (Sanders and Cope, 1968). Therefore, as with diazinon and chlorpyrifos, the reported 96-hour *Ceriodaphnia* LC_{50} values for carbaryl appear to be similar to those of other invertebrates.

Other studies have detected carbaryl in water samples collected in the Central Valley. In a study conducted from 1991 to 1992, twenty-one percent of collected samples resulted in toxicity to *C. dubia*. Carbaryl was one of four insecticides Foe (1995) reports as being responsible for most of the toxicity. The other three are chlorpyrifos, diazinon and fonofos. Carbaryl was detected at concentrations ranging from 0.06 to 8.4 µg/L in water samples collected from the San Joaquin River basin's west side, where it is used during the early irrigation season as a common foliar spray on beans and tomatoes. The Department of Pesticide Regulation also monitored insecticide concentrations in the San Joaquin River Basin in April 1991 and 1992, and detected diazinon, chlorpyrifos and carbaryl in April of one or both years (Ross, 1991a and 1993). Between November 1991 and April 1994, USGS collected water samples from the San Joaquin River at Vernalis on a daily basis (MacCoy *et al.*, 1995). Carbaryl was detected a total of 21 times at concentrations ranging from 0.032 to 0.197 µg/L. Carbaryl was detected 11 times between the months of April and June at concentrations ranging from 0.032 to 0.176 µg/L.

DiGiorgio *et al.* (1995) detected carbaryl concentrations in the Alamo River (Colorado River Basin) ranging from 0.005 to 0.052 µg/L during 1993 and 1994. In that study, carbaryl displayed a bimodal seasonal distribution, with detections in May and June and in September through November. In the Imperial Valley carbaryl is applied primarily on melons in May and June and in August through October.

Implications of Toxicity

The data discussed above provides some indication of the magnitude, frequency and duration of toxicity to laboratory test organisms in samples collected from the Delta. The number of acutely toxic samples collected from back sloughs, and the identification of compounds causing such toxicity, suggest that toxicants in the Delta originate primarily from island tracts and upland agricultural areas draining into back sloughs. Furthermore, toxicity observed in samples collected from back sloughs strongly suggests that most of the invertebrate toxicity in the Delta originates from agricultural operations rather than other land use practices, such as industrial or urban discharges.

As previously stated, the primary focus of this year's monitoring was to identify chemicals causing toxicity. Nevertheless, the results from seven follow-up sampling events suggested that chemicals potentially existed at toxic levels for extended periods of time. Alternatively, it is possible that back slough waterways experience short pulses of toxicants. Additional studies should be conducted to evaluate the duration of toxicant exposure in the field, especially since back sloughs have longer water residence times and

provide nursery areas for many fish species. Increased toxicant exposure time may have some impact on larval fish and their smaller more sensitive food species.

The CVRWQCB's Basin Plan does not have a water quality objective for chlorpyrifos, diazinon or carbaryl. Therefore, we compared our values to suggested criteria to protect freshwater organisms. In all 19 cases where chlorpyrifos caused or contributed to the toxicity of a sample, concentrations exceeded the recommended Hazard Assessment Criterion of 0.02 µg/L (chronic) proposed by the California Department of Fish and Game (CDFG; Menconi and Paul, 1994). Fourteen out of the nineteen contained concentrations exceeding the acute Hazard Assessment Criterion of 0.07 µg/L.

In eight cases, diazinon was thought to cause or contribute to toxicity. In all cases, concentrations exceeded the recommended water quality criteria of 0.009 µg/L from the National Academy of Sciences (1973) and 0.008 µg/L from the International Joint Commission (1975). Concentrations also exceeded the CDFG Hazard Assessment Criteria of 0.04 µg/L (chronic) and 0.08 µg/L (acute) (Menconi and Cox, 1994).

The CDFG released a Hazard Assessment Criteria of 2.53 µg/L (both acute and chronic) for carbaryl (Siepmann and Jones, 1998). The one sample in which the majority of toxicity was caused by carbaryl exceeded this value.

Selenastrum Toxicity

Based on the statistical comparisons to laboratory control water, no toxicity to *Selenastrum* was observed in the Delta. However, contaminants may inhibit growth more frequently than this comparison might indicate. The EPA recommended control water is MILLI-Q water or its equivalent. Although equal amounts of nutrients are added to each test replicate, ambient waters contain naturally occurring nutrients and chelators which make trace metals more bioavailable. These do not exist in laboratory control water. Therefore, when algal growth in ambient water samples are statistically compared to the glass distilled control water, few samples show a significant reduction in cell growth. In cases where toxicants are present, the beneficial effects of the nutrient load may mask the detrimental effects of a toxicant in ambient water samples, making them appear similar to, or more viable than, the controls.

With increasing awareness of this limitation, an alternative, i.e. modified, approach was used to analyze data collected in this study. This approach was based on the assumption that ambient waters would be more similar in nutrient concentration and composition relative to one another than to standard laboratory control water. Ambient samples were ranked by growth performance relative to other ambient samples collected on the same day. The samples most frequently exhibiting low cell growth as described above included the San Joaquin River at Vernalis, Paradise Cut, Sycamore Slough, Old River at Tracy and Prospect Slough. The low growth in samples collected from the Old River at Tracy may be due to toxicants moving downstream from Paradise Cut. When growth was severely inhibited, the sample was passed through a C8 SPE column to determine if non-polar organic compounds might be the cause. Comparisons between an unmanipulated sample and a sample passed through a C8 SPE column help eliminate variations in nutrient concentrations. Therefore, this comparison is preferred over the comparison of an ambient sample to other ambient samples collected on the same day.

Causes of Toxicity

This alternative approach demonstrated toxic effects of non-polar organic compound(s) in five of ten samples analyzed in TIEs. Two of the five samples were collected in and around Paradise Cut. The remaining three samples were taken from other back sloughs and a agricultural drain from a Delta island tract.

Implications of Toxicity

The special studies conducted around Paradise Cut suggest that toxicants originated in agricultural runoff rather than from local NPDES discharges. Some data suggests that runoff from alfalfa may be causing this impairment. Diuron and simazine were detected in samples around Paradise Cut, however, concentrations were believed to be insufficient to cause the observed growth suppression. The reported EC_{50} values for *Selenastrum* to diuron range from 2.2 to 11.0 ppb (Cortright *et al.*, 1995). *Selenastrum* sensitivity to simazine is more variable, with EC_{50} values ranging from 0.6 ppb to 190.7 ppb (Cortright *et al.*, 1995).

Pimephales Toxicity

Only three testing events were conducted with *Pimephales*. Two of the tests were conducted with samples collected during rain events in January and May 1995. The third set of samples was collected as part of the routine monitoring program. No toxicity was observed.

Overview

The 1994 water year[1] was a critically dry year with 40% of average runoff statewide. In contrast, the 1995 water year was wet with 180% of average runoff (Roos, 1996). During both water years, samples were collected from the Sacramento and San Joaquin mainstem rivers during rain events. Toxicity was more severe in the critically dry water year for both *Pimephales* and *Ceriodaphnia*. Several instances of significant *Ceriodaphnia* mortality were reported during the critically dry year while no mortality was observed in the mainstem rivers during the wet year. In addition, minnow growth inhibition was reported twice during the dry year while no instances of growth suppression were reported in the following wet year. It should be mentioned that the number of rain event samples collected and tested with the *Pimephales* was less during the second year of this study, so representation of the 1995 water year is inadequate to make a fair comparison.

Combined data from 1993 through 1995 reveals persistent patterns of toxicity to *Ceriodaphnia*. The toxicity to *Ceriodaphnia* manifested itself as reproductive inhibition at two sites: Prospect and Duck Sloughs. Further investigation showed that reproduction was significantly lower in samples collected from each of the two sloughs during dry months (May through September) when irrigation of crops takes place. Further investigation is needed to ascertain the cause of this reproductive inhibition.

Decreased primary production in the *Selenastrum* bioassays occurred in samples collected at Paradise Cut in both study years. Several samples from both monitoring years exhibited enhanced growth after the water was passed through C8 SPE columns. This

[1]A water year begins 1 October of one year and ends 30 September of the following year.

enhancement suggests that non-polar organic compounds are responsible for the growth suppression observed. On several occasions, similar reductions in primary production occurred in samples collected downstream of Paradise Cut in the Old River at Tracy and the Delta Mendota Canal (sampled first year only). Growth in these samples was not significantly lower than in controls, however, when compared to growth in water samples collected from other sites, low growth was more apparent. Greater suppression occurring in samples collected from Paradise Cut appears to be seasonal and flow dependent. Greater suppression occurs more frequently in the summer months, which may be related to flow and/or to specific land use practices. Foe and Connor (1991) report that samples collected from Mendota Pool, which receives water from the Delta Mendota Canal, inhibited alga growth compared to other samples collected within the San Joaquin watershed from 1988 to 1990. Foe and Connor also suggested that if toxicants were the cause of reduced growth in samples collected from Mendota Pool, those same toxicants may be present in the source water, the Sacramento-San Joaquin Delta. Further investigation is needed to evaluate the relationship between poor water quality in the southern Delta and Mendota Pool. In addition, studies should attempt to determine the chemical and geological source of reduced growth.

Ecological Impacts

The data generated during the second year of this study demonstrates that insecticides present in samples collected from the Delta cause acute toxicity to the laboratory organism, *Ceriodaphnia*. Most of this toxicity occurred in samples collected from back sloughs which drain agricultural farm land. Approximately 90% of all reported pesticide use is for agricultural purposes. Agricultural pesticide use increased 37% between 1991 and 1995 (Liebman, 1997). The ecological significance of the toxicological patterns described in this study is not known. Some aquatic communities in the Central Valley and the Delta are known to be in decline (Herbold *et al.* 1992). Phytoplankton and zooplankton abundance have decreased by one to two orders of magnitude since the mid seventies (Alpine and Cloern, 1992: Obrebski *et al.*, 1992). Fish populations, particularly species which rely upon zooplankton as a food for larval and juvenile stages, are also known to be in decline (SWRCB, 1994). A number of factors have been cited for these losses including water diversions, habitat destruction and toxicants. The magnitude, frequency and duration of toxicity observed during this and previous studies suggest that these toxic events could be contributing to a portion of this problem. In this study, pesticides exceeded concentrations that are reported to be toxic to several small crustaceans that reside in the Delta. In some cases, the data suggests that these toxic levels potentially persisted for days to weeks.

EPA recommends the use of laboratory bioassays to protect aquatic communities from toxic exposure. However, much controversy exists in the literature about the ecological relevance of the tests. The Pelston Conference was held in 1996 to evaluate this controversy. Grothe *et al.* (1996), which summarizes the Pelston conference, suggests that ambient toxicity testing can be a useful tool for indicating effects to aquatic communities. Recently, de Vlaming (1995) reviewed all of the available literature and concluded that the evidence for instream impacts is strongest when acute toxicity is observed in bioassays on ambient water. More importantly, de Vlaming found that in all

seven studies conducted with chlorpyrifos, toxicity in laboratory assays did correlate and possibly underestimated the in-situ effects.

Follow-up studies should be conducted to better understand the ecological significance of the toxicity. These studies could include the use of indigenous species in laboratory assays or *in situ* evaluations to better determine community and population level responses. The results of this study have identified chemicals, times and locations in the estuary where more focused ecological follow-up is warranted.

Recommendations for Future Studies

Following two years of data collection, the limitations and advantages to using the EPA three species test as a tool to evaluate the extent, severity and sources of toxicity in a complex surface water system have become apparent.

Ceriodaphnia

Ceriodaphnia bioassay data has served as a sensitive and valuable tool for detecting and identifying toxicants. Using that sensitivity advantageously, three key issues should be addressed:

- Most importantly, the duration of toxicity must be addressed. Data collected this year suggests that lethal concentrations of toxicants persist in the field for several consecutive days or may pulse through the system repeatedly. Future study designs should include daily sampling to clarify this question. Static renewal toxicity tests could use each daily sample as the renewal water to better reflect the toxicant concentration fluctuations in the field. At sites where toxicity persists for several consecutive days, *in situ* evaluations should be used to evaluate community and population level responses.
- Toxicity Identification Evaluations should be conducted on samples collected from Prospect Slough and Duck Slough. Persistent poor invertebrate reproduction was observed at these sites during the irrigation season. Preliminary work suggests that toxicity is due to a filterable toxicant, however more work is needed to conclusively identify the toxic chemical(s).
- Additional tests should be conducted in the Cache Creek watershed to determine the cause of the toxicity that was seen this year during a rain event. Objectives should address the frequency of toxicity throughout a rainy season, the sources of toxicity and the impact on receiving waters during high flow periods.

Selenastrum

Repeated instances of low cell growth in samples collected in the Southern Delta, particularly at Paradise Cut, occurred during both years of monitoring. Non-polar organic compounds have been shown to cause growth suppression in some instances. Special studies related to samples collected from Paradise Cut during June 1994 demonstrate that toxicants originated in agricultural return waters rather than local NPDES discharges. Further studies are needed to evaluate the role of agricultural runoff in the southern Delta. Studies should include the following sites: the San Joaquin River at Vernalis, Paradise Cut, Old River at Tracy and drainages, including agricultural and NPDES facilities,

received by Paradise Cut. Secondarily, Delta Mendota Canal and Delta Mendota Pool may also be included in the study design. Although the current algae testing protocol has some limitations, this laboratory has utilized TIE procedures which may better identify the causes for reduced growth (Clark, in prep). In addition, a clean site control should be considered for more appropriate statistical comparisons.

Pimephales

Most of the fathead minnow bioassays were conducted during the first year of the study. Results of this and other studies have demonstrated toxicity in samples collected from the mainstem rivers. These rivers play a critical role in the health of the ecosystem by providing a significant source of dilution water and habitat for fish. However, due to the limitations of conducting TIEs on chronically toxic samples, the cause(s) of toxicity has not been identified. Some preliminary results (unpublished laboratory data) suggests that pathogen interactions may also be contributing to this toxicity. TIE procedures are generally initiated about ten days after sample collection. This storage time can result in chemical degradation rendering it problematic to identify a toxicant which is already at or near the toxic threshold. With these limitations in mind, the following studies are recommended.

- Studies utilizing fathead minnow are needed outside the boundaries of the Delta on tributaries to the Sacramento and Mokelumne Rivers where concentrations of the unknown chemical(s) causing toxicity may be higher and toxicity greater. Compounds causing toxicity may be more effectively identified there.
- Practical, alternative bioassays should be developed to include more sensitive endpoints and native fish species. Increased sensitivity will allow for better toxicity identification. Native fish species will provide more ecologically relevant data. If water matrices and number of multiple stressors make it problematic to identify toxic constituents, then *in situ* studies should be conducted to take a more direct approach to evaluating the health of the ecosystem.
- Biomarkers may serve as a useful indicator of specific stressors. Histopathologic aberrations in an organism's tissues are useful biomarkers of exposure and adverse effect (Hinton *et al.*, 1992). They constitute sensitive and reliable indicators of an organism's health. In particular, histopathologic alterations in reproductive organs may be linked to effects at the population level.

Recommendations for the Bay Protection Toxic Clean-up Program

Following two years of data collection, it has become increasingly evident that a majority of compounds causing mortality to *Ceriodaphnia dubia* originate in agricultural return water.

Samples from four sites exhibited toxicity to *Ceriodaphnia* on more than one occasion and in each instance a chemical contributing to toxicity was identified. In addition, monitoring suggested that toxicity potentially existed at each of these sites for a sufficient duration and magnitude to possibly impact resident species with similar sensitivities. Furthermore, the conditions under which these toxic conditions occurred are likely to be

repeated in future years. The Regional Board should consider listing the following sites as toxic hot spots.

Sampling Location	Events exhibiting toxicity	Primary toxicant
Ulatis Creek	9/1, 9/13 and 9/18/94	chlorpyrifos
Paradise Cut[1]	4/27 and 4/30/94	carbofuran
	3/9 and 3/15/95	chlorpyrifos
Duck Slough	3/21 and 3/25/95	chlorpyrifos
French Camp Slough[1]	3/23 and 3/28/94	chlorpyrifos
	9/2 and 9/7/94	chlorpyrifos
San Joaquin River at Vernalis[1]	1/27 and 2/10/94	diazinon

The Regional Board should carefully consider the interaction between the magnitude and duration of toxicity to determine whether or not a site should be considered as a toxic hot spot. For example, when concentrations of a compound cause acute mortality to *Ceriodaphnia*, the chemical may only need to persist in the field for 48 hours to have the same population level effect to resident species as lower concentrations causing chronic mortality persisting for several weeks.

Since October 1994, data collected from this and other studies have identified diazinon as the primary cause of toxicity on several occasions in samples collected from Mosher Slough. The largest component of the slough's discharge is urban runoff from the City of Stockton. Although only some TIEs have been conducted on samples collected from Mosher Slough, all samples listed in Table 30 have caused acute mortality to *Ceriodaphnia* and have had concentrations of diazinon above the laboratory's 96-hour LC_{50} concentrations (0.425 µg/L). For these reasons, the Regional Board should consider Mosher Slough as a toxic hot spot as well.

[1]These three sites were recommended as Toxic Hot Spots in the 1993-1994 Report.

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FIGURE 1
The map identifies sites within the Delta

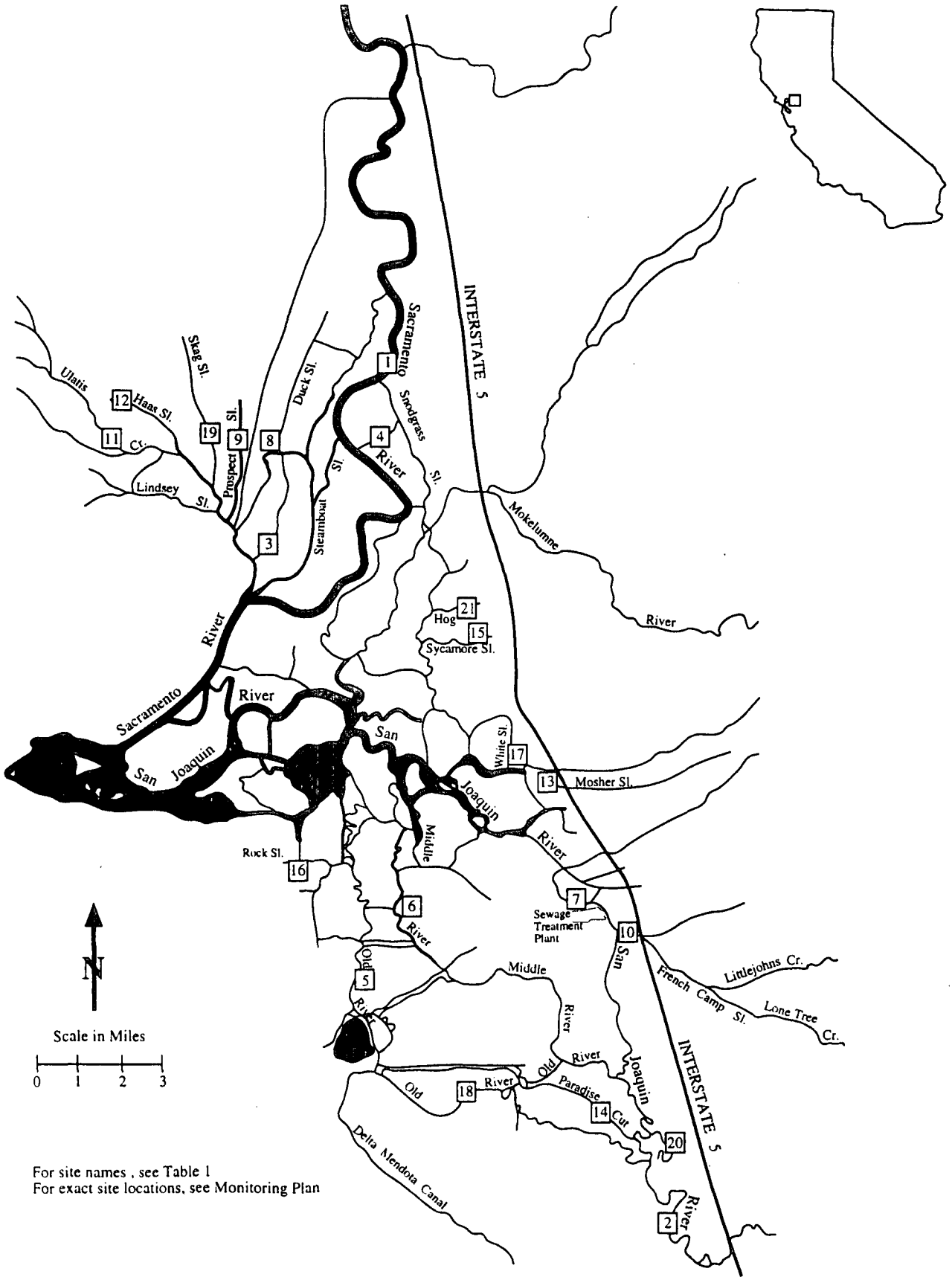


FIGURE 2.
The map identifies the sampling sites within the Cache Creek watershed.

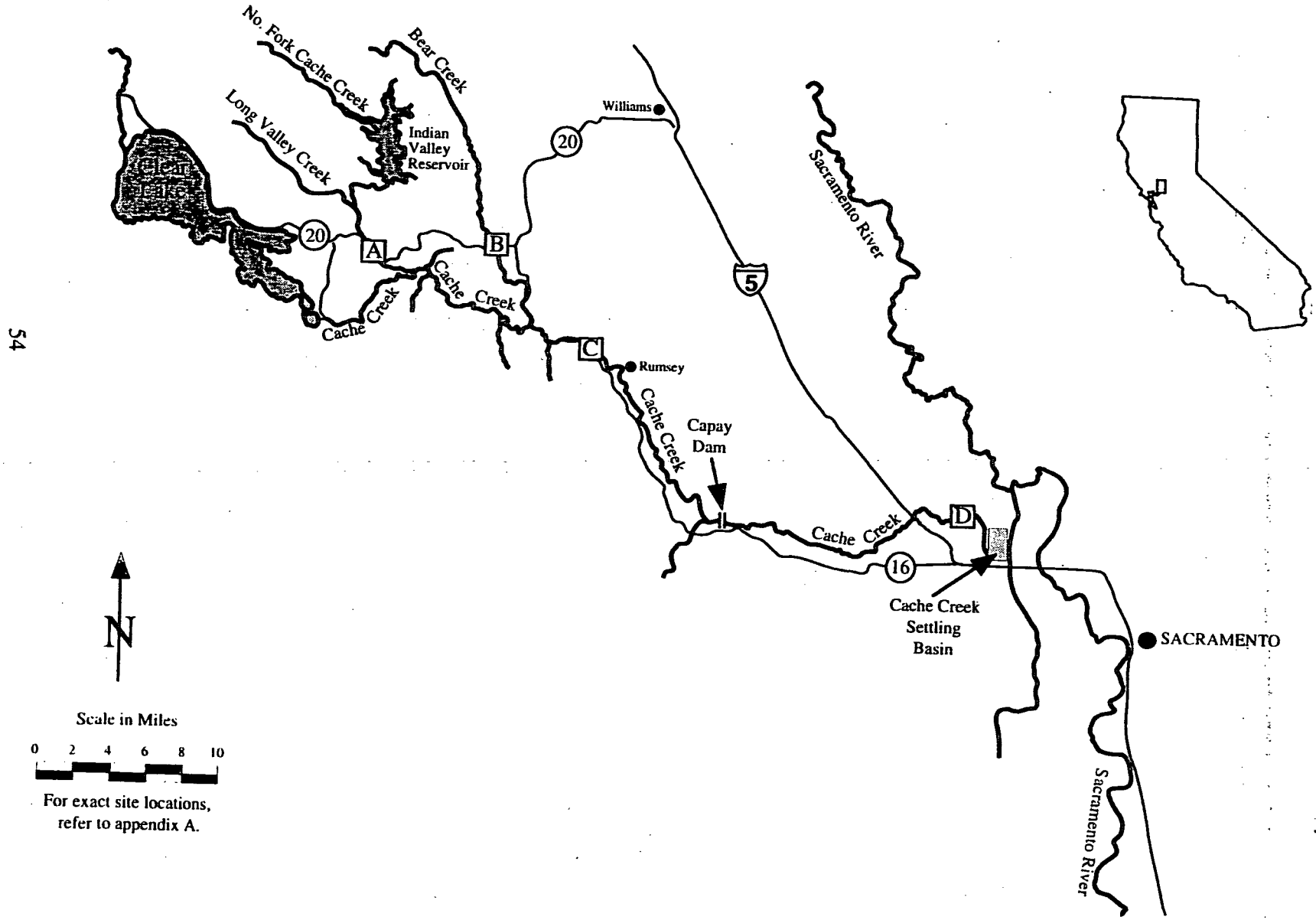


FIGURE 3.
The map identifies the sampling sites within the Paradise Cut special studies area.

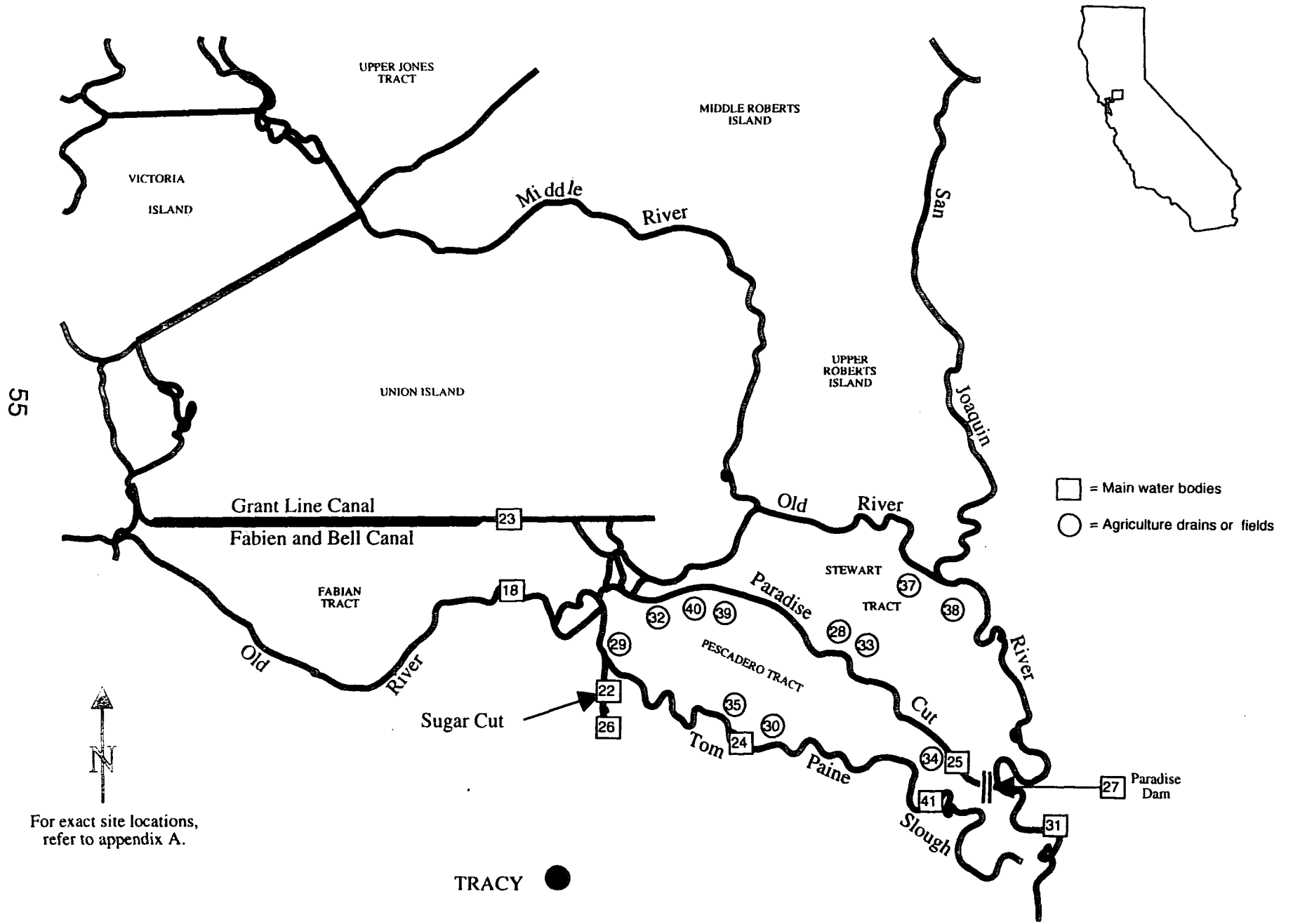


Figure 4a. Flow Chart of TIE Procedures Commonly Used During Toxicity Testing

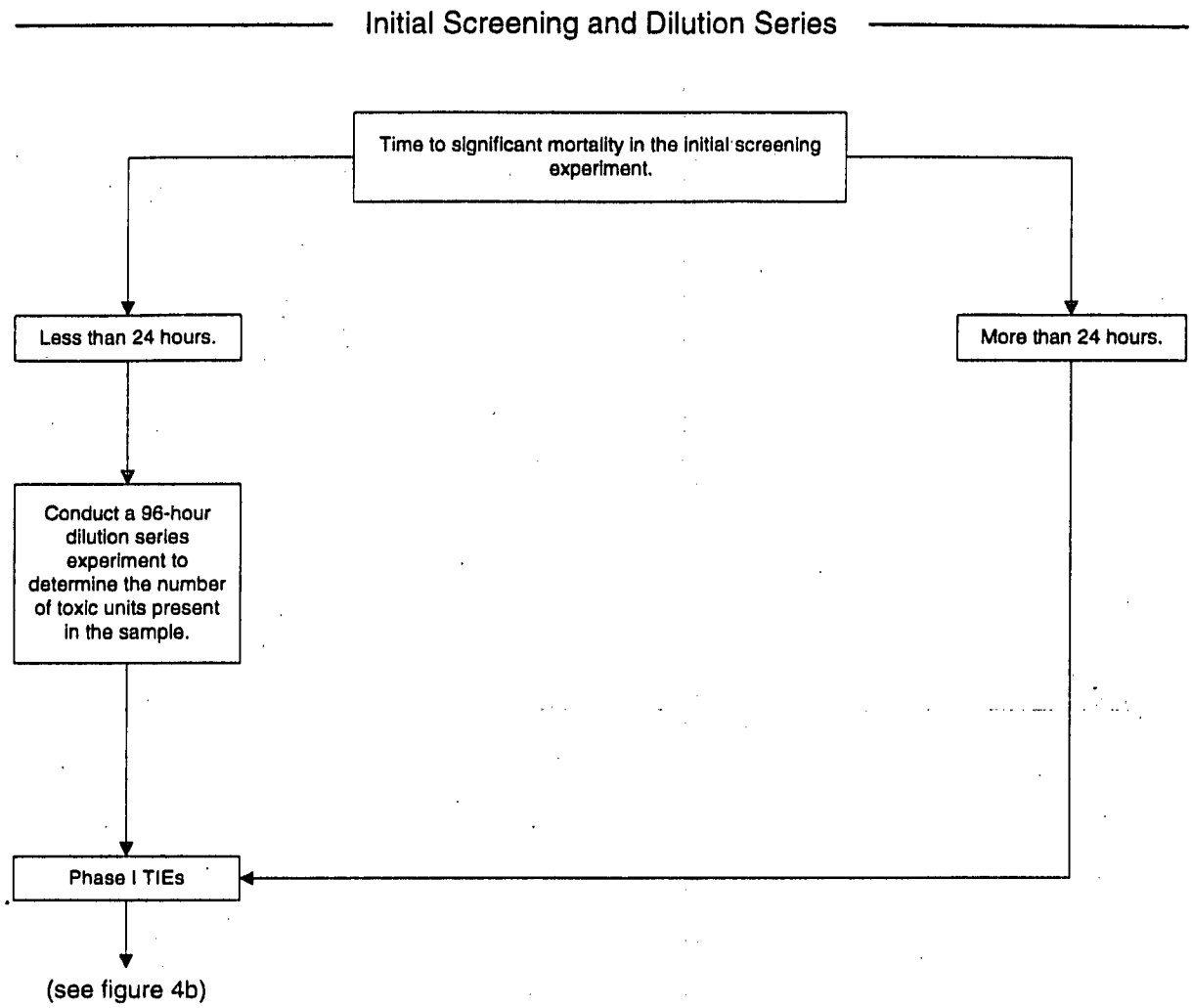


Figure 4b. Flow Chart of TIE Procedures Commonly Used During Toxicity Testing

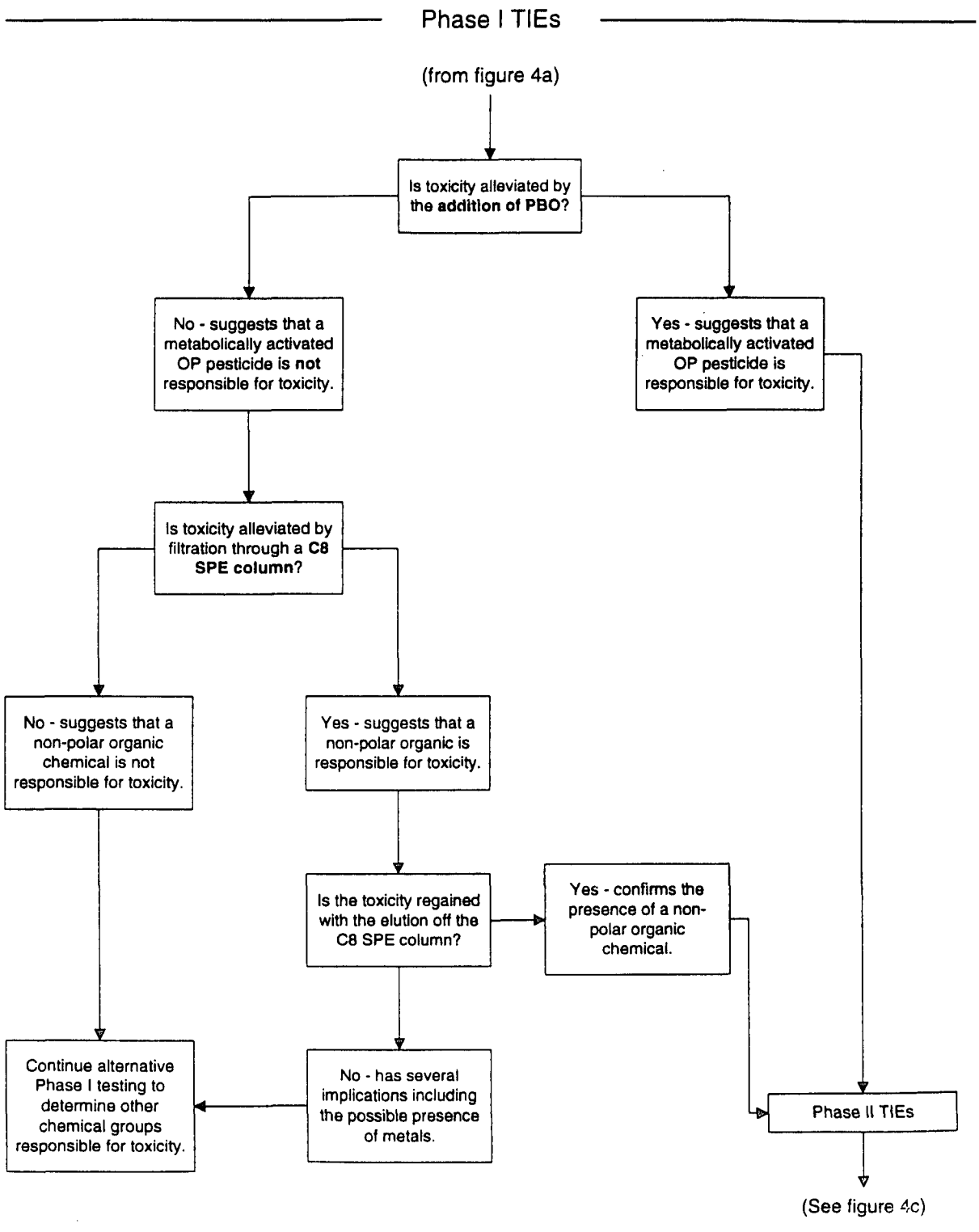
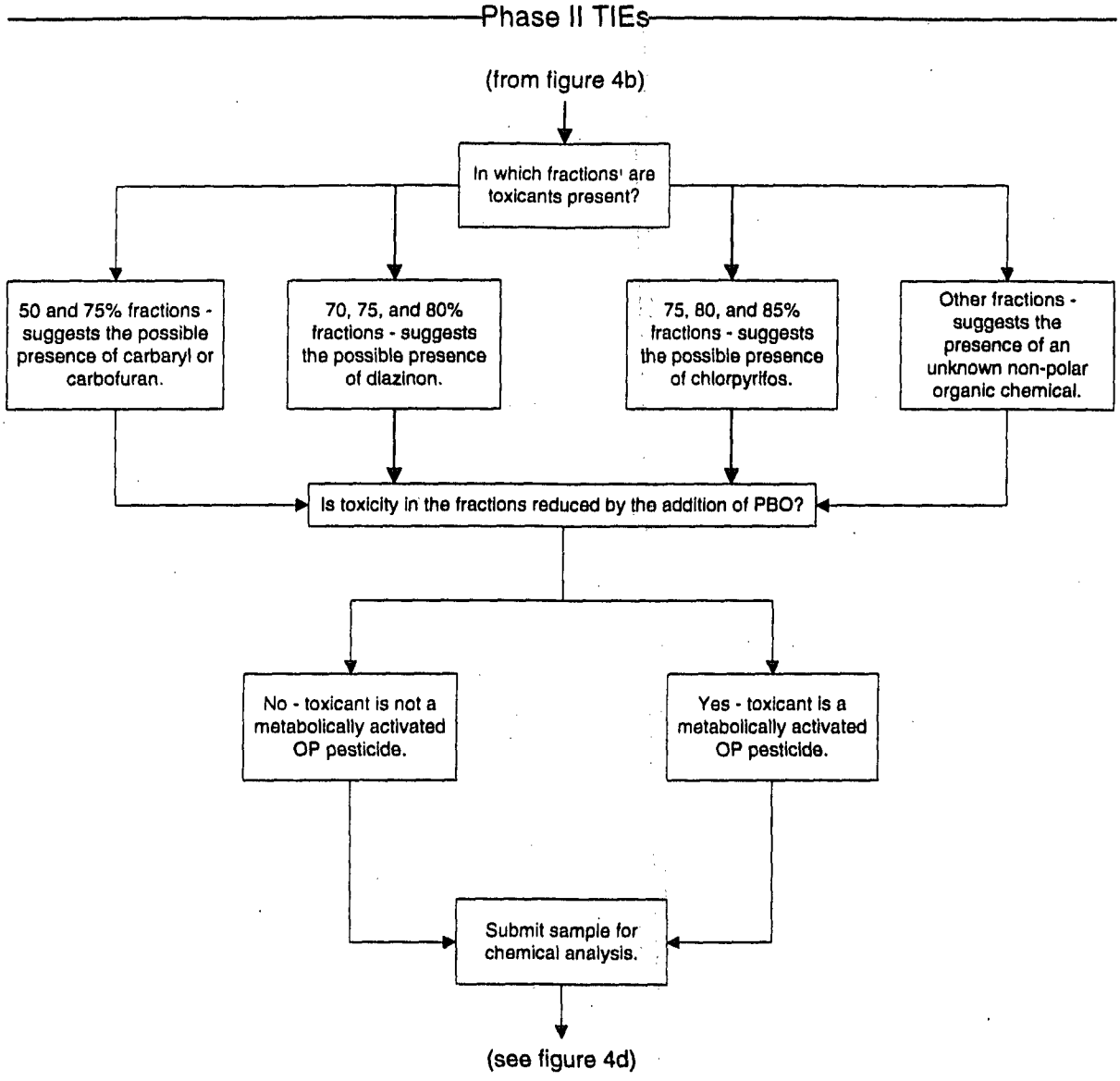


Figure 4c. Flow Chart of TIE Procedures Commonly Used During Toxicity Testing



1. Fractions are produced by eluting the C8 SPE column with MeOH:water fractions ranging from 50 to 100% MeOH in water.

Figure 4d. Flow Chart of TIE Procedures Commonly Used During Toxicity Testing

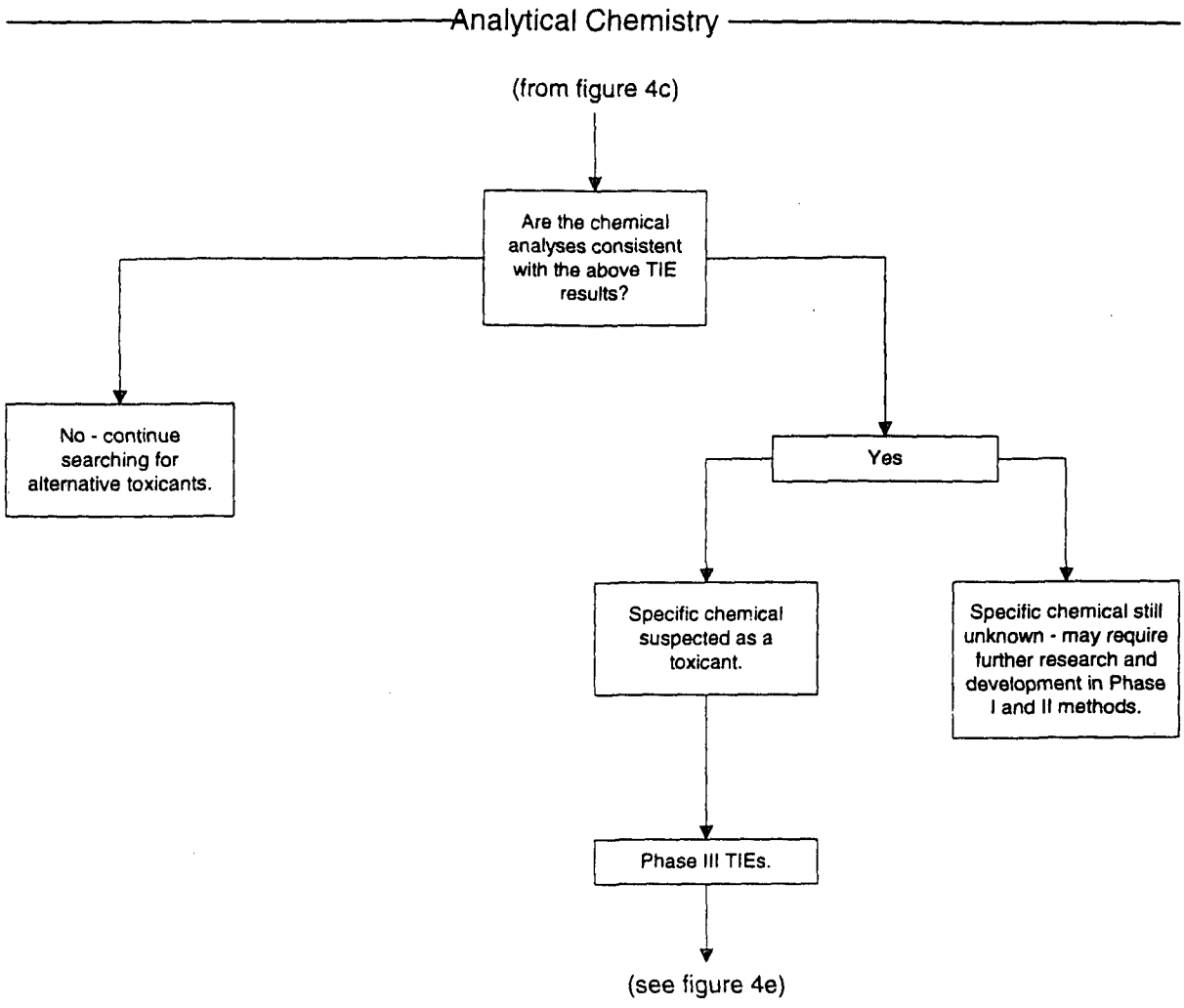


Figure 4e. Flow Chart of TIE Procedures Commonly Used During Toxicity Testing

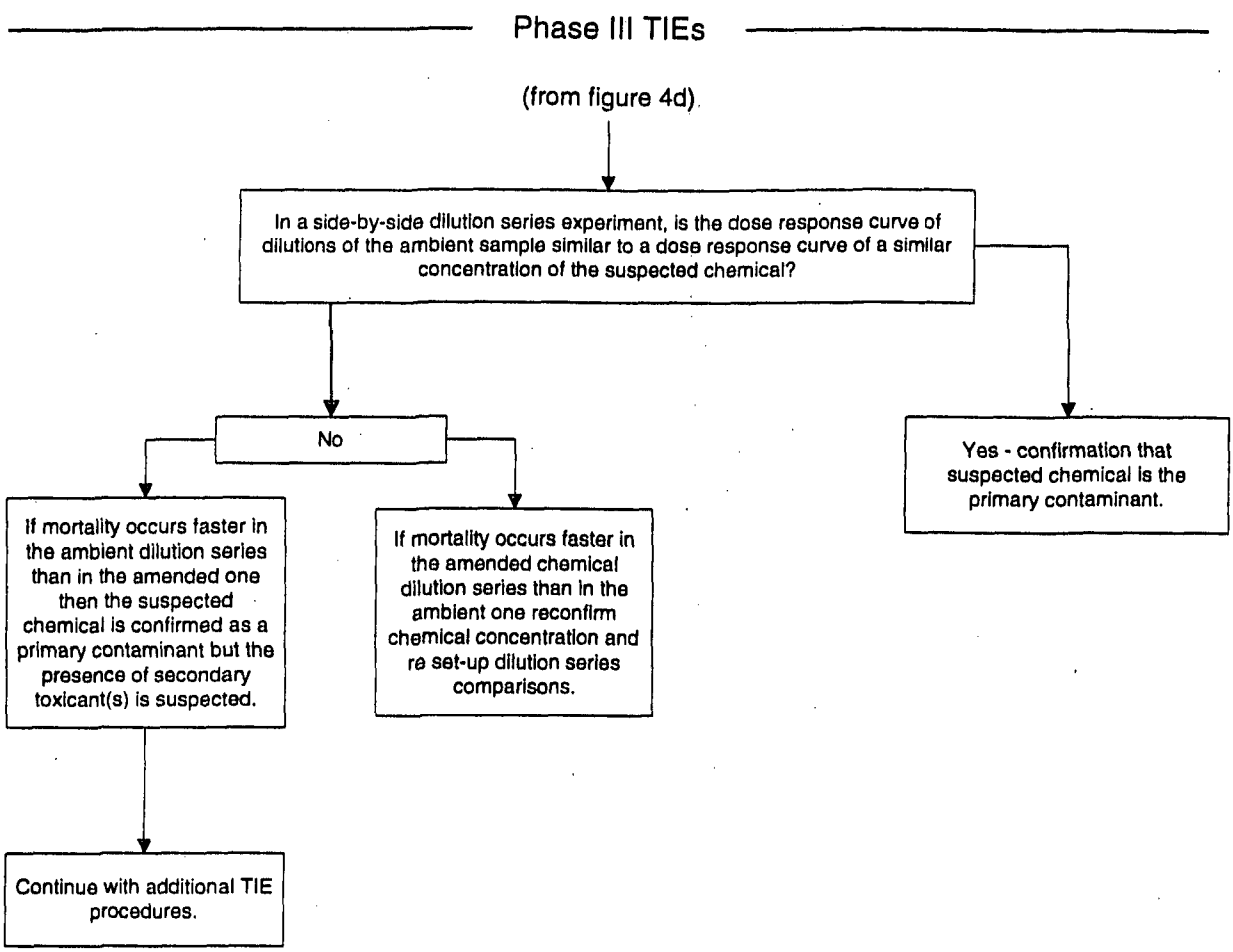


Table 1. Site summary and map key for Figures 1, 2 and 3.

Map ID	Location	Type of Waterway
1	Sacramento River at Greene's Landing	Main River Inputs to Delta
2	San Joaquin River at Vernalis	
3	Ryer Island	Agricultural Drains within the Delta Islands and Tracts
4	Pierson Tract	
5	Victoria Island	
6	Upper Jones Tract	
7	Middle Roberts Tract	
8	Duck Slough	Back Sloughs within the Delta
9	Prospect Slough	
10	French Camp Slough	
11	Ulatis Creek	
12	Haas Slough	
13	Mosher Slough	
14	Paradise Cut	
15	Sycamore Slough	
16	Rock Slough	
17	White Slough	
18	Old River at Tracy Blvd.	
19	Skag Slough	
20	Walthall Slough	
21	Hog Slough	
A	North Fork Cache Creek	Cache Creek Watershed and tributaries
B	Bear Creek	
C	Cache Creek at Rumsey	
D	Cache Creek at Rd. 102	

Table 1 (continued). Site summary and map key for Figures 1, 2 and 3.

Map ID	Location	Type of Waterway
22	Sugar Cut	Paradise Cut Special Studies Area, including inputs received by Paradise Cut
23	Grantline	
24	Tom Payne Slough	
25	Upstream Paradise Cut	
26	Tracy Wastewater Treatment Plant outfall	
27	Paradise Dam	
28	Stewart's Tract West	
29	Mac Arthur Blvd.	
30	Pescadero	
31	San Joaquin River	
32	Delta Ave.	
33	Stewart's Tract East	
34	Duel Vocational Institute	
35	Alfalfa @ Tom Payne Slough	
36	El Rancho South Drain	
37	Corn	
38	Safflower	
39	Alfalfa	
40	Sullivan's Tile Drain	
41	Upstream Tom Payne Slough @ Paradise Reclamation District Office	

Table 2. Summary and interpretations of typical TIE procedures.

Manipulation	Chemicals Removed or Inactivated
Addition of piperonyl butoxide	Organophosphate insecticides
C8 Solid Phase Extraction	Non-polar organic chemicals
Temporary pH shift to 3	Hydrolyzable organics; may increase metal solubility
Temporary pH shift to 11	Precipitates metals, hydrolyze organics
Addition of EDTA	Cationic metals (Al, Cd, Cu, Zn, Pb, Fe, Ni)
Addition of sodium thiosulfate	Cu, Se, Ag, Hg, Cd, chlorine, bromine, ozone
Air stripping	Volatile chemicals and surfactants
0.45 µm filtration	Particle bound chemicals

Table 3. Routine Delta Monitoring 1994-95 *Ceriodaphnia* Mortality

Sample	% Mortality												
	6/3	7/12	8/9	9/1	10/5	11/7	12/4	1/9	2/28	3/21	5/1	5/31	6/27
Laboratory Control	0	0	0	0	10.0	0	0	0	0	10	0	0	10.0
SJR @ Vernalis	10	10	0	0	0	0	0		10	0	20	0	0
SR @ Greene's Landing	0	0	0	0	10	0	0		0	0	10	0	0
Duck Slough	0	0	0	0	0	0	0	0	0	A 100	0	0	0
Prospect Slough	0	10	10	0	0	0	0		0	0	0	10	0
French Camp Slough	0	10	0	A 100	0	0	0	0	0	C 50	0	0	10
Ulatis Creek	0	0	0	C 90	0	A 100	A 100	0	0	A 100	0	0	0
Paradise Cut	0	A 100	0	0	0	0	0	0	0	0	0	0	0
Sycamore Slough		10	0	10	0	0			C 90	0	10	0	0
Ryer Island Main Drain		0	0	0	0	10	0	0	0	0	10	A 100	0
Haas Slough			0	0	0		A 100	0	0		10	44	0
Rock Slough							0		0		0	0	0
White Slough							0		0			0	0
Pierson Tract							0	0	0		0	0	0
Victoria Island Drain							0	0	0	0	0	0	0
Upper Jones Tract							0	0	0	0	20	0	0
Middle Roberts							0	10	0		0	60	0
Mosher Slough							A 100	A 100	10	A 100	A 100	0	0
Cache Creek										0			
Old River @ Tracy										0			
Mokelumne										0			
Wathall Slough	0	0	0				0						
Sugar Cut	0												
Hog Slough		10											

Highlighted areas indicate a significant increase in mortality relative to the laboratory control water. An " A" next to data indicates that most of the mortality occurred in less than 96 hours while mortality after 96 hours is represented by a "C". The mortality endpoint was analyzed using Fisher's Exact Test.

Table 4. Routine Delta Monitoring 1994-95 *Ceriodaphnia* Reproduction

Sample	Reproduction (neonates/adult)												
	6/3	7/12	8/9	9/1	10/5	11/7	12/4	1/9	2/28	3/21	5/1	5/31	6/27
Laboratory Control	30.8	33.7	28.4	22.6	25.8	19.8	26.6	31.6	24.5	23.7	19.9	23.8	17.0
SJR @ Vernalis	30.1	49.8	26.8	28.4	35.3	27.0	35.9		26.5	37.3	22.0	43.8	21.8
SR @ Greene's Landing	33.1	39.9	14.5	28.3	28.7	37.0	33.1		22.5	28.9	20.5	30.7	18.0
Duck Slough	13.5	11.8	7.4	8.9	22.9	22.2	30.8	21.7	5.2	*	28.3	32.7	15.3
Prospect Slough	10.8	18.8	5.6	7.6	17.7	17.6	27.5		21.5	12.0	21.6	20.2	11.0
French Camp Slough	29.8	43.1	26.3	*	36.7	38.1	34.2	40.3	28.2	28.7	27.4	39.3	16.9
Ulatis Creek	38.1	53.3	29.0	18.9	27.0	*	*	16.9	30.3	*	27.3	42.2	27.2
Paradise Cut	41.3	*	27.8	30.0	35.3	27.5	29.2	36.4	29.5	29.8	27.3	41.7	31.0
Sycamore Slough		57.0	30.1	26.8	30.0	31.9			*	34.3	18.1	34.0	26.1
Ryer Island Main Drain		36.7	19.8	20.5	27.0	29.6	41.9	21.7	23.8	20.7	22.2	*	21.5
Haas Slough			27.1	27.7	29.5		*	15.9	30.8		26.8	34.4	24.4
Rock Slough							33.7		20.7		23.9	39.9	19.7
White Slough							32.0		32.8			45.6	30.3
Pierson Tract							40.9	16.7	22.9		23.9	34.4	24.1
Victoria Island Drain							30.7	23.4	28.2	23.5	24.5	34.9	21.7
Upper Jones Tract							35.8	31.2	15.5	26.4	20.6	30.1	18.4
Middle Roberts							25.2	19.8	8.4		13.6	24.3	14.2
Mosher Slough							*	*	27.5	*	*	36.9	22.9
Cache Creek										4.5	17.0	40.4	
Old River @ Tracy										32.4			
Mokelumne										31.6			
Wathall Slough	46.8	48.7	31.4				30.9						
Sugar Cut	38.6												
Hog Slough		50.9											

* Reproductive endpoint was omitted due to significant mortality occurring before reproductive age.

Table 5. TIEs conducted on the Ulatis Creek sample collected 1 September 1994 implicated metabolically activated pesticides as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Chlorpyrifos was detected at .058 µg/L by GC/MS, a concentration expected to cause chronic toxicity. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality							Conclusion
		1	2	3	4	5	6	7	
Initial Screen	Whole Sample						40	90	Toxicity detected.
Phase I	Whole Sample			5	60	100	100	100	Confirmation of toxicity.
	PBO Addition							0	Alleviation of toxicity suggests presence of metabolically activated pesticide(s).

1. Individual tests were set up on the following dates: Initial Screening on 3 September 1994 and Phase I on 19 September 1994.
2. For control and control blank performance refer to Appendix G, Table5 and Appendix F, Table 13.

Table 6. TIEs conducted on the Ulatis Creek sample collected 13 September 1994 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .09 µg/L by GC/MS. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality (day)							Conclusion
		1	2	3	4	5	6	7	
Initial Screen	Whole Sample		37	95	100				Toxicity detected.
Phase I	Whole Sample		20	100	100	100	100	100	Confirmation of toxicity.
	PBO Addition			5	5	10	10	10	Alleviation of toxicity suggests presence of metabolically activated pesticide(s).
Phase II[2]	50% Fraction							0	Recovery of toxicity in the 80, 85% fractions suggest the possible presence of chlorpyrifos.
	70% Fraction							0	
	75% Fraction							0	
	80% Fraction	20	100	100	100	100	100	100	
	85% Fraction						10	40	
	90% Fraction		20	30	30	30	30	30	
	95% Fraction					10	10	10	
	100% Fraction		10	10	10	10	10	10	

1. Individual tests were set up on the following dates: Initial Screening on 14 September 1994, Phase I on 19 September 1994 and Phase II on 16 November 1994.
2. Add back @ 6X ambient concentration.
3. For control and control blank performance refer to Appendix F, Tables 11, 13, and 15.

Table 7. TIEs conducted on the Ulatis Creek sample collected 18 September 1994 implicated metabolically activated pesticides as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Chlorpyrifos was detected at .048 µg/L by GC/MS, a concentration expected to cause chronic toxicity. Malathion also was detected at .025 µg/L by GC/MS. The malathion concentration is below concentrations likely to cause toxicity.

Test type[1]	Treatments	Mortality							Conclusion
		1	2	3	4	5	6	7	
Initial Screen Phase I	Whole Sample			20	30	75	75	75	Toxicity detected.
	PBO Addition							0	Alleviation of toxicity suggests presence of metabolically activated pesticide(s).

1. Individual tests were set up on the following dates: Initial Screening and Phase I on 19 September 1994.
2. For control and control blank performance refer to Appendix F, Table 13.

Table 8. TIEs conducted on the Ulatis Creek sample collected 7 November 1994 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .047 µg/L by GC/MS and .103 µg/L by ELISA. Malathion also was detected at .061 µg/L by GC/MS and may have contributed to toxicity in the 70% methanol fraction. No other organophosphorous pesticides were detected at above a quarter of a toxic unit.

Test type[1]	Treatments	Mortality							Conclusion
		1	2	3	4	5	6	7	
Initial Screen	Whole Sample		100	100	100	100	100	100	Toxicity detected.
	Whole Sample		100	100	100	100	100	100	Confirmation of toxicity.
Phase I	PBO Addition			7	7	13	13	33	Alleviation of toxicity suggests presence of metabolically activated OP pesticide(s).
	C8 Solid Phase Extracted				7	7	7	7	Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
Phase II[2]	50% Fraction							0	Recovery of toxicity in the 70, 75 and 85% fractions suggests the possible presence of chlorpyrifos.
	70% Fraction	10	30	90	100	100	100	100	
	75% Fraction			20	100	100	100	100	
	80% Fraction	100	100	100	100	100	100	100	
	85% Fraction			10	10	10	10	10	
	90% Fraction							0	
	95% Fraction	10	11	11	11	44	44	44	
	100% Fraction			10	10	20	20	40	

1. Individual tests were set up on the following dates: Initial Screening on 9 November 1994, Phase I on 12 November 1994 and Phase II on 16 November 1994.
2. Add back at 5x ambient concentration.
3. For control and control blank performance refer to Appendix G, Table 6 and Appendix F, Tables 14 and 15.

Table 9. TIEs conducted on the Ulatis Creek sample collected 4 December 1994 implicated metabolically activated OP pesticides as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .045 µg/L by ELISA, although this value is below the kit detection limit. Chlorpyrifos was detected at 1/2 of a toxic unit and diazinon was detected at 1/3 of a toxic unit (.133 µg/L by ELISA). The toxicity of chlorpyrifos and diazinon are known to be additive. There is also the possibility of the presence of a third toxicant in the 90 and 95% fraction.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample			100	100	Toxicity detected.
Phase I	Whole Sample		47	100	100	Confirmation of toxicity.
	PBO Addition				0	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Ulatis sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).
	C8 Solid Phase Extracted (1/5)				0	Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
Phase II[2]	50% Fraction				0	Recovery of toxicity in the 80 and 85% fractions suggest the possible presence of chlorpyrifos. In addition, the recovery of toxicity in the 90 and 95% fractions suggest the possible presence of another toxicant.
	70% Fraction				0	
	75% Fraction		10	10	10	
	80% Fraction	100	100	100	100	
	85% Fraction	100	100	100	100	
	90% Fraction		10	10	40	
	95% Fraction				56	
	100% Fraction				0	

1. Individual tests were set up on the following dates: Initial Screening on 7 December 1994, Phase I on 10 December 1994 and Phase II on 5 January 1995.
2. Add back at 5x ambient concentration.
3. For control and control blank performance refer to Appendix G, Table 7 and Appendix F, Tables 16 and 18.

Table 10. TIEs conducted on the Ulatis Creek sample collected 9 March 1995 implicated a metabolically activated compound. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Chlorpyrifos was detected at concentrations greater than one toxic unit, .137 µg/L by ELISA and .230 µg/L by GC. Diazinon may have contributed to toxicity with over 1/2 a toxic unit, .293 µg/L by ELISA and .270 µg/L by GC.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	100	100	100	100	Toxicity detected.
Dilution Series	Whole Sample	100	100	100	100	Linear interpolation estimated 3 toxic units based on the results of this dilution series.
	50% Dilution	45	100	100	100	
	25% Dilution				0	
	12.5% Dilution				0	
Phase I	Whole Sample	100	100	100	100	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO.
	PBO Addition				0	However, the low mortality in the Ulatis sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).

1. Individual tests were set up on the following dates: Initial Screening on 11 March 1995, dilution series on 13 March 1995 and Phase I on 17 March 1995.
2. For control and control blank performance refer to Appendix H, Table 4 and Appendix F, Tables 20 and 21.

Table 11. TIEs conducted on the Ulatis Creek sample collected 21 March 1995 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .134 µg/L by ELISA and .100 µg/L by GC. Carbofuran also was detected by GC at .800 µg/L, approximately 1/3 of a toxic unit.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	100	100	100	100	Toxicity detected.
Dilution Series	Whole Sample	100	100	100	100	The control and control blank for this test did not perform satisfactorily.
	50% Dilution		80	100	100	Linear interpolation estimated 3 toxic units based on the results of this dilution series.
	25% Dilution				0	
	12.5% Dilution				0	
Phase I	Whole Sample	100	100	100	100	Acute toxicity exhibited by the Ulatis sample during this test would seem to confirm toxicity detected during the initial screening.
	PBO Addition				0	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Ulatis sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).
	C8 Solid Phase Extracted (4/20)				0	Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
Phase III[2]	Whole sample	100	100	100		Similarities of time to death between both series confirm that toxicity was due to chlorpyrifos.
	100% spike	100	100	100		
	75% dilution	80	100	100		
	75% spike	13	93	100		
	50% dilution		100	100		
	50% spike			67		
	25% dilution			0		
	25% spike			7.1		

1. Individual tests were set up on the following dates: Initial Screening on 22 March 1995,dilution series and Phase I on 24 March 1995 and Phase III on 20 April 1995.
2. The dilution treatments refer to a dilution of the field sample with laboratory control water. The spike treatments refer to a non-toxic laboratory water spiked with the amount of contaminant measured in the field sample and subsequently diluted with laboratory control water equivalent to its corresponding percent dilution.
3. For control and control blank performance refer to Appendix G, Table 10 and Appendix F, Tables 22 and 25.

Table 12. TIEs conducted on the Paradise Cut sample collected 12 July 1994 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .550 µg/L by ELISA and .444 µg/L by GC/MS. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality					Conclusion
		1	2	3	4	5	
Initial Screen	Whole Sample	100	100	100	100	100	Toxicity detected.
Dilution Series	Whole Sample	100	100	100	100	100	Linear interpolation estimated 6 toxic units based on the results of this dilution series.
	50% Dilution	100	100	100	100	100	
	25% Dilution	30	100	100	100	100	
	12.5% Dilution					100	
	6.25% Dilution					30	
Phase I	Whole Sample	100	100	100	100		Confirmation of toxicity.
	PBO Addition			80	100		Alleviation of toxicity suggests presence of metabolically activated pesticide (s).
	C8 Solid Phase Extracted				0		Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
	Eluate Add-back in non-toxic water	50	100	100	100		Recovery of toxicity confirms presence of non-polar organic toxicant(s).
Phase II[2]	50% Fraction					10	Recovery of toxicity in the 80 and 85% fractions suggests the possible presence of chlorpyrifos.
	70% Fraction					0	
	75% Fraction					0	
	80% Fraction	100	100	100	100	100	
	85% Fraction	30	100	100	100	100	
	90% Fraction					0	
	95% Fraction					0	
	100% Fraction					0	

1. Individual tests were set up on the following dates: Initial Screening on 14 July 1994, dilution series on 19 July 1994, Phase I on 17 July 1994 and Phase II on 19 July 1994.
2. Add back at 6x ambient concentration.
3. For control and control blank performance refer to Appendix G, Table 2 and Appendix F, Table 3.

Table 13. TIEs conducted on the Paradise Cut sample collected 19 July 1994 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .068 µg/L by GC/MS. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality								Conclusion
		1	2	3	4	5	6	7	8	
Initial Screen	Whole Sample					53	89	95	100	Toxicity detected.
Phase I	Whole Sample			20	100	100	100			Confirmation of toxicity.
	Whole Sample (8/12)			53	73	100	100			
	PBO Addition (8/12)			7	14	14	14			Alleviation of toxicity suggests presence of metabolically activated pesticide(s).
	C8 Solid Phase Exracted						0			Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
	Eluate Add-back in non-toxic water		30	90	100	100	100			Recovery of toxocity confirms presence of non-polar organic toxicant(s).
Phase II[2]	50% Fraction			7	7	7				Recovery of toxicity in the 80% fraction suggests the possible presence of chlorpyrifos. Alleviation of toxicity with the addition of PBO strengthens this possibility. Toxicity in the 100% fraction also may suggest the presence of another toxicant.
	70% Fraction					0				
	75% Fraction					0				
	80% Fraction		57	100	100	100				
	80% (8/18)		100	100	100					
	80% + PBO (8/18)				0					
	85% Fraction					0				
	90% Fraction					7				
	95% Fraction					7				
	100% Fraction	7	21	36	50	64				

1. Individual tests were set up on the following dates: Initial Screening on 19 July 1994, Phase I on 4 August 1994 and Phase II on 12 August 1994 and 18 August 1994.
2. Add back at 6x ambient concentration.
3. For control and control blank performance refer to Appendix F, Tables 3, 6, 7, and 8.

Table 14. TIEs conducted on the Paradise Cut sample collected 9 March 1995 implicated metabolically activated pesticide(s) as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Chlorpyrifos was detected at concentrations expected to cause the observed mortality, .146 µg/L by ELISA and .230 µg/L by GC. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	25	100	100	100	Toxicity detected.
Phase I	Whole Sample	25	100	100	100	Confirmation of toxicity.
	PBO Addition				0	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Paradise Cut sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).

1. Individual tests were set up on the following dates: Initial Screening and Phase I on 17 March 1995.
2. For control and control blank performance refer to Appendix F, Table 21.

Table 15. TIEs conducted on the Paradise Cut sample collected 15 March 1995 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .145 µg/l by ELISA and .080 µg/l by GC. Diazinon also was detected at approximately a fourth of a toxic unit, .125 µg/l, by ELISA.

Test type[1]	Treatments	Mortality							Conclusion
		1	2	3	4	5	6	7	
Initial Screen & Phase I	Whole Sample (3/17)			10	90	100	100	100	Toxicity detected.
	Whole Sample (3/24)	33	87	100	100				Confirmation of toxicity.
	PBO Addition (3/17)	30	35	40	40				The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Paradise Cut sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).
	PBO Addition (3/24)	8	15	15	15				
	C8 Solid Phase Extracted (4/20)			0					Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
Phase III[2]	Whole sample	100	100	100					Similarities of time to death between both series suggest that toxicity may be chlorpyrifos.
	100% spike	33	100	100					
	75% dilution	20	100	100					
	75% spike	0	100	100					
	50% dilution	0	100	100					
	50% spike	0	7.1	14					
	25% dilution			0					
	25% spike			0					

1. Individual tests were set up on the following dates: Initial Screening on 17 March 1995, Phase I on 17 March 1995 and 24 March 1995 and Phase III on 20 April 1995.
2. The dilution treatments refer to a dilution of the field sample with laboratory control water. The spike treatments refer to a non-toxic laboratory water spiked with the amount of contaminant measured in the field sample and subsequently diluted with laboratory control water equivalent to its corresponding percent dilution.
3. For control and control blank performance refer to Appendix F, Tables 21, 22, and 25.

Table 16. TIEs conducted on the Duck Slough sample collected 21 March 1995 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .896 µg/L by ELISA and at .490 µg/L by GC. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	100	100	100	100	Toxicity detected.
Dilution Series	Whole Sample	100	100	100	100	Toxicity detected to the 12.5% dilution suggests that toxicant(s) is present at >8 units.
	100% + PBO	93	100	100	100	
	50% Dilution	100	100	100	100	
	50% + PBO		7	7	7	
	25% Dilution	100	100	100	100	
	12.5% Dilution	6.7	100	100	100	
Phase I	Whole Sample	100	100	100	100	Confirmation of toxicity.
	PBO Addition 100% + PBO	93	100	100	100	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Duck Slough sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).
	50% + PBO		7	7	7	
	C8 Solid Phase Extracted (4/12)			0		Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
Phase III[2]	25% dilution	100	100	100		Similarities of time to death between both series confirm that toxicity was due to chlorpyrifos.
	25% spike	100	100	100		
	12.5% dilution		100	100		
	12.5% spike		100	100		
	6.25% dilution		6.7	13		
	6.25% spike			0		
	3.13% dilution		6.7	20		
	3.13% spike			6.7		

1. Individual tests were set up on the following dates: Initial Screening on 22 March 1995, dilution series and Phase I on 24 March 1995 and Phase III on 12 April 1995.
2. The dilution treatments refer to a dilution of the field sample with laboratory control water. The spike treatments refer to a non-toxic laboratory water spiked with the amount of contaminant measured in the field sample and subsequently diluted with laboratory control water equivalent to its corresponding percent dilution.
3. For control and control blank performance refer to Appendix G, Table 10 and Appendix F, Tables 22 and 24.

Table 17. TIEs conducted on the Duck Slough sample collected 25 March 1995 implicated metabolically activated pesticides as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Chlorpyrifos was detected at approximately eight toxic units, .511 µg/L by ELISA and at .300 µg/L by GC. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	100	100	100	100	Toxicity detected.
Dilution Series	25% Dilution	100	100	100	100	Linear interpolation estimated 11.3 toxic units based on the results of this dilution series.
	12.5% Dilution		100	100	100	
	6.25% Dilution			5	15	
	3.13% Dilution				0	
Phase I	25% Dilution	100	100	100	100	Confirmation of toxicity.
	PBO Addition 25% + PBO		5	5	5	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Duck Slough sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).

1. Individual tests were set up on the following dates: Initial Screening on 29 March 1995 and dilution series and Phase I on 31 March 1995.
2. For control and control blank performance refer to Appendix H, Table 7 and Appendix F, Table 23.

Table 18. TIEs conducted on the French Camp Slough sample collected 2 September 1994 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .130 µg/L by GC/MS. Malathion also was detected at .021 µg/L by GC/MS.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample		70	100	100	Toxicity detected.
Phase I	Whole Sample		100	100	100	Confirmation of toxicity.
	PBO Addition				0	Alleviation of toxicity suggests presence of metabolically activated pesticide(s).
	C8 Solid Phase Extracted				0	Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
	Eluate Add-back in non-toxic water	100	100	100	100	Recovery of toxicity confirms presence of non-polar organic toxicant(s).
Phase II[2]	50% Fraction				0	
	70% Fraction				0	
	75% Fraction				0	
	80% Fraction	100	100	100	100	Artifactual toxicity due to the addition of MeOH was present in the control blank of the initial Phase II. Recovery of toxicity in the 80% fraction suggests the possible presence of chlorpyrifos. Alleviation of toxicity with the addition of PBO to this fraction strengthens this possibility.
	80% Fraction (9/17)	100	100	100	100	
	80% Fraction + PBO (9/17)				0	
	85% Fraction				0	
	90% Fraction	40	40	40	40	
	95% Fraction		5	5	10	
	100% Fraction				0	

1. Individual tests were set up on the following dates: Initial Screening on 3 September 1994, Phase I on 9 September 1994 and Phase II on 14 September 1994 and 17 September 1994.
2. Add back at 3x ambient concentration.
3. For control and control blank performance refer to Appendix G, Table 4 and Appendix F, Tables 10, 11, and 12.

Table 19. TIEs conducted on the French Camp Slough sample collected 7 September 1994 implicated chlorpyrifos as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at .096 µg/L by GC/MS. Malathion also was detected at .018 µg/L by GC/MS.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	0	100	100	100	Toxicity detected.
Dilution Series	Whole Sample	5	100	100	100	Dilution series was done only to a 50% dilution. Detection of toxicity
	50% Dilution			95	95	to the 50% dilution suggests that toxicant(s) is present at approximately 2 toxic units.
Phase I	Whole Sample	5	100	100	100	Confirmation of toxicity.
	PBO Addition				0	Alleviation of toxicity suggests presence of metabolically activated pesticide(s).
Phase II[2]	50% Fraction				0	
	70% Fraction				0	
	75% Fraction		5	10	10	
	80% Fraction	100	100	100	100	Artifactual toxicity due to the addition of MeOH was present in the
	80% Fraction (9/17)	100	100	100	100	control blank of the initial Phase II. Recovery of toxicity in the 80 and 85% fractions suggests the possible presence of chlorpyrifos.
	80% + PBO (9/17)				0	Alleviation of toxicity with the addition of PBO to the 80% fraction
	85% Fraction		35	65	65	strengthens this possibility.
	90% Fraction				0	
	95% Fraction	10	15	15	15	
	100% Fraction			5	10	

1. Individual tests were set up on the following dates: Initial Screening on 7 September 1994, dilution series and Phase I on 9 September 1994 and Phase II on 14 September 1994 and 17 September 1994.
2. Add back at 3x ambient concentration.
3. For control and control blank performance refer to Appendix F, Tables 9-12.

Table 20. TIEs conducted on the Mosher Slough sample collected 4 December 1994 implicated metabolically activated pesticide(s) as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Diazinon was detected at approximately one toxic unit, .403 µg/L by ELISA. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	0	0	0	100	Toxicity detected.
Phase I	Whole Sample		100	100	100	Confirmation of toxicity.
	PBO Addition				0	Alleviation of toxicity suggests presence of metabolically activated pesticide(s).

1. Individual tests were set up on the following dates: Initial Screening on 7 December 1994 and Phase I on 15 December 1994.
2. For control and control blank performance refer to Appendix G, Table 7 and Appendix F, Table 17.

Table 21. TIEs conducted on the Mosher Slough sample collected 9 January 1995 implicated metabolically activated pesticides as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Chlorpyrifos and diazinon were each detected at one toxic unit, .087 µg/L and .422 µg/L, respectively, by ELISA .

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	0	0	100	100	Toxicity detected.
Phase I	Whole Sample		100	100	100	Confirmation of toxicity.
	PBO Addition				0	Alleviation of toxicity suggests presence of metabolically activated pesticide(s).

1. Individual tests were set up on the following dates: Initial Screening on 11 January 1995 and Phase I on 15 January 1995.
2. For control and control blank performance refer to Appendix G, Table 8 and Appendix F, Table 19.

Table 22
TIEs conducted on the Mosher Slough sample collected 21 March 1995 implicated metabolically activated OP pesticides as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Chlorpyrifos was detected at .053 µg/L and .050 µg/L by ELISA and GC, respectively. Diazinon was detected at .316 µg/L by ELISA and .190 µg/L by GC. The effects of these chemicals are additive. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	10	100	100	100	Toxicity detected.
Phase I	Whole Sample	93	100	100	100	Confirmation of toxicity.
	PBO Addition				0	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Mosher sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).
	C8 Solid Phase Extracted (4/13)			0		Alleviation of toxicity suggests presence of non-polar organic toxicant(s).

1. Individual tests were set up on the following dates: Initial Screening on 22 march 1995 and the Phase I on 24 March 1995.
2. For control and control blank performance refer to Appendix G, Table 10 and Appendix F, Table 22.

Table 23. TIEs conducted on the Mosher Slough sample collected 24 March 1995 implicated metabolically activated pesticides as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[2] Chlorpyrifos was detected at greater than one toxic unit, .116 µg/L by ELISA. Diazinon was detected at about 1/4 of a toxic unit, .110 µg/L by ELISA.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	100	100	100	100	Toxicity detected.
Dilution Series	Whole Sample	100	100	100	100	Linear interpolation estimated 2.7 toxic units based on the results of this dilution series.
	50% Dilution		20	100	100	
	25% Dilution				0	
	12.5% Dilution		6.7	6.7	6.7	
Phase I	50% Sample		20	100	100	Confirmation of toxicity.
	50% Sample + PBO	13	20	20	20	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Mosher sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).

1. Individual tests were set up on the following dates: Initial Screening on 29 March 1995, dilution series and Phase I on 31 March 1995.
2. For control and control blank performance refer to Appendix H, Table 7 and Appendix F, Table 23.

Table 24. TIEs conducted on the Mosher Slough sample collected 1 May 1995 implicated metabolically activated pesticides as the primary compounds responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Chlorpyrifos was detected at greater than one toxic unit, .120 µg/L by ELISA. Diazinon was detected at about 1toxic unit, .416 µg/L by ELISA.

Test type[1]	Treatments	Mortality			Conclusion
		1	2	3	
Initial Screen	Whole Sample	80	100	100	Toxicity detected.
	Whole sample	20	100	100	Similarities of time to death between both series confirm that toxicity was due to both chlorpyrifos and diazinon.
	100% Spike	33	100	100	
	75% Dilution		13	100	
Phase III[2]	75% Spike		26	100	
	50% Dilution			13	
	50% Spike			0	
	25% Dilution			6.7	
	25% Spike			0	

1. Individual tests were set up on the following dates: Initial Screening on 2 May 1995, Phase I on 3 May 1995 and Phase III on 17 May 1995.
2. The dilution treatments refer to a dilution of the field sample with laboratory control water. The spike treatments refer to a non-toxic laboratory water spiked with the amount of contaminant measured in the field sample and subsequently diluted with laboratory control water equivalent to its corresponding percent dilution.
3. For control and control blank performance refer to Appendix G, Table 11 and Appendix F, Table 27.

Table 25. TIEs conducted on the Ryer Island sample collected 31 May 1995 implicated carbaryl as the primary compound responsible for toxicity. All controls and control blanks performed satisfactorily unless otherwise noted in the conclusion column.[3] Carbaryl was detected at 7 µg/L by GC. No other organophosphorous pesticides were detected.

Test type[1]	Treatments	Mortality				Conclusion
		1	2	3	4	
Initial Screen	Whole Sample	100	100	100	100	Toxicity detected.
Phase I	Whole Sample	100	100	100		Confirmation of toxicity.
	PBO Addition	100	100	100		No alleviation of toxicity suggesting toxicity is not due to metabolically activated pesticide(s).
	C8 Solid Phase Extracted			0		Alleviation of toxicity suggests presence of non-polar organic toxicant(s).
	Eluate Add-back in non-toxic water	100	100	100		Recovery of toxicity confirms presence of non-polar organic toxicant(s).
Phase II	50% Fraction	100	100	100	100	Recovery of toxicity in the 50 and 70% fractions, suggests the possible presence of carbaryl.
	70% Fraction	93	100	100	100	
	75% Fraction				0	
	80% Fraction			6.7	6.7	
	85% Fraction				0	
	90% Fraction				0	
	95% Fraction				0	
	100% Fraction				0	
	50% Fraction	100	100	100		Fraction exhibiting toxicity in the original Phase II TIE were amended with PBO. Addition of PBO to these fractions did not alleviate toxicity suggesting toxicity is not due to metabolically activated OP pesticide(s).
	50%+PBO	100	100	100		
	70% Fraction	53	100	100		
	70%+PBO	33	100	100		
Phase III[2]	eluate @ 1.5X	100	100	100	100	Similarities of time to death between both series, based on measured values, confirm that toxicity was due to carbaryl. Eluate add-backs were substituted for dilutions of the ambient sample in this Phase III TIE due to the age of the sample
	spike @ 1.5X	100	100	100	100	
	eluate @ 1.25X	100	100	100	100	
	spike @ 1.25X	60	100	100	100	
	eluate @ 1.0X	93	100	100	100	
	spike @ 1.0X	53	100	100	100	
	eluate @ 0.75X	53	100	100	100	
	spike @ 0.75X		87	93	100	
	eluate @ 0.50X		53	60	67	
	spike @ 0.50X		6.7	6.7	6.7	

1. Individual tests were set up on the following dates: Initial Screening on 2 June 1995, Phase I on 7 June 1995, Phase II on 19 June 1995 and 30 June 1995 and Phase III on 3 October 1995
2. Eluate add-backs refer to a nontoxic water spiked with the eluate at a series of concentrations based on a measured value of the compound. A spike refers to a non-toxic water spiked with the amount of compound equivalent to its corresponding eluate add-backs.
3. For control and control blank performance refer to Appendix G, Table 12 and Appendix F, Tables 29- 32.

Table 26. Routine Delta Monitoring 1994-95 *Selenastrum* Growth

Sample	Cell Counts (x 10^4)										
	6/3	7/12	8/9	9/1	11/7	12/4	1/9	2/28	5/1	5/31	7/17
Laboratory Control	66.4	42.8	36.9	87.1	66.0	55.0	36.7	83.9	81.1	73.7	63.6
SJR @ Vernalis	124.8	68.2	293.0	252.3	213.7	224.0		136.4	150.1	150.4	239.6
SR @ Greene's Landing	294.3	119.6	287.7	249.6	212.5	238.0		170.8	220.2	161.0	243.5
Prospect Slough	229.5	205.5	296.5	221.6	204.7	169.7		165.2	160.8	115.0	247.2
Paradise Cut	36.3	26.8	147.8	192.6	244.7	234.3	131.4	77.4	169.8	154.8	228.2
Lindsay Slough		192.6	311.9	286.9	244.1	219.1		136.6	182.6	172.5	187.1
Rock Slough		203.5	287.8	249.8	234.8	149.9		129.0	178.4	169.6	188.5
Sycamore Slough		189.0	264.7	255.5				34.0	135.3	180.8	261.0
White Slough		145.4	302.7	254.6	246.6	247.7		145.2		140.2	242.6
Old R. @ Tracy	69.2	118.4	281.1	224.2	240.5	256.2	67.0	128.2	185.0	169.2	237.8
Duck Slough	133.6						40.3	133.0			
French Camp Slough	203.5						137.7				
Ulatis Creek	230.3						132.5		162.0		
Skag Slough		131.8	291.0	242.0	225.0						
Hog Slough		246.8									
Haas Slough				275.4		196.7		78.6			
Mosher Slough						202.8	142.9	137.9		151.1	185.7
Ryer Is Main Drain							147.4	127.4			
Pierson Tract							130.2	122.7			
Victoria Is Drain							49.7	130.0	159.2		
Upper Jones Tract							185.3	163.7			
Middle Roberts							92.2				

Table 27. Routine Delta Monitoring 1994-95 *Selenastrum* Growth

Sample	Cell Counts (x 10^4)											
	6/3	7/12	8/9	9/1	11/7	12/4	1/9	2/28	5/1	5/31	7/17	Frequency
Laboratory Control	66.4	42.8	36.9	87.1	66.0	55.0	36.7	83.9	81.1	73.7	63.6	
SJR @ Vernalis	104.8	68.2	293.0	252.3	213.7	224.0		136.4	150.1	150.4	239.6	5/10
SR @ Greene's Landing	294.3	119.6	287.7	249.6	212.5	238.0		170.8	220.2	161.0	243.5	1/10
Prospect Slough	229.5	205.5	296.5	221.6	204.7	169.7		165.2	160.8	115.0	247.2	4/10
Paradise Cut	36.3	26.8	147.8	192.6	244.7	234.3	131.4	77.4	169.8	154.8	228.2	5/11
Lindsay Slough		192.6	311.9	286.9	244.1	219.1		136.6	182.6	172.5	187.1	1/9
Rock Slough		203.5	287.8	249.8	234.8	149.9		129.0	178.4	169.6	188.5	2/9
Sycamore Slough		189.0	264.7	255.5				34.0	135.3	180.8	261.0	3/7
White Slough		145.4	302.7	254.6	246.6	247.7		145.2		140.2	242.6	1/8
Old R. @ Tracy	69.2	118.4	281.1	224.2	240.5	256.2	67.0	128.2	185.0	169.2	237.8	4/10
Duck Slough	133.6						40.3	133.0				1/3
French Camp Slough	203.5						137.7					0/2
Ulatis Creek	230.3						132.5		162.0			0/3
Skag Slough		131.8	291.0	242.0	225.0							0/4
Hog Slough		246.8										0/1
Haas Slough				275.4		196.7		78.6				2/3
Mosher Slough						202.8	142.9	137.9		151.1	185.7	1/5
Ryer Is Main Drain							147.4	127.4				1/2
Pierson Tract							130.2	122.7				1/2
Victoria Is Drain							49.7	130.0	159.2			2/3
Upper Jones Tract							185.3	163.7				0/2
Middle Roberts							92.2					0/1

Individual highlighted cells represent the lowest 33% of algae cell counts for each sampling event for this year.

Table 28. Results of C8 manipulation on samples which exhibited low algal growth in their original screening tests.[1]

Sample	Percent Enhancement or inhibition[2] in CSPEW[3] sample	Percent Enhancement or inhibition[1] in Control Blank
Duck Slough 1/9/95	378*	-54
Lateral in Paradise Cut Irrigation District, Mac Arthur Blvd. 6/14/94	313*	-27
Victoria Island Drain 1/9/95	220*	-46
Ulatis Creek 3/9/95	140*	-34
Paradise Cut 6/3/94	46*	-12
Paradise Cut 3/1/95	37	27
Sycamore Slough 2/28/95	29	36
Stewart's Tract East 6/14/94	26	10
Paradise Cut 3/9/95	14	-6
Paradise Cut 7/12/94	-8	13

1. Asterisks indicate samples believed to contain non-polar organic chemicals. These phytotoxic compounds may have been responsible for low algal growth in the original screening studies. This table lists the percent change after a C8 manipulation. The percent change is presented for both the ambient sample and its associated control. The control blank enhancement or inhibition represents the effect of C8 column manipulation on a sample. Asterisks indicate samples which had a significant improvement of algal growth in the treated ambient sample compared to the untreated ambient sample without a commensurate enhancement in the control blank (Two tailed, unpaired T-test, $p \leq 0.05$).

2. Percent enhancement or inhibition = $\frac{\text{(cell count in solid phase extracted water- cell count in untreated water)}}{\text{cell count in untreated water}} \times 100$

3. CSPEW=C8 Solid Phase Extracted Water

Table 29. Summary of TIE results.

Sample, Collection Date and Reason for Collection	Observed Toxic Units[1]	Toxicity alleviated with addition of PBO?	Toxicity alleviated after application to C8 SPE column?	Toxicity regained with extraction off the C8 SPE column?	Which fractions are toxicants present in?[1]	Confirmation in Phase III	Additional Comments
Typical Chlorpyrifos Response	1	Yes	Yes	Yes	80, 85	-	
Typical Diazinon Response	1	Yes	Yes	Yes	75,80	-	
Typical Carbaryl Response	1	No	Yes	Yes	70,50	-	
Ulatis Creek 9/1/94 - Routine Monitoring	1	Yes					Chronic Toxicity
Ulatis Creek 9/13/94 - Follow-up	2	Yes	Yes	Yes	80,85		
Ulatis Creek 9/18/94 - Follow-up	1	Yes	-	-			Chronic Toxicity
Ulatis Creek 11/7/94 - Routine Monitoring	2	Yes	Yes	Yes	80,70,75,95		
Ulatis Creek 12/4/94 - Routine Monitoring	2	Yes	Yes	Yes	80,85,95,90		Potential for another toxicant
Ulatis Creek 3/9/95 - Rain Event	3*	Yes					
Ulatis Creek 3/21/95 - Routine Monitoring	3*	Yes	Yes			Yes	
Paradise Cut 7/12/94 - Routine Monitoring	6*	Yes	Yes	Yes	80,85		
Paradise Cut 7/19/94 - Follow-up	2	Yes	Yes	Yes	80,100		Chronic Toxicity
Paradise Cut 3/9/95 - Rain Event	2	Yes					
Paradise Cut 3/15/95 - Follow-up	2	Partially				Yes	
Duck Slough 3/21/95 - Routine Monitoring	>8	Yes				Yes	
Duck Slough 3/25/95 - Follow-up	11.3*	Yes					
French Camp Slough 9/2/94 - Routine Monit.	2	Yes	Yes	Yes	80		
French Camp Slough 9/7/94 - Follow-up	2	Yes	Yes	Yes	80,85		
Mosher Slough 12/4/94 - Routine Monitoring	2	Yes					
Mosher Slough 1/9/95 - Routine Monitoring	2	Yes					
Mosher Slough 3/21/95 - Routine Monitoring	2	Yes					
Mosher Slough 3/24/95 - Follow-up	2.7*	Yes					
Mosher Slough 5/1/95 - Routine Monitoring	2		Yes			Yes	
Ryer Island Drain 5/31/95 - Routine Monit.	2[NP]	No	Yes	Yes	50,70	Yes	

NP The control mortality in the dilution series test control did not meet the laboratory criteria for test acceptability, however, this information is provided to make the necessary comparison between the expected toxic units and the observed toxic units. Carbaryl was confirmed as the primary toxicant in a Phase III.

1. The observed toxic units were calculated from experiments that were set up in a TIE styled test. An * indicates that the number of toxic units were calculated using linear interpralation based on data generated in a dilution series test.

2. Toxic fractions are listed in order from most to least toxic.

Table 29. Summary of TIE results (continued).

Sample, Collection Date and Reason for Collection	Chlorpyrifos Concentration[3] (µg/L)	Chlorpyrifos Concentration approximating or exceeding 96-hour LC_{50}	Diazinon Concentration[3] (µg/L)	Diazinon Concentration approximating or exceeding 96-hour LC_{50}	Other Chemical Concentration (µg/L)	Other Chemicals approximating or exceeding 96-hour LC_{50}
Typical Chlorpyrifos Response	0.080					
Typical Diazinon Response			0.425			
Typical Carbaryl Response					4.5 carbaryl	
Ulatis Creek 9/1/94 - Routine Monitoring	0.058					
Ulatis Creek 9/13/94 - Follow-up	0.090	X				
Ulatis Creek 9/18/94 - Follow-up	0.048				0.025 malathion	
Ulatis Creek 11/7/94 - Routine Monitoring	0.075	X			0.061 malathion	
Ulatis Creek 12/4/94 - Routine Monitoring	0.045		0.133			
Ulatis Creek 3/9/95 - Rain Event	0.184	X	282			
Ulatis Creek 3/21/95 - Routine Monitoring	0.117	X			0.800 carbofuran	
Paradise Cut 7/12/94 - Routine Monitoring	0.497	X				
Paradise Cut 7/19/94 - Follow-up	0.068	X				
Paradise Cut 3/9/95 - Rain Event	0.188	X				
Paradise Cut 3/15/95 - Follow-up	0.113	X	0.125			
Duck Slough 3/21/95 - Routine Monitoring	0.693	X				
Duck Slough 3/25/95 - Follow-up	0.406	X				
French Camp Slough 9/2/94 - Routine Monit.	0.130	X			0.021 malathion	
French Camp Slough 9/7/94 - Follow-up	0.096	X			0.018 malathion	
Mosher Slough 12/4/94 - Routine Monitoring			0.403	X		
Mosher Slough 1/9/95 - Routine Monitoring	0.087	X	0.422	X		
Mosher Slough 3/21/95 - Routine Monitoring	0.052		253			
Mosher Slough 3/24/95 - Follow-up	0.116	X	0.110			
Mosher Slough 5/1/95 - Routine Monitoring	0.120	X	0.416	X		
Ryer Island Drain 5/31/95 - Routine Monit.					7.0 carbaryl	X

3. The concentration presented in these columns is the average of all available analytical data.

Table 30. Samples collected from Mosher Slough causing acute mortality to *Ceriodaphnia* are listed with associated diazinon and chlorpyrifos concentrations (ELISA). The 96-hour LC_{50}s for each of these compounds is approximately 0.400 and 0.080 µg/L, respectively. The toxicity of these two compounds is additive.

Mosher Slough Sampling Date	Time to 100% Mortality (days)	Diazinon (µg/L)	Chlorpyrifos (µg/L)
10/5/95	3	0.459	ND
11/5/94	2	0.499	Not available
12/4/94	4	0.403	Not available
1/9/95	3	0.422	0.087
3/21/95	2	0.316	0.053
5/1/95	2	0.417	0.094
10/29/96	1	0.486	0.103
11/13/97	4	0.461	0.59

APPENDIX A

SITE DESCRIPTIONS

Table A-1
Description of Sampling Locations for Sites Illustrated in Figure 1 (Delta)

Location	Description
Sacramento River at Greene's Landing (site 1)	Samples collected from mid-channel off pump platform. Pump is accessed by way of Randall Island Rd. and is approximately 10 river miles downstream of Freeport.
San Joaquin River at Vernalis (site 2)	Samples collected from mid-channel off County Road J3 bridge.
Ryer Island (site 3)	Samples collected from middle of drain (Elkhorn Slough) at discharge pumps. Drain discharges into Cache Slough upstream of Rio Vista.
Pierson Tract (site 4)	Samples collected from middle of drain off Vorden Rd. bridge at intersection with Alfalfa Rd. Drain discharges into Snodgrass Slough.
Victoria Island (site 5)	Samples collected from middle of drain at discharge pump. Drain discharges into Old River @ Hwy. 4 bridge.
Upper Jones Tract (site 6)	Samples collected from middle of drain at North-West corner of tract. Access by way of Bacon Island Rd. The drain discharges into Middle River.
Middle Roberts Tract (site 7)	Samples collected from middle of drain at discharge pump. Access via Trapper Jacobs Rd. Drain discharges into Burns Cutoff.
Duck Slough (site 8)	Samples collected from middle of drain off discharge pump platform. Drain discharges into Miners Slough at Five Points Marina.
Prospect Slough (site 9)	Samples collected from mid-channel by boat at confluence of Liberty Cut and Toe Drain.
French Camp Slough (site 10)	Samples collected from mid-channel off Manthey Rd. bridge. Slough is discharged into the San Joaquin R. about 1 mile upstream of Hwy. 4 bridge.
Ulatis Creek (site 11)	Samples collected from mid-channel under bridge at Brown Rd. Ulatis Creek discharges into Cache Slough.
Haas Slough (site 12)	Samples collected from mid-channel by boat just upstream of confluence with Prairie Slough. Slough discharges into Cache Slough.
Mosher Slough (site 13)	Samples collected from mid-channel off Mariners Dr. bridge.
Paradise Cut (site 14)	Samples collected from middle of south channel off Paradise Rd. bridge.
Sycamore Slough (site 15)	Samples collected from mid-channel by boat 4 to 4.5 miles upstream of confluence with Mokelumne River. The location varied by tide and was typically determined by Water Hyacinth mass.
Rock Slough (site 16)	Samples collected from mid-channel off Delta Rd./Holland Tract Rd. bridge.
White Slough (site 17)	Samples taken from mid-channel by boat at intersection of Bishop Cut and White Slough.
Old River at Tracy Blvd. (site 18)	Samples collected in mid-channel off Tracy Blvd. bridge.
Skag Slough (site 19)	Samples collected from mid-channel off Liberty Island Rd. bridge. Slough discharges into Cache Slough upstream of Lindsey Slough.

Table A-1
Description of Sampling Locations for Sites Illustrated in Figure 1 (Delta)

Walthall Slough (site 20)	Samples collected from mid-channel off Woodward Rd. bridge.
Hog Slough (site 21)	Samples collected from mid-channel by boat 3 to 3.5 miles upstream of confluence with Mokelumne River. The location varied by tide.

Table A-2
Description of Sampling Locations for Sites Illustrated in Figure 2 (Cache Creek)

Location	Description
North Fork Cache Creek (site A)	Samples collected from mid-channel off Highway 20 bridge. North Fork Cache Creek discharges into Cache Creek.
Bear Creek (site B)	Samples collected from mid-channel off Highway 20 bridge. Bear Creek discharges into Cache Creek.
Cache Creek at Rumsey (site C)	Samples collected from mid-channel off Rumsey bridge.
Cache Creek at Rd. 102 (site D)	Samples collected from mid-channel off County Road 102 bridge.

Table A-3
Exact Location of Sites illustrated in Figure 3 (Paradise Cut Special Studies Area)

Location	Description
Sugar Cut (site 22)	Shore sample from Holly Sugar site
Grantline (site 23)	Bridge sample at Tracy Blvd.
Tom Payne Slough (site 24)	Bridge sample at Paradise Rd.
Upstream Paradise Cut (site 25)	Bridge sample from WP railroad tracks (east of I-5)
Tracy Wastewater Treatment Plant outfall (site 26)	Shore sample from the south end of Sugar Cut
Paradise Dam (site 27)	Shore sample from the eastern end of Paradise Cut
Stewart's Tract West (site 28)	Drain sample from Stewart's Tract into Paradise Cut
Mac Arthur Blvd. (site 29)	Drain sample from MacArthur Blvd. (Pescadero Irrigation District main drain)
Pescadero (site 30)	
San Joaquin River (site 31)	Shore sample upstream of Paradise Cut Dam
Delta Ave. (site 32)	Drain sample from Delta Ave. (Pescadero Irrigation District main drain)
Stewart's Tract East (site 33)	Drain sample from Stewart's Tract into Paradise Cut
Duel Vocational Institute (DVI) (site 34)	Drain sample from DVI upstream of the discharge into Paradise Cut
Alfalfa @ Tom Payne Slough (site 35)	Drain samples immediately downstream of an alfalfa field (sampling was contingent on site anonymity)
El Rancho South Drain (site 36)	
Corn (site 37)	Drain samples immediately downstream of a corn field (sampling was contingent on site anonymity)
Safflower (site 38)	Drain samples immediately downstream of a safflower field (sampling was contingent on site anonymity)
Alfalfa (site 39)	Drain samples immediately downstream of an alfalfa field (sampling was contingent on site anonymity)
Sullivan's Tile Drain (site 40)	Tile drain sample from Pescadero Irrigation District off Delta Ave.
Upstream Tom Payne Slough @ eastern end (site 41)	Shore sample at eastern end of Tom Payne Slough

APPENDIX B

MINIMUM DETECTION LIMITS FOR ORGANIC CHEMICAL ANALYSIS

Table B-1. Recovery and precision data for organic chemicals analyzed by the U.S. Geological Survey using Gas Chromotograph/Mass Spectrometer. Data are based on six determinations of the compounds at 0.1 microgram per liter in reagent water.

Analytes	MDL's (µg/L)	Mean Recov. (%)	Relative std. dev. (%)
Alachlor	<.009	86	3
Atrazine	<.017	89	6
Atrazine-desethyl[1]	<.003	12	8
Azinphos-methyl[1]	<.038	78	15
Benfluralin	<.013	46	9
Butylate	<.008	80	3
Carbaryl[1]	<.046	151	10
Carbofuran[1]	<.013	108	4
Chlorpyrifos	<.005	83	2
Cyanazine	<.013	96	4
p,p-DDE	<.010	48	6
Diazinon	<.008	77	3
Dieldrin	<.008	67	4
Diethylanaline	<.006	73	3
Dimethoate	<.024	11	68
Disulfoton	<.008	72	4
EPTC	<.005	80	2
Ethalfluralin	<.013	54	8
Ethoprop	<.012	80	5
Fonofos	<.008	75	3
alpha-HCH	<.007	77	3
Linuron	<.039	126	10
Malathion	<.014	90	5

Analytes	MDL's (µg/L)	Mean Recov. (%)	Relative std. dev. (%)
Metolachlor	<.009	92	3
Metribuzin	<.012	42	9
Molinate	<.007	82	3
Napropamide	<.010	83	4
Ethyl-Parathion	<.022	83	9
Methyl-Parathion	<.035	73	15
Pebulate	<.009	79	4
Pendimethalin	<.018	46	13
cis-Permethrin	<.016	37	13
Phorate	<.011	77	4
Prometon	<.008	77	3
Pronamide	<.009	76	4
Propachlor	<.015	79	6
Propanil	<.016	96	5
Propargite	<.006	59	3
Simazine	<.008	76	3
Tebuthiuron	<.015	88	6
Terbacil[1]	<.030	75	13
Terbufos	<.012	74	5
Thiobencarb	<.008	85	3
Triallate	<.008	75	4
Trifluralin	<.012	47	8

1. Pesticides having poor performance that are reported with an E code to caution the user that measured concentrations are estimated and need to be evaluated carefully because of the potential for variable performance.

Table B-2. Recovery and precision data for organic chemicals analyzed by APPL, Inc. using Gas or Liquid Chromotograph. Data are based on seven determinations of the compounds in reagent water.[1]

Analytes (Method 8141)	MDL's (µg/L)	Mean Recov. (%)	Relative std. dev. (%)
Azinphosmethyl	1.00	100	6
Bolstar	0.10	126	2
Chlorpyrifos	0.05	131	2
Coumaphos	0.10	110	5
Def	0.10	136	4
Demeton-S	0.20	100	4
Diazinon	0.05	130	3
Dichlorvos	0.20	55	10
Dimethoate	0.10	103	5
Disulfoton	0.10	108	2
EPN	0.10	105	3
EPTC	0.40	36	13
Ethion	0.10	115	1
Ethoprop	0.10	123	3
Fensulfothion	0.20	98	57
Fenthion	0.10	117	2
Malathion	0.40	105	1
Merphos	0.10	332	12
Mevinphos	0.70	101	10
Naled	0.50	125	19
Parathion, ethyl	0.10	111	1
Parathion, methyl	0.10	118	4
Phorate	0.10	91	3
Prowl	0.10	125	3
Ronnel	0.10	115	2
Stirophos	0.15	104	4
Sulfotep	0.10	111	2
TEPP	0.50	223	15
Tributyl Phos.	0.30	139	9
Triphenyl Phos.	0.20	130	5
Trichloronate	0.10	105	1
Trifluralin	0.10	116	4
Tukothion	0.20	281	6

Analytes (Method 632)	MDL's (µg/L)	Mean Recov. (%)	Relative std. dev. (%)
A. Sulfoxide	0.05	13	2
A. Sulfone	0.05	33	1
Aldicarb	0.40	76	4
Aminocarb	0.40	87	3
Barban	3.50	97	32
Benomyl (Carbendazim)	0.40	58	3
Bromacil	0.40	104	18
Carbaryl	0.10	94	4
Carbofuran	0.10	92	4
Chloropropham	3.50	83	19
Chloroxuron	0.40	97	8
Diuron	0.40	90	6
Fenuron	0.40	85	4
Fluometuron	0.40	92	6
3-Hydroxcarbo.	0.10	32	2
IPBC	0.40	94	12
Linuron	0.40	90	9
Methiocarb	0.40	87	4
Methomyl	0.10	70	5
Mexacarbate	3.50	85	5
Monuron	0.40	91	5
Neburon	0.40	84	12
Oxamyl	0.40	42	3
Propachlor	3.50	90	5
Propham	3.50	100	16
Propoxur	0.40	88	4
Siduron	0.40	93	6
Tebuthiuron	0.40	83	3

1. Amounts of the compounds spiked ranged from 0.5-2.0 micrograms per liter but were consistent for each compound across the seven determinations ie. the amount spiked for diazinon was always 0.5 micrograms per liter whereas the amount spiked for naled was always 2.0 micrograms per liter.

Figure C-1. Control summary chart for the 7-day Ceriodaphnia sodium chloride reference toxicant testing. Individual survival mean values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

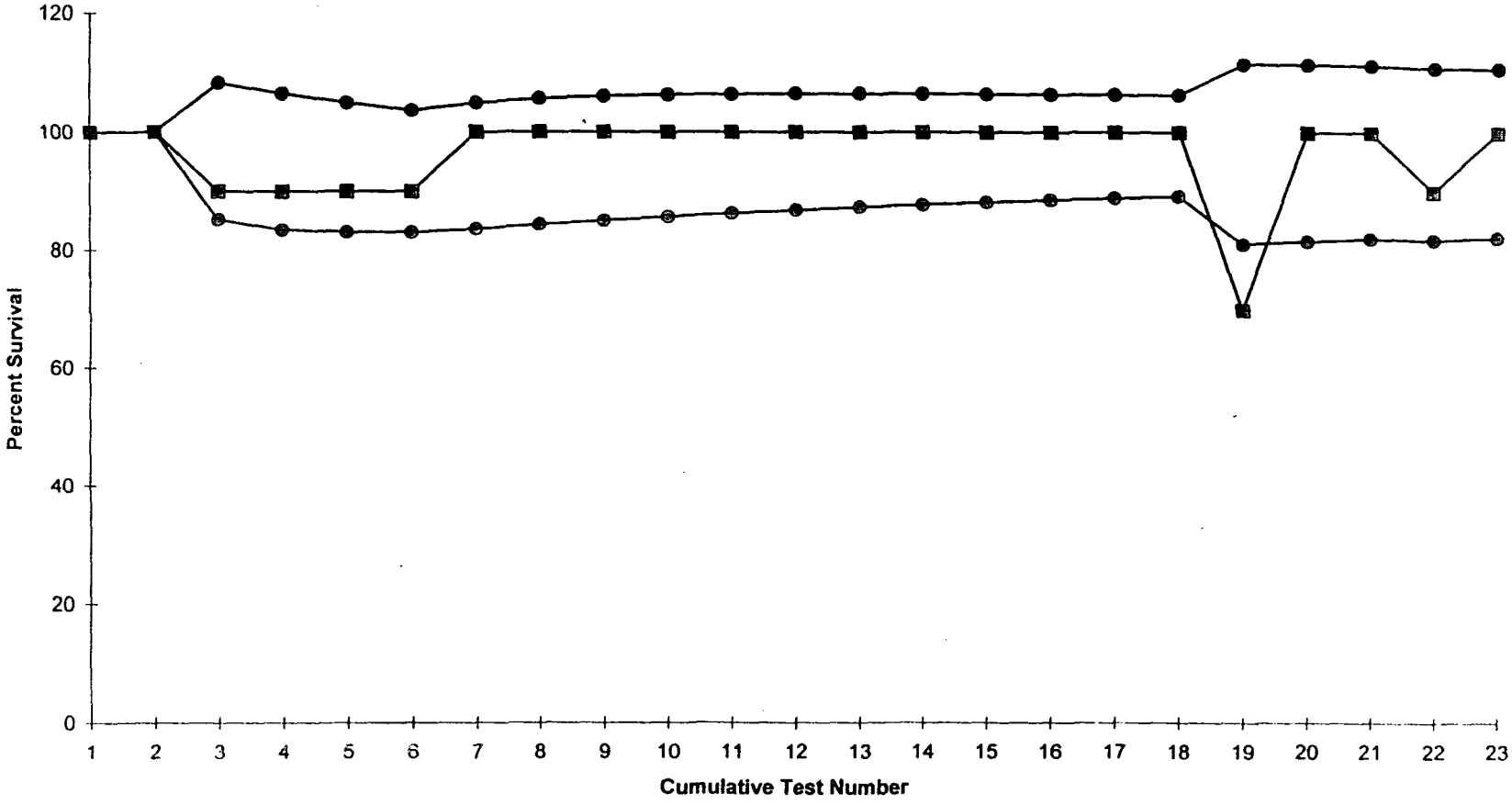


Table C-1. Control summary data for the 7-day *Ceriodaphnia* sodium chloride reference toxicant testing.

Test Date	Control Percent Survival	Upper 95% Control Limit	Lower 95% Control Limit
May-93	100		
Jun-96	100	100.0	100.0
Aug-93	90	108.2	85.1
Sep-93	90	106.5	83.5
Oct-93	90	105.0	83.0
Nov-93	90	103.7	83.0
Dec-93	100	105.0	83.6
Jan-94	100	105.7	84.3
Mar-94	100	106.1	85.0
Apr-94	100	106.3	85.7
May-94	100	106.5	86.3
Jul-94	100	106.5	86.8
Aug-94	100	106.5	87.3
Sep-94	100	106.5	87.8
Oct-94	100	106.5	88.2
Nov-94	100	106.4	88.6
Dec-94	100	106.4	88.9
Jan-95	100	106.3	89.2
Feb-95	70	111.5	81.1
Apr-95	100	111.4	81.6
May-95	100	111.3	82.1
Jun-95	90	110.9	81.8
Jul-95	100	110.8	82.2

Figure C-2. Control summary chart for the 7-day Ceriodaphnia sodium chloride reference toxicant testing. Individual LC 50 values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

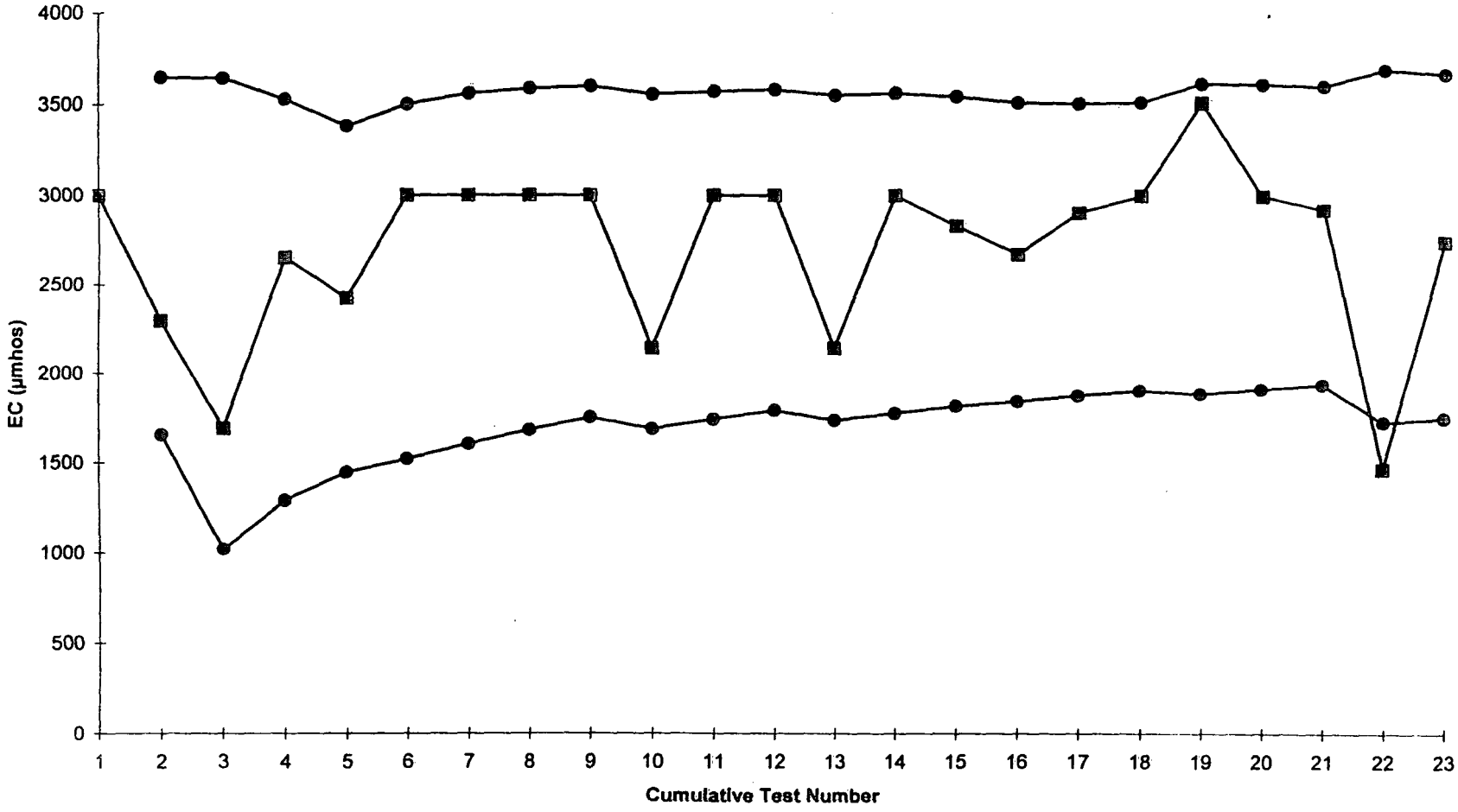


Table C-2. Control summary data for the 7-day *Ceriodaphnia* sodium chloride reference toxicant testing.

Test Date	LC_{50} (EC µmhos)	Upper 95% Control Limit	Lower 95% Control Limit
May-93	3000		
Jun-93	2297.5	3642.2	1655.3
Aug-93	1691.1	3639.6	1019.5
Sep-93	2649.5	3526.0	1293.0
Oct-93	2423.9	3379.4	1445.4
Nov-93	3000	3499.4	1521.3
Dec-93	3000	3556.1	1604.5
Jan-94	3000	3583.7	1681.8
Mar-94	3000	3596.2	1751.0
Apr-94	2143.9	3552.7	1688.5
May-94	3000	3568.5	1741.7
Jul-94	3000	3577.2	1790.5
Aug-94	2143.9	3548.5	1736.0
Sep-94	3000	3559.3	1776.4
Oct-94	2828.7	3541.6	1815.5
Nov-94	2671.9	3511.9	1844.4
Dec-94	2905.6	3506.3	1876.7
Jan-95	3000	3512.4	1904.9
Feb-95	3512	3614.6	1887.3
Apr-95	3000	3611.4	1915.4
May-95	2925.9	3600.7	1941.6
Jun-95	1472	3693.0	1731.1
Jul-95	2750	3672.3	1755.2

Figure C-3. Control summary chart for the 7-day Ceriodaphnia sodium chloride reference toxicant testing. Individual mean young produced values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

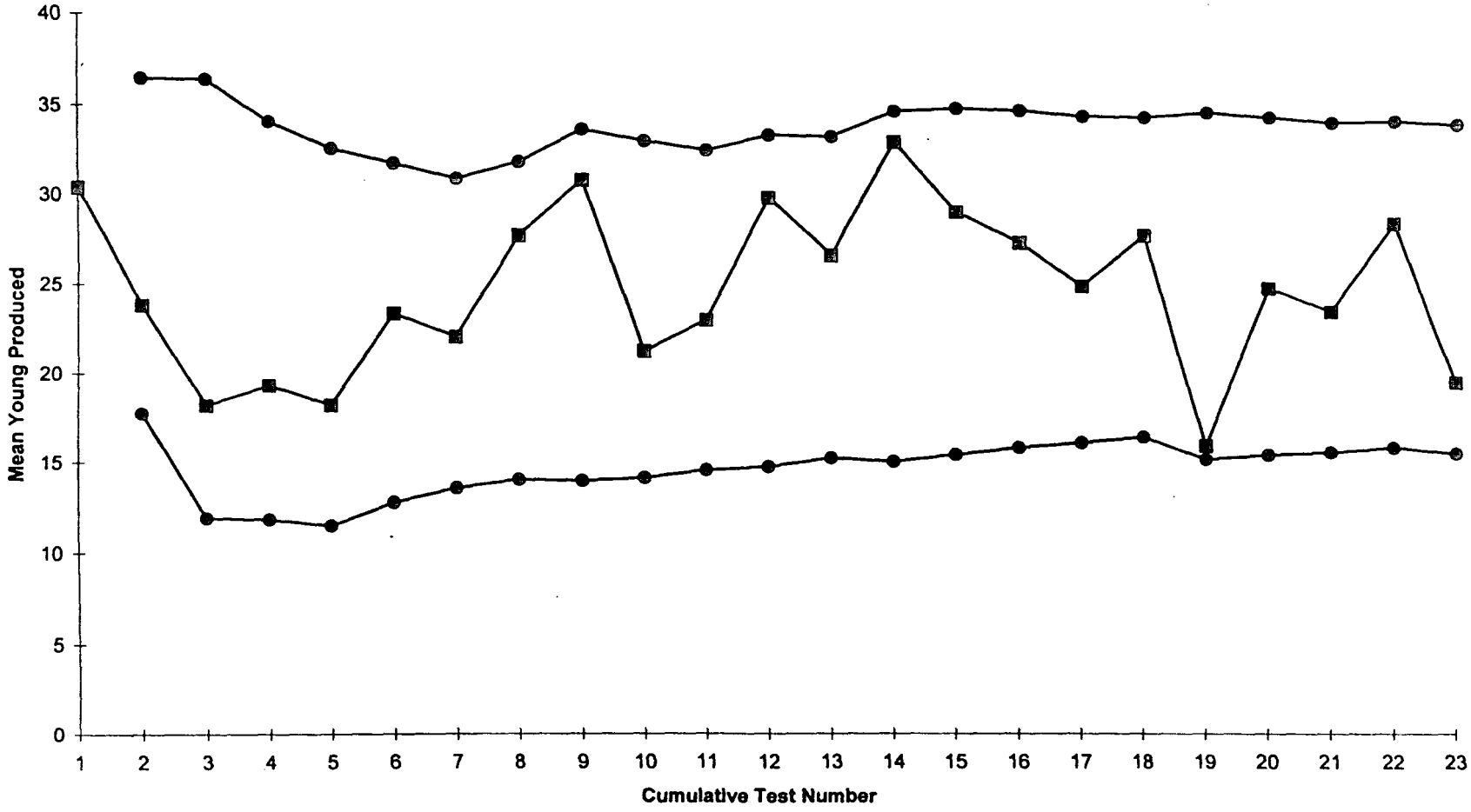


Table C-3. Control summary data for the 7-day *Ceriodaphnia* sodium chloride reference toxicant testing.

Test Date	Control Reproduction (mean young produced)	Upper 95% Control Limit	Lower 95% Control Limit
May-93	30.4		
Jun-93	23.8	36.4	17.8
Aug-93	18.2	36.3	11.9
Sep-93	19.3	34.0	11.8
Oct-93	18.2	32.5	11.5
Nov-93	23.3	31.6	12.8
Dec-93	22	30.8	13.6
Jan-94	27.6	31.7	14.0
Mar-94	30.7	33.5	13.9
Apr-94	21.2	32.8	14.1
May-94	22.9	32.3	14.5
Jul-94	29.7	33.2	14.7
Aug-94	26.5	33.1	15.2
Sep-94	32.8	34.5	15.0
Oct-94	28.9	34.7	15.4
Nov-94	27.2	34.6	15.8
Dec-94	24.8	34.2	16.1
Jan-95	27.6	34.2	16.4
Feb-95	15.9	34.4	15.1
Apr-95	24.7	34.2	15.4
May-95	23.4	33.9	15.5
Jun-95	28.3	34.0	15.8
Jul-95	19.5	33.8	15.5

Figure C-4. Control summary for the 7-day Ceriodaphnia sodium chloride reference toxicant testing. Individual reproduction EC_{50} values are plotted as squares and the upper and lower control limits are plotted as circles.

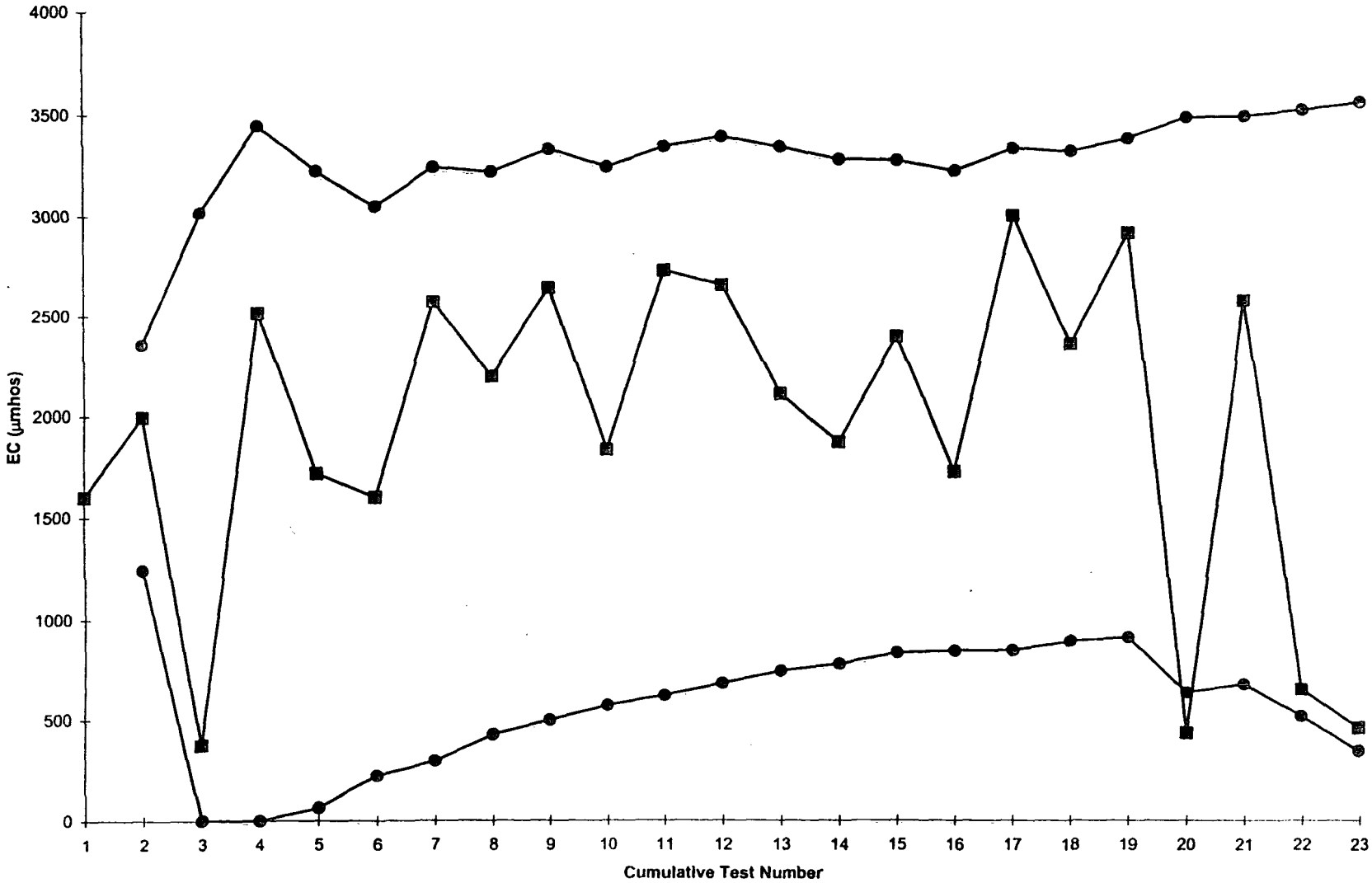


Table C-4. Control summary data for the 7-day *Ceriodaphnia* sodium chloride reference toxicant testing.

Test Date	EC_{50} (EC µmhos)	Upper 95% Control Limit	Lower 95% Control Limit
May-93	1603		
Jun-93	1996.7	2356.6	1243.1
Jul-93	377.4	3014.7	0.0
Sep-93	2515.1	3444.2	0.0
Oct-93	1718.3	3221.6	62.6
Nov-93	1601.4	3048.4	222.2
Dec-93	2571.1	3240.2	297.8
Jan-94	2195.1	3217.3	427.3
Mar-94	2641.5	3327.9	498.7
Apr-94	1833.5	3239.9	570.7
May-94	2727.9	3339.9	620.2
Jul-94	2656.1	3390.5	682.4
Aug-94	2107.1	3338.8	744.9
Sep-94	1872.5	3279.1	780.4
Oct-94	2394.3	3272.6	835.5
Nov-94	1724	3222.2	844.7
Dec-94	3001.4	3333.5	847.3
Jan-95	2357	3317.7	892.7
Feb-95	2915.3	3383.4	912.2
Apr-95	435.3	3488.0	636.4
May-95	2579.1	3494.7	678.9
Jun-95	651.5	3525.7	517.5
Jul-95	460.4	3561.0	346.4

Figure C-5. Control chart for the 96-hour Selenastrum sodium chloride reference toxicant testing. Individual mean cell count values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

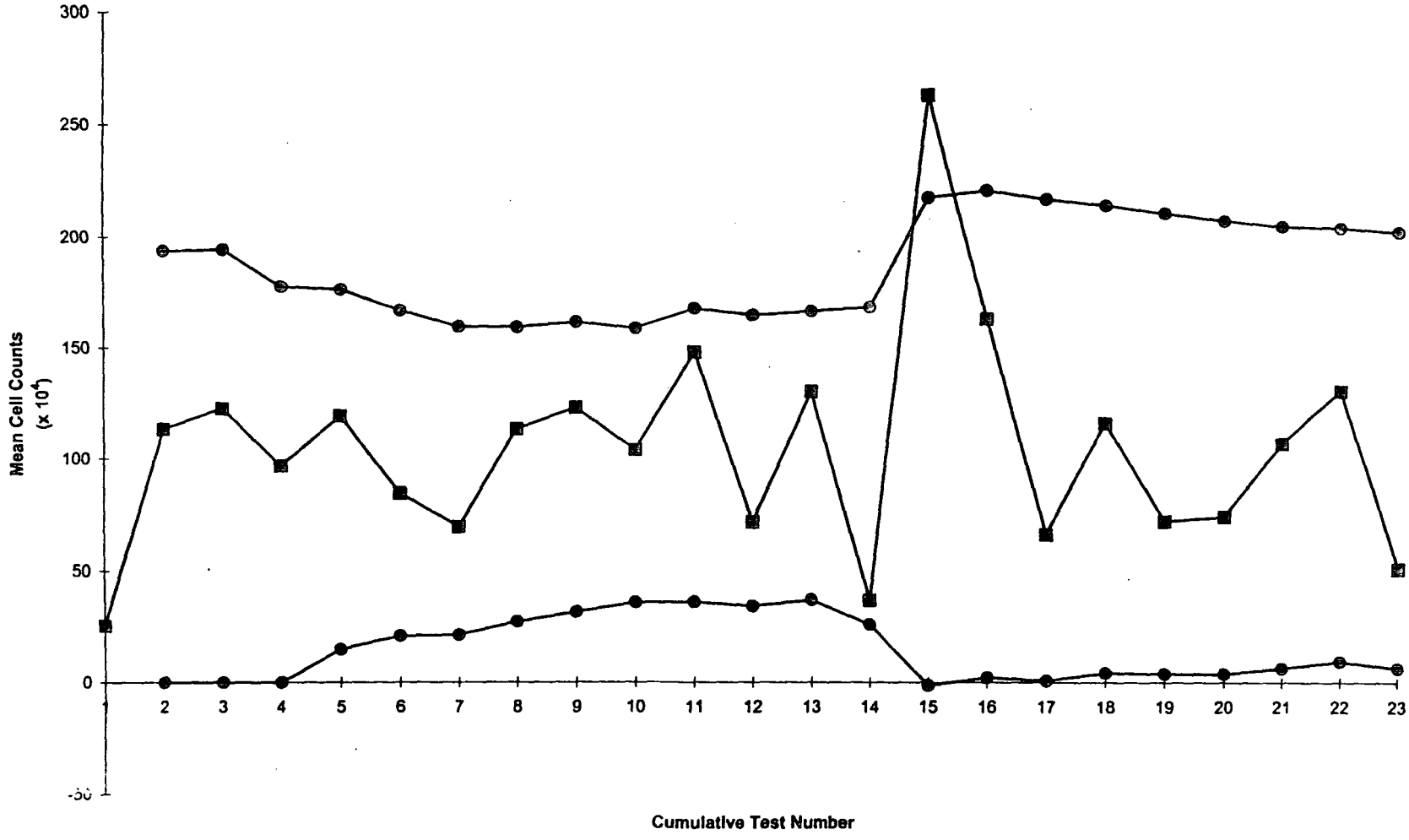


Table C-5. Control chart for the 96-hour *Selenastrum* sodium chloride reference toxicant testing.

Test Date	Control Growth (x 10^4)	Upper 95% Control Limit	Lower 95% Control Limit
May-93	25.7		
Jun-93	113.5	193.8	0.0
Jul-93	122.6	194.3	0.0
Aug-93	96.7	177.5	0.0
Sep-93	119.4	176.2	14.9
Oct-93	84.5	166.4	21.0
Nov-93	69.6	159.1	21.5
Dec-93	113.4	159.0	27.4
Jan-94	123	161.2	31.8
Mar-94	104	158.4	36.1
Apr-94	147.9	167.4	36.3
May-94	71.7	164.2	34.4
Jul-94	130.3	166.2	37.3
Aug-94	37.1	168.0	26.2
Sep-94	263	217.7	-1.4
Nov-94	162.8	220.9	2.2
Dec-94	66.2	217.0	0.8
Jan-95	116	214.3	4.3
Feb-95	72	210.8	3.9
Apr-95	74.1	207.4	3.9
May-95	106.9	204.9	6.6
Jun-95	130.6	204.2	9.5
Jul-95	51.1	202.4	6.5

Figure C-6. Control summary chart for the 96-hour Selenastrum sodium chloride reference toxicant testing. Individual IC50 values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

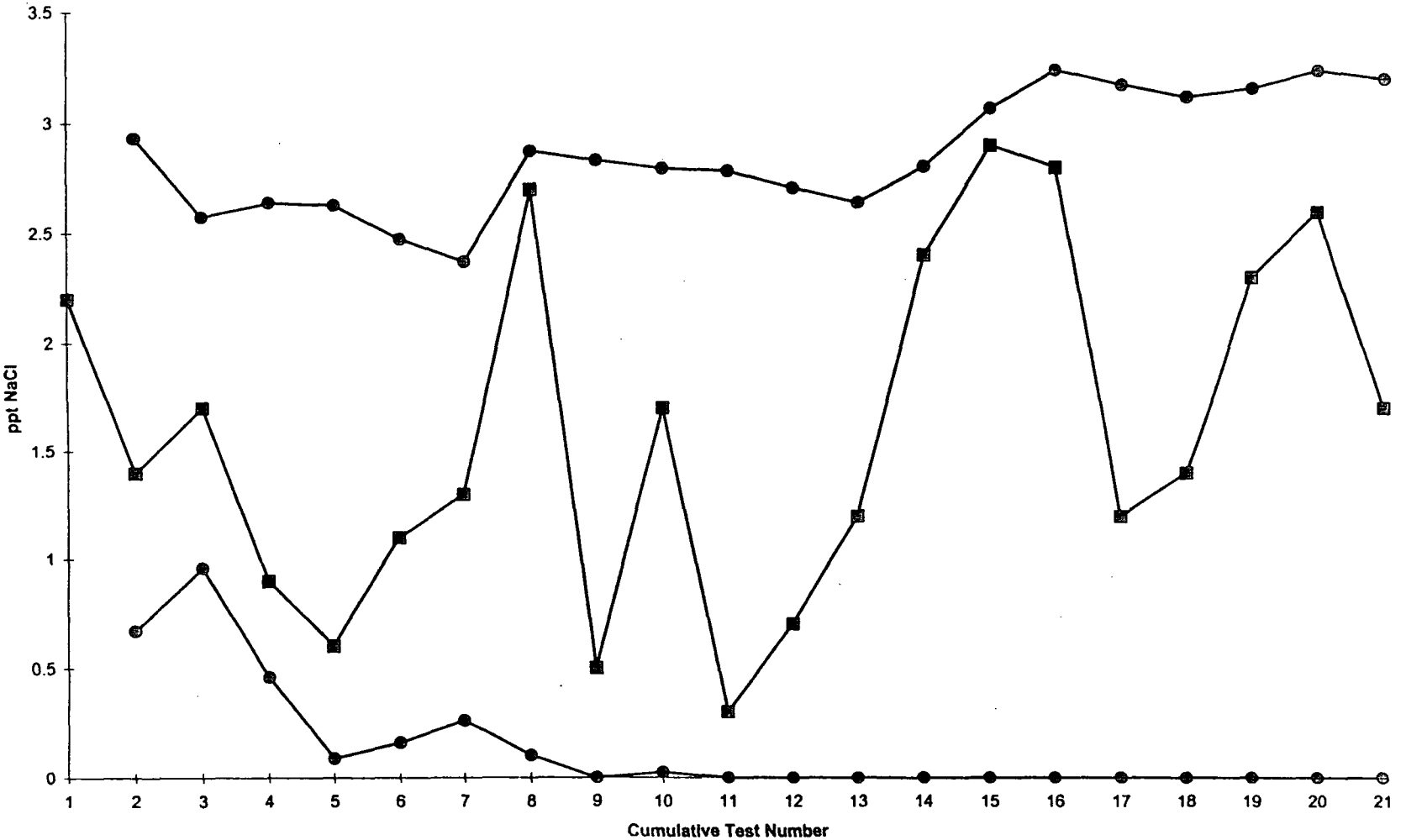


Table C-6. Control chart for the 96-hour *Selenastrum* sodium chloride reference toxicant testing.

Test Date	IC_{50} (ppt NaCl)	Upper 95% Control Limit	Lower 95% Control Limit
May-93	2.2		
Jun-93	1.4	2.9	0.7
Jul-93	1.7	2.6	1.0
Sep-93	0.9	2.6	0.5
Oct-93	0.6	2.6	0.1
Nov-93	1.1	2.5	0.2
Dec-93	1.3	2.4	0.3
Jan-94	2.7	2.9	0.1
Mar-94	0.5	2.8	0.0
Apr-94	1.7	2.8	0.0
May-94	0.3	2.8	0.0
Jul-94	0.7	2.7	0.0
Aug-94	1.2	2.6	0.0
Sep-94	2.4	2.8	0.0
Nov-94	2.9	3.1	0.0
Jan-95	2.8	3.2	0.0
Feb-95	1.2	3.2	0.0
Apr-95	1.4	3.1	0.0
May-95	2.3	3.2	0.0
Jun-95	2.6	3.2	0.0
Jul-95	1.7	3.2	0.0

Figure C-7. Control summary chart for the 7-day Pimephales sodium chloride reference toxicant testing. Individual percent survival values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

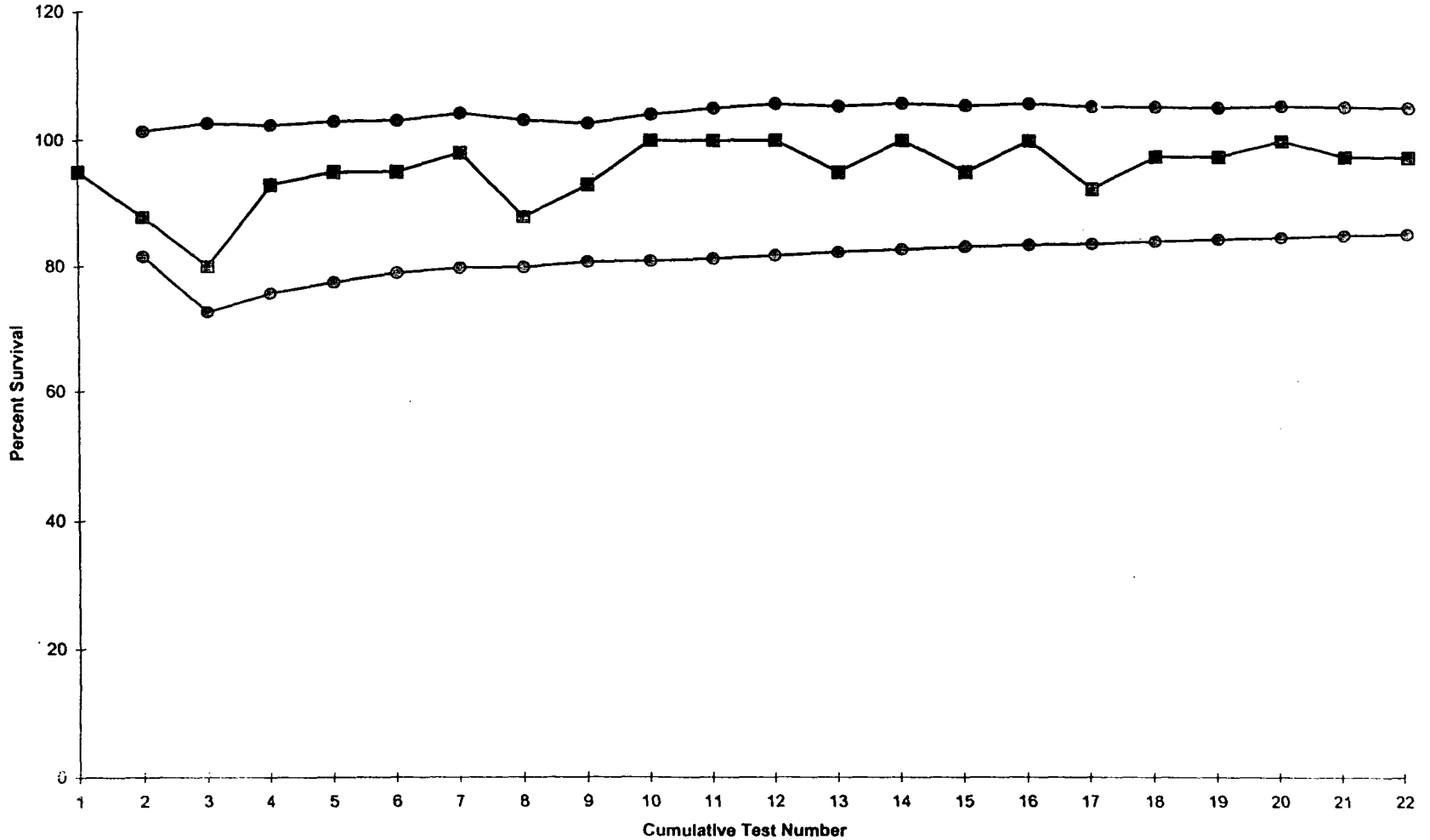


Table C-7. Control summary data for the 7-day *Pimephales* sodium chloride reference toxicant testing.

Test Date	Control Percent Survival	Upper 95% Control Limit	Lower 95% Control Limit
May-93	95		
Jun-93	88	101.4	81.6
Jul-93	80	102.7	72.7
Aug-93	93	102.4	75.6
Sep-93	95	103.0	77.4
Oct-93	95	103.1	78.9
Nov-93	98	104.2	79.8
Dec-93	88	103.2	79.8
Jan-94	93	102.6	80.7
Apr-94	100	104.1	80.9
May-94	100	105.1	81.3
Jul-94	100	105.8	81.7
Aug-94	95	105.4	82.3
Sep-94	100	105.8	82.7
Oct-94	95	105.5	83.2
Nov-94	100	105.8	83.6
Dec-94	92.5	105.4	83.7
Jan-95	97.5	105.3	84.1
Feb-95	97.5	105.2	84.5
May-95	100	105.5	84.8
Jun-95	97.5	105.4	85.1
Jul-95	97.5	105.3	85.4

Figure C-8. Control summary chart for the 7-day Pimephales sodium chloride reference toxicant testing. Individual LC_{50} values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

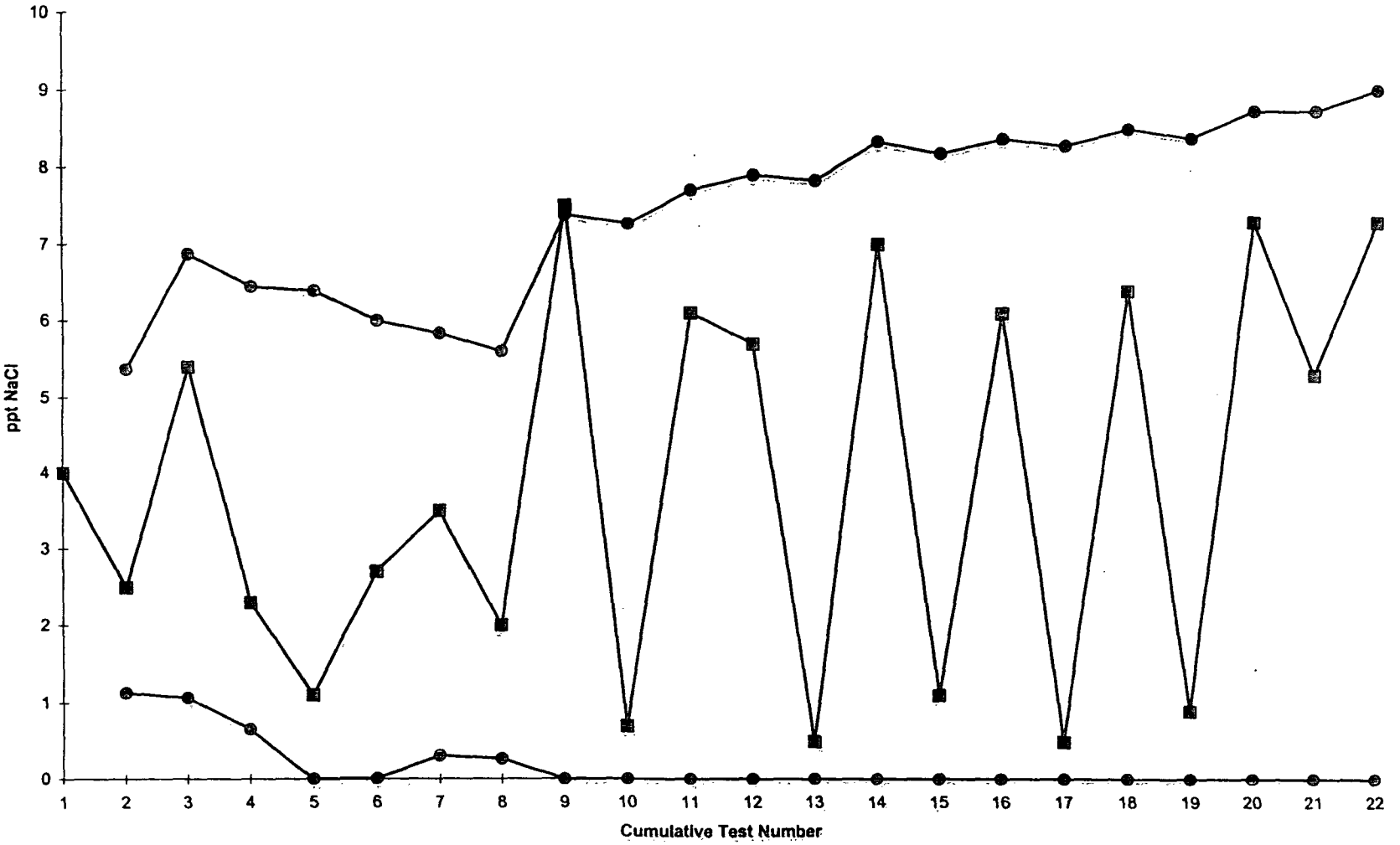


Table C-8. Control summary data for the 7-day *Pimephales* sodium chloride reference toxicant testing.

Test Date	LC_{50} (ppt NaCl)	Upper 95% Control Limit	Lower 95% Control Limit
May-93	4		
Jun-93	2.5	5.4	1.1
Jul-93	5.4	6.9	1.1
Aug-93	2.3	6.4	0.7
Sep-93	1.1	6.4	0.0
Oct-93	2.7	6.0	0.0
Nov-93	3.5	5.8	0.3
Dec-93	2	5.6	0.3
Jan-94	7.5	7.4	0.0
Apr-94	0.7	7.3	0.0
May-94	6.1	7.7	0.0
Jul-94	5.7	7.9	0.0
Aug-94	0.5	7.8	0.0
Sep-94	7	8.3	0.0
Oct-94	1.1	8.2	0.0
Nov-94	6.1	8.4	0.0
Dec-94	0.5	8.3	0.0
Jan-95	6.4	8.5	0.0
Feb-95	0.9	8.4	0.0
May-95	7.3	8.7	0.0
Jun-95	5.3	8.7	0.0
Jul-95	7.3	9.0	0.0

Figure C-9. Control summary chart for the 7-day Pimephales sodium chloride reference toxicant testing. Individual mean growth values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

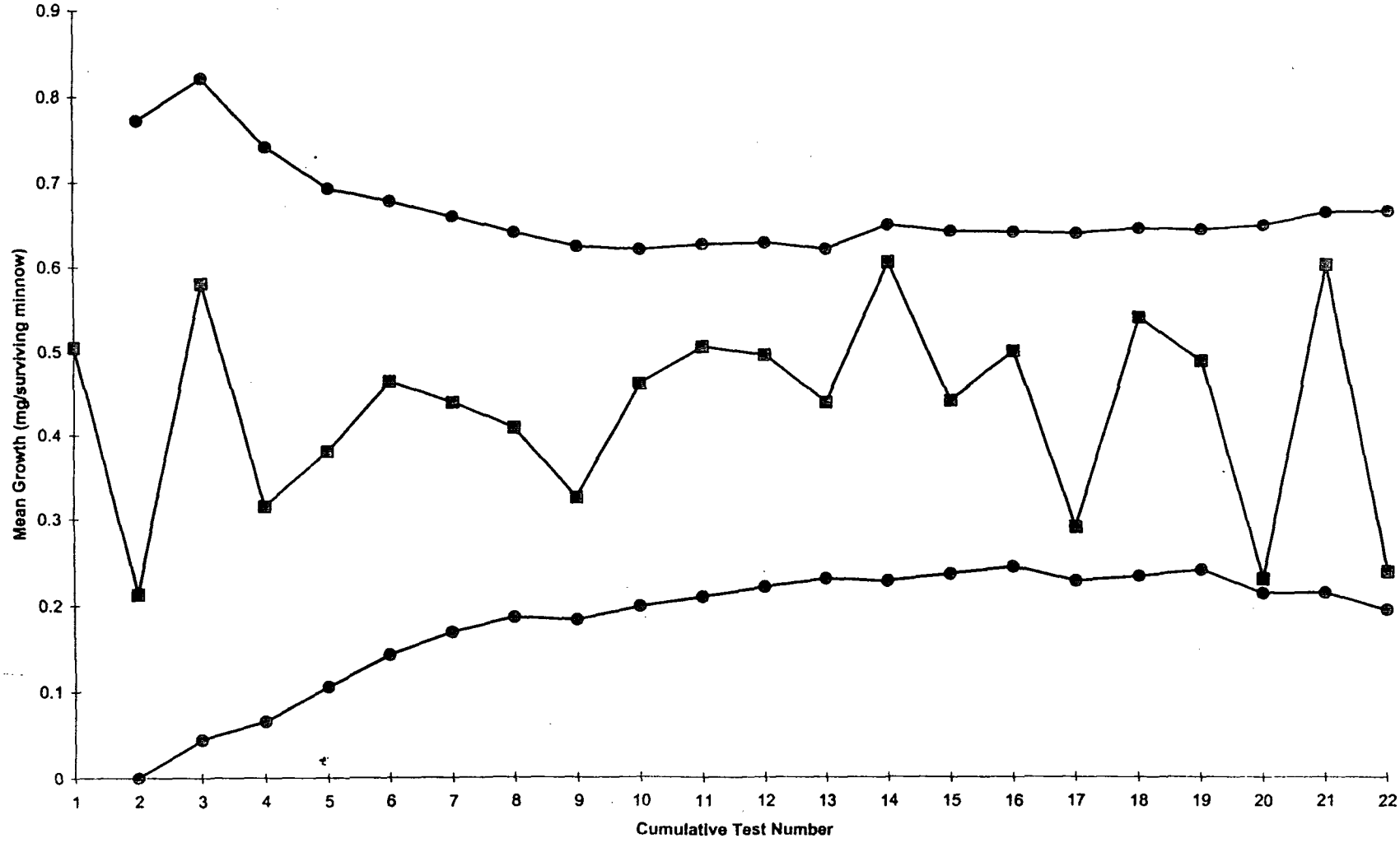


Table C-9. Control summary data for the 7-day *Pimephales* sodium chloride reference toxicant testing.

Test Date	Control Growth (mg/surviving minnow)	Upper 95% Control Limit	Lower 95% Control Limit
May-93	0.505		
Jun-93	0.213	0.77	0.00
Jul-93	0.58	0.82	0.04
Aug-93	0.315	0.74	0.07
Sep-93	0.38	0.69	0.11
Oct-93	0.463	0.68	0.14
Nov-93	0.438	0.66	0.17
Dec-93	0.408	0.64	0.19
Jan-94	0.325	0.62	0.18
Apr-94	0.46	0.62	0.20
May-94	0.505	0.63	0.21
Jul-94	0.495	0.63	0.22
Aug-94	0.438	0.62	0.23
Sep-94	0.605	0.65	0.23
Oct-94	0.44	0.64	0.24
Nov-94	0.5	0.64	0.24
Dec-94	0.29	0.64	0.23
Jan-95	0.54	0.64	0.23
Feb-95	0.488	0.64	0.24
May-95	0.23	0.65	0.21
Jun-95	0.603	0.66	0.21
Jul-95	0.238	0.67	0.19

Figure C-10. Control summary chart of the 7-day Pimephales sodium chloride reference toxicant testing. Individual EC_{50} values are plotted as squares and the upper and lower 95 percent control limits are plotted as circles.

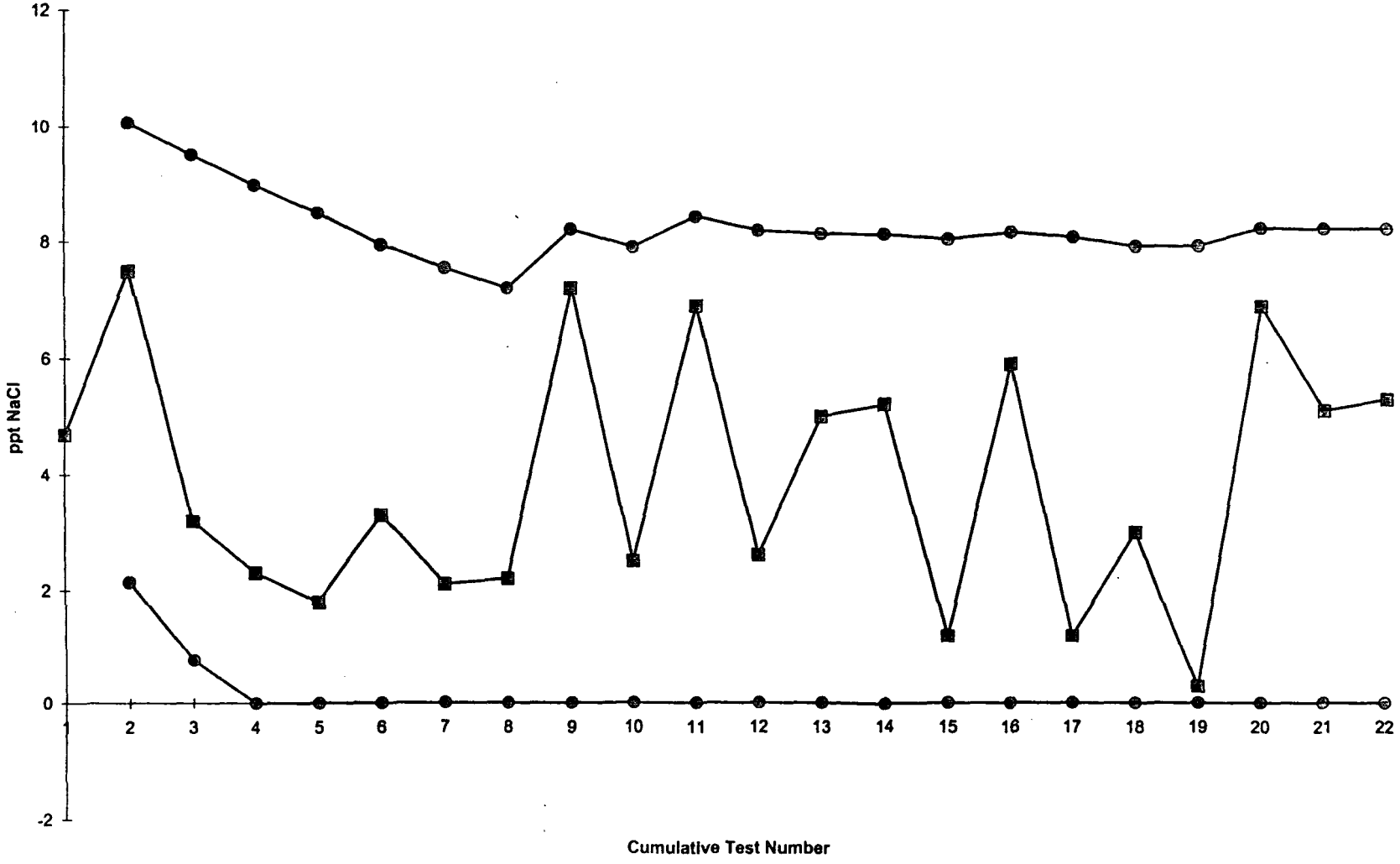


Table C-10. Control summary data for the 7-day *Pimephales* sodium chloride reference toxicant testing.

Test Date	EC_{50} (ppt NaCl)	Upper 95% Control Limit	Lower 95% Control Limit
May-93	4.7		
Jun-93	7.5	10.1	2.1
Jul-93	3.2	9.5	0.8
Aug-93	2.3	9.0	0.0
Sep-93	1.8	8.5	0.0
Oct-93	3.3	7.9	0.0
Nov-93	2.1	7.5	0.0
Dec-93	2.2	7.2	0.0
Jan-94	7.2	8.2	0.0
Apr-94	2.5	7.9	0.0
May-94	6.9	8.4	0.0
Jul-94	2.6	8.2	0.0
Aug-94	5	8.1	0.0
Sep-94	5.2	8.1	0.0
Oct-94	1.2	8.0	0.0
Nov-94	5.9	8.1	0.0
Dec-94	1.2	8.1	0.0
Jan-95	3	7.9	0.0
Feb-95	0.3	7.9	0.0
May-95	6.9	8.2	0.0
Jun-95	5.1	8.2	0.0
Jul-95	5.3	8.2	0.0

Table D-1
Delta Monitoring 6/3/94 Water Chemistry Summary

Treatment	Initial pH	EC (µmhos)	Hardness (mg/L)
Laboratory Control (Glass Distilled)		0	
Laboratory Control (Dilute EI)	8.37	190	100
Laboratory Control (SSEPAMH)	8.37	215	84
SJR @ Vernalis	7.68	700	214
SR @ Greene's Landing	8.42	125	66
Duck Slough	8.24	200	104
Prospect Slough	8.19	240	92
French Camp Slough	7.87	120	58
Ulatis Creek	8.72	470	228
Paradise Cut	7.75	1000	384
Wathall Slough	8.64	318	272
Sugar Cut	7.94	900	296
Grantline	8.03	750	238
Old River @ Tracy	8.11	750	238
Tom Payne Slough	8.15	890	274
Upstream Paradise Cut	8.27	920	292
Tracy Wastewater Treatment Plant outfall	8.20	1090	368

Table D-2
Delta Monitoring 7/12/94 Chemistry Summary

Treatment	Initial pH	EC (µmhos)	Hardness (mg/L)	TSS (mg/L)
Laboratory Control (Glass Distilled)	7.72	15	0	
Laboratory Control (Dilute EI)	8.03	202		
Laboratory Control (SSEPAMH)	8.09	185		
SJR @ Vernalis	8.32	800	200	105.0
SR @ Greene's Landing	8.14	122	44	
Duck Slough	8.05	170	72	
Prospect Slough	8.33	215	76	84.3
French Camp Slough	8.39	170	76	58.8
Ulatis Creek	8.65	500		
Paradise Cut	7.85	1300	400	
Hog Slough	8.54	395	112	14.8
Sycamore Slough	8.53	225	76	36.4
Wathall Slough	7.25	430	128	61.5
Ryer Island	8.06	195	68	72.9
Rock Slough	7.46	433	88	
White Slough	7.49	200	92	
Skag Slough	7.61	165	80	
Old River @ Tracy	7.07	700	232	
Lindsay Slough	7.58	180	84	

Table D-3
Delta Monitoring 8/9/94 Water Chemistry Summary

Treatment	Initial pH	EC (µmhos)	Hardness (mg/L)
Laboratory Control (Glass Distilled)	8.96	0	4
Laboratory Control (Dilute EI)	8.44	185	88
Laboratory Control (SSEPAMH)	8.36	220	84
SJR @ Vernalis	8.13	750	216
SR @ Greene's Landing	8.44	118	56
Duck Slough	8.56	165	68
Prospect Slough	8.37	182	72
French Camp Slough	8.53	225	84
Ulatis Creek	8.24	680	260
Paradise Cut	7.88	1100	360
Haas Slough	8.12	500	240
Sycamore Slough	8.50	145	60
Wathall Slough	8.23	440	172
Ryer Island	8.56	210	76
Rock Slough	8.28	499	100
White Slough	8.27	222	68
Lindsay Slough	8.24	335	124
Snag Slough	8.36	160	84
Old River @ Tracy	7.97	850	236

Table D-4
Delta Monitoring 9/1-2/94 Water Chemistry Summary

Treatment	Initial pH	EC (µmhos)	Hardness (mg/L)
Laboratory Control (Glass Distilled)	9.08	0	
Laboratory Control (Dilute EI)	7.68	195	
Laboratory Control (Dilute EI) A/E filtered	8.52	195	
Laboratory Control (Dilute EI) .22µm filtered	8.55	197	
Laboratory Control (SSEPAMH)	8.47	190	
SJR @ Vernalis	8.18	750	192
SR @ Greene's Landing	8.53	185	68
Duck Slough	8.28	175	70
Duck Slough A/E filtered	8.53	190	
Duck Slough .22µm filtered	8.52		
Prospect Slough	7.72	220	86
French Camp Slough	8.21	240	82
Ulatis Creek	7.61	620	232
Paradise Cut	7.79	1420	368
Haas Slough	7.82	700	300
Sycamore Slough	8.44	225	76
Ryer Island	8.35	190	70
Skag Slough	8.12	175	64
Rock Slough	7.84	690	110
White Slough	7.89	240	84
Old River @ Tracy	7.85	800	202
Lindsay Slough	8.12	190	72

Table D-5
Delta Monitoring 10/5-6/94 Water Chemistry Summary

Treatment	Initial pH	EC (µmhos)	Hardness (mg/L)
Laboratory Control (Glass Distilled)	8.60	11	2
Laboratory Control (Dilute EI)	8.34	201	84
Laboratory Control (SSEPAMH)	8.26	224	78
SJR @ Vernalis	8.15	710	164
SR @ Greene's Landing	7.93	139	56
Duck Slough	8.41	229	128
Prospect Slough	8.26	458	172
French Camp Slough	8.21	202	68
Ulatis Creek	8.58	580	232
Paradise Cut	7.87	1090	360
Haas Slough	8.38	340	124
Sycamore Slough	8.43	189	68
Ryer Island	8.41	209	80
Lindsay Slough	8.27	182	72
Skag Slough	8.30	218	84
Rock Slough	8.06	510	108
White Slough	7.79	351	112
Old River @ Tracy	7.98	790	228

Table D-6
Delta Monitoring 11/7-8/94 Water Chemistry Summary

Treatment	Initial pH	EC (µmhos)	Hardness (mg/L)
Laboratory Control (Glass Distilled)	8.77	0	
Laboratory Control (Dilute EI)	8.31	200	92
Laboratory Control (SSEPAMH)	8.37	205	80
SJR @ Vernalis	8.29	550	180
SR @ Greene's Landing	8.18	120	60
Duck Slough	8.41	220	84
Prospect Slough	8.34	800	328
French Camp Slough	8.25	500	192
Ulatis Creek	8.30	360	176
Paradise Cut	8.45	1300	408
Smith Canal 11/6	7.98	360	128
Smith Canal 11/8	8.11	650	192
Sycamore Slough	8.32	155	60
Ryer Island	8.39	240	88
Lindsay Slough	8.05	210	76
Skag Slough	8.31	198	80
Rock Slough	8.09	550	116
Haas Slough	7.84	450	196
White Slough	7.96	370	100
Old River @ Tracy	7.93	700	200

Table D-7
Water Chemistry for Routine Delta Monitoring 1/9/95
Set up on 1/11/95

Treatment	Initial pH	EC (µmhos)	Hardness (mg/L)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)	-	0	0	-	-
Laboratory Control (Dilute EI)	7.83	184	82	-	-
Laboratory Control (SSEPAMH)	8.21	237	82	-	-
Ulatis Creek	7.71	150	68	-	-
French Camp Slough	7.73	217	68	-	-
Haas Slough	7.69	218	72	-	-
Paradise Cut	7.34	1490	436	-	-
Ryer Is. Main Drain	8.29	770	366	-	-
Duck Slough	7.76	650	234	-	-
Pierson Tract	8.05	780	298	-	-
Victoria Is. Drain	8.16	690	184	-	-
Upper Jones Is. Drain	8.09	700	184	-	-
Old River @ Tracy	7.64	750	-	-	-
Middle Roberts Is. Drain	6.90	1350	386	-	-
Mosher Slough	7.83	186	50	.087	.422

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-8
Water Chemistry for Routine Delta Monitoring 12/4/94 and 12/5/94
Set up on 12/6/94 and 12/7/94

Treatment	Initial pH	EC (µmhos)	Hardness (mg/L)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)	8.64	10	0	-	-
Laboratory Control (Dilute EI)	8.11	200	92	-	-
Laboratory Control (SSEPAMH)	7.82	222	84	-	-
SJR @ Vernalis	7.75	700	184	-	-
SR @ Greene's Landing	8.23	160	64	-	-
Ulatis Creek	7.72	300	112	ND	.133
French Camp Slough	7.63	359	96	-	-
Walthall Slough	7.44	840	268	-	-
Prospect Slough	7.90	600	212	-	-
Haas Slough	7.29	349	148	ND	.049
Paradise Cut	6.98	1500	508	-	-
Rock Slough	7.90	700	132	-	-
White Slough	7.78	342	108	-	-
Ryer Is. Main Drain	7.13	600	184	-	-
Duck Slough	7.94	448	168	-	-
Pierson Tract	7.55	381	152	-	-
Victoria Is. Drain	7.69	850	216	-	-
Upper Jones Is. Drain	7.22	690	180	-	-
Lindsay Slough	8.16	270	112	-	-
Old River @ Tracy	7.72	800	228	-	-
Middle Roberts Is. Drain	7.90	1840	556	-	-
Mosher Slough	8.00	160	68	ND	.403

\ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-9
Water Chemistry for Delta Rain Series 1/9/95-1/14/95
Set up on 1/14/95, 1/15/95

Treatment	pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Turbidity		TSS (mg/L)		Chlorpyrifos (µg/L)	Diazinon (µg/L)
				x	se	x	se		
Laboratory Control (Glass Distilled)	-	0	0	-	-	-0.53	0.15	-	-
Laboratory Control (Dilute EI)	7.98	191	88	-	-	-	-	-	-
Laboratory Control (SSEPAMH)	7.64	240	84	-	-	-	-	-	-
SJR @ Vernalis 1/9	7.84	520	-	-	-	-	-	-	.049
SJR @ Vernalis 1/10	7.83	600	-	-	-	-	-	-	-
SJR @ Vernalis 1/11	7.64	550	-	-	-	-	-	-	.091
SJR @ Vernalis 1/12	7.88	432	-	-	-	-	-	-	.054
SJR @ Vernalis 1/13	7.92	498	-	-	-	-	-	-	.095
SJR @ Vernalis 1/14	7.45	370	-	-	-	-	-	-	-
SR @ Greene's Landing 1/10	7.73	100	52	124.3	1.2	374.4	17.3	-	.047
SR @ Greene's Landing 1/11	7.72	90	44	125.0	0.0	327.3	11.2	-	-
SR @ Greene's Landing 1/12	8.20	90	42	102.7	0.6	191.7	29.6	-	.055
SR @ Greene's Landing 1/13	8.27	99	58	110.0	0.0	167.8	8.5	-	-
SR @ Greene's Landing 1/14	7.69	90	40	119.7	1.5	156.4	3.2	-	ND

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-10
Water Chemistry for Delta Rain Event 1/23/95-1/25/95
Set up on 1/26/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)	8.74	5	-	-	-
Laboratory Control (Dilute EI)	7.11	185	-	-	-
Laboratory Control (SSEPAMH)	7.40	210	-	-	-
SJR @ Vernalis 1/23	6.80	500	-	-	-
SJR @ Vernalis 1/24	7.08	500	-	-	-
SJR @ Vernalis 1/25	7.14	450	-	-	-
Old River @ Tracy 1/23	7.32	550	-	-	-

Table D-11
Water Chemistry for Routine Delta Monitoring 2/28/95 and 3/1/95
Set up on 3/2/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)	8.83	0	0	-	-
Laboratory Control (Dilute EI)	8.28	185	84	-	-
Laboratory Control (SSEP/MH)	8.05	217	84	-	-
SJR @ Vernalis	8.04	445	112	-	-
SR @ Greene's Landing	8.32	130	66	-	-
Ulatis Creek	8.10	610	324	-	-
French Camp Slough	8.34	180	86	-	-
Prospect Slough	7.92	500	244	-	-
Haas Slough	8.00	700	422	-	-
Paradise Cut	6.83	1850	658	-	-
Rock Slough	7.79	298	92	-	-
Sycamore Slough	7.71	550	210	ND	ND
White Slough	7.96	350	114	-	-
Ryer Island Main Drain	7.28	950	566	-	-
Duck Slough	7.72	1000	472	-	-
Pierson Tract	7.77	580	294	-	-
Victoria Island Drain	7.85	850	272	-	-
Upper Jones Island Drain	7.84	800	250	-	-
Mosher Slough	7.52	315	108	-	-
Old River @ Tracy	7.75	550	164	-	-
Lindsay Slough	8.13	270	120	-	-
Middle Roberts	7.65	2000	646	-	-

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-12
Water Chemistry for Delta Rain Event 3/1/95, 3/8/95 to 3/11/95
Set up on 3/10/95 and 3/11/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)				-	-
Laboratory Control (Dilute EI)	8.03	185	90	-	-
Laboratory Control (SSEPAMH)	8.36	255	86	-	-
SR @ Greene's Landing 3/9/95	8.06	98	46	-	ND
SR @ Greene's Landing 3/11/95	8.54	79	30	-	ND
SJR @ Vernalis 3/8/95	7.76	610	172	-	ND
SJR @ Vernalis 3/9/95	7.76	600	180	-	ND
SJR @ Vernalis 3/10/95	8.37	600	168	-	ND
SJR @ Vernalis 3/11/95	8.11	330	114	-	ND
Paradise Cut 3/9/95	7.51	1510	558	.146	ND
Ryer Island 3/9/95	7.44	1140	654	-	-
Mosher Slough 3/9/95	8.14	72	34	.107	.328
Ulatis Creek 3/9/95	7.89	135	96	.137	.293
French Camp Slough 3/9/95	7.92	178	84	-	-
Duck Slough 3/1/95	8.03	1200	472	-	-
Duck Slough 3/9/95	7.66	700	360	-	-
Old River @ Tracy 3/9/95	7.72	620	180	-	-

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-13
Water Chemistry for Delta Rain Event 3/13/95 and 3/15/95
Set up on 3/17/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)	-	-	0	-	-
Laboratory Control (Dilute EI)	-	-	90	-	-
Laboratory Control (SSEPAMH)	-	-	86	-	-
Ulatis Creek 3/13/95	-	-	208	ND	.056
Paradise Cut 3/15/95	-	-	536	.142	.125

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-14
Water Chemistry for Routine Delta Monitoring 3/21/95
Set up on 3/22/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)			0		
Laboratory Control (Dilute EI)	8.37	200	104		
Laboratory Control (SSEPAMH)	8.22	245	88		
SJR @ Vernalis	8.27	280	86	ND	ND
SR @ Greene's Landing	8.36	65	56		
Mokelumne River	8.72	74	36		
Ulatis Creek	8.04	465	186	.134	.046(11.5)
French Camp Slough	8.34	175	84	ND	ND
Old River @ Tracy	8.20	300	88		
Prospect Slough	8.45	100	56		
Cache Creek	8.08	300	188		
Paradise Cut	8.09	335	136		
Sycamore Slough	7.95	419	146		
Ryer Is. Main Drain	7.87	1250	728		
Duck Slough	7.93	900	388	.896	ND
Victoria Is. Drain	8.02	1100	288		
Upper Jones Is. Drain	7.89	1220	378		
Mosher Slough	8.59	60	36	.093	.316

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.
(#) Number in parentheses represents the CV% for the ELISA run which exceeds the acceptable value according to the lab QA manual but is within the manufacturer's recommended range.

Table D-15
Water Chemistry for Routine Delta Monitoring 5/1/95
Set up on 5/2/95 and 5/3/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)	9.01	5	0	-	-
Laboratory Control (Dilute EI)	8.23	210	88	-	-
Laboratory Control (SSEPAMH)	8.16	235		-	-
SJR @ Vernalis	8.56	120	56	-	-
SR @ Greene's Landing	7.91	75	34	-	-
Ulatis Creek	8.14	550	206	-	-
French Camp Slough	8.06	150	56	-	-
Prospect Slough	8.37	600	192	-	-
Haas Slough	8.54	700	328	-	-
Paradise Cut	7.97	250	74	-	-
Rock Slough	8.17	249	64	-	-
Sycamore Slough	8.09	110	40	-	-
Ryer Island Main Drain	8.00	235	104	-	-
Duck Slough	8.38	1100	420	-	-
Pierson Tract	8.07	500	212	-	-
Victoria Is. Drain	8.18	335	92	-	-
Upper Jones Is. Drain	8.20	750	198	-	-
Middle Roberts Is. Drain	8.41	650	192	.044 (14.9)	ND
Mosher Slough	7.93	95	32	.120	.417
Cache Creek @ 102	8.27	275	158	-	-
Old River @ Tracy	8.26	175	48	-	-
Lindsay Slough	8.17	345	128	-	-

ND Non Detect Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.
(#) Number in parentheses represents the CV% for the ELISA run which exceeds the acceptable value according to the lab QA manual but is within the manufacturer's recommended range.

Table D-16
Water Chemistry for Routine Delta Monitoring 5/31/95
Set up on 6/1/95 and 6/2/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)			0	-	-
Laboratory Control (Dilute EI)	8.29	207	88	-	-
Laboratory Control (SSEPAMH)	8.29	233	84	-	-
SJR @ Vernalis	8.49	117	40	-	-
SR @ Greene's Landing	8.21	95	40	-	-
Ulatis Creek	8.40	600	240	-	-
French Camp Slough	8.25	138	56	-	-
Prospect Slough	8.48	630	244	-	-
Cache Creek	8.66	610	252	-	-
Haas Slough	8.28	590	268	-	-
Paradise Cut	8.22	139	132	-	-
Rock Slough	8.29	170	248	-	-
Sycamore Slough	7.84	115	48	-	-
White Slough	8.23	340	116	-	-
Ryer Is. Drain	8.40	152	66	ND	ND
Duck Slough	8.39	900	360	-	-
Mosher Slough	8.26	133	56	ND	ND
Middle Roberts	8.12	520	154	ND	ND
Pierson Tract	7.82	407	160	-	-
Upper Jones	7.94	700	80	-	-
Victoria Is.	8.03	600	152	-	-
Old River @ Tracy			44	-	-
Lindsay Slough			116	-	-

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-17
Chemistry for Routine Delta Monitoring 6/27/95
Set up on 6/28/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)			0	-	-
Laboratory Control (Dilute EI)	8.36	180	89	-	-
Laboratory Control (SSEPAMH)	7.73	245	98	-	-
SJR @ Vernalis	8.07	375	116	-	-
SR @ Greene's Landing	7.43	90	34	-	-
Haas Slough	8.09	700	324	-	-
Pierson Tract	8.17	420	178	-	-
Ulatis Creek	8.86	700	272	-	-
Rock Slough	8.57	240	62	-	-
French Camp Slough	8.42	149	52	-	-
White Slough	8.22	298	86	-	-
Prospect Slough	8.36	570	200	-	-
Middle Roberts	8.03	600	172	-	-
Paradise Cut	7.98	800	274	-	-
Sycamore Slough	8.47	82	32	-	-
Ryer Is. Main Drain	8.63	151	70	-	-
Duck Slough	8.22	399	154	-	-
Victoria Is. Drain	8.25	435	116	-	-
Old River @ Tracy				-	-
Lindsay Slough				-	-
Upper Jones Is. Drain	8.35	500	152	-	-
Mosher Slough	8.45	150	68	-	-

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-18
Water Chemistry for Routine Delta Monitoring 7/17/95
Set up on 7/18/95

Treatment	Initial pH	EC (µmhos)	Total Hardness (mg/L as $CaCO_3$)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Laboratory Control (Glass Distilled)			0	-	-
Laboratory Control (Dilute EI)	8.31	195	96	-	-
Laboratory Control (SSEPAMH)	7.85	240	72	-	-
SJR @ Vernalis	8.25	115	36	-	-
SR @ Greene's Landing	8.50	100	40	-	-
Haas Slough	8.16	690	288	-	-
Pierson Tract	7.67	310	124	-	-
Ulatis Creek	8.38	510	216	-	-
Rock Slough	7.33	230	60	-	-
French Camp Slough	7.45	211	76	-	-
White Slough	8.03	170	60	-	-
Prospect Slough	8.42	550	204	-	-
Middle Roberts	7.87	690	188	-	-
Paradise Cut	7.84	180	52	-	-
Sycamore Slough	8.37	82	24	-	-
Ryer Is. Main Drain	7.79	125	72	-	-
Duck Slough	7.95	140	60	-	-
Victoria Is. Drain	7.51	420	100	-	-
Old River @ Tracy				-	-
Lindsay Slough				-	-
Upper Jones Is. Drain	7.57	510	128	-	-
Mosher Slough	7.79	150	64	-	-

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table D-19
Cache Creek Water Chemistry

Site	pH	EC (µmhos)	Hardness (mg/l as CaCO3)	TSS	Turbidity
Cache Creek @ 102 3/3/95	7.72	550	322	29±0	8
Cache Creek @ 102 3/9/95	7.94	180	170	8310±458	50*
Cache Creek @ 102 3/10/95	ND	ND	136	3067±30	243*
Cache Creek @ 102 3/11/95	8.04	170	128	2128±33	200*
Cache Creek @ 102 3/13/95	7.86	282	172	1211±25	250*
Cache Creek @ 102 3/21/95	7.91	225	188	1223±43	ND
Cache Creek @ 102 5/2/95	8.27	275	ND	348±11	ND
Cache Creek @ Clear Lake 3/10/95	7.52	220	136	73±5	26
Cache Creek @ Rumsey 3/13/95	7.91	272	174	601±35	220*
North Fork Cache Creek 3/10/95	8.14	123	92	2547±112	225*
North Fork Cache Creek 3/13/95	8.14	144	88	616±6	220*
Willow @ 105 3/9/95	7.97	173	126	2551±9	150*
W. Yolo Bypass 3/10/95	8.11	90	62	791±29	310*
E. Yolo Bypass 3/10/95	7.88	246	148	1553±2	250*
Bear Creek @ Hwy 20 3/10/95	8.19	383	196	564±17	160*
Clearlake 3/13/95	8.05	240	138	18±1	9.3
Bear Creek 3/13/95	7.87	455	256	310±8	120*
Willow Slough 3/13/95	7.92	146	84	395±5	250*
Putah Creek 3/13/95	7.78	299	172	295±4	175*
Sutter Bypass 3/13/95	7.94	73	46	109±3	117*
Corona Mine 3/13/95*	8.26	850	652	441±6	ND

* Corona Mine water chemistry was measured two months after collection (5/3/95).
* Turbidity values accompanied by an asterisk are questionable due to the heavy sediment load.
ND = no data

APPENDIX E

ORGANIC CHEMICAL ANALYSIS

Table E-1. Summary of dissolved pesticide concentrations detected in this study by USGS. The Minimum Detection Limits (MDL's in µg/L) of pertinent analytes are shown in the table on the left and the percent recovery of spiked surrogate compounds are shown in the table on the right.

	Pesticide Analysis in µg/L								
Sample	Car	Cbf	Chl	Dia	Eth	Fon	Mal	MPt	Pro
Min. Detect. Limits	.046	.013	.005	.008	.012	.008	.010	.035	.006
Paradise Cut 6/3/94				.009					
OR @ Tracy 6/3/94				.015		.007			
Vernalis 6/3/94				.041			.012		
Paradise Cut 7/19/94			.068						
Ulatis Ck. 9/1/94			.058						
French Camp 9/2/94			.13				.021		
French Camp 9/7/94			.096	.015			.018		
Ulatis Ck. 9/12/94			.09						
Ulatis Ck. 9/18/94			.048				.025		
Ulatis Ck. 11/7/94			.047	.09			.061		

% Recovery	
ADS	DiS
--	--
200	100
200	100
200	100
100	70
100	70
100	70
100	70
100	70
100	70
90	70

ID	Analyte
Car	Carbaryl (Carbamate)
Cbf	Carbofuran (Carbamate)
Chl	Chlorpyrifos (OP Pesticide)
Dia	Diazinon (OP Pesticide)
Eth	Ethoprop (OP Pesticide)
Fon	Fonofos
Mal	Malathion (OP Pesticide)
MPt	Methyl-Parathion (OP Pesticide)
Pro	Propargite (Sulfite Ester)
ADS	Alpha D6 HCH Surrogate
DiS	Diazinon Surrogate

Table E-2. Summary of dissolved herbicide concentrations detected in this study by the USGS.
The Minimum Detection Limits (MDL's in µg/L) of pertinent analytes are shown in the main table and the percent recovery of the surrogate compound is shown in the table on the right.

	Herbicide Analysis in µg/L																% Rec
Sample	Ala	Atr	But	Cya	DCP	DeA	EPT	Met	Mol	Nap	Peb	Prn	Prm	Sim	Teb	Tri	TeS
Min. Detect. Limits	.009	.017	.008	.013	.004	.005	.005	.009	.007	.010	.009	.009	.008	.008	.015	.012	--
Paradise Cut 6/3/94		.027					.059	.29	.011		.005			.020		.008	120
OR @ Tracy 6/3/94				.009			.23	.11	.009	.016	.01			.019		.005	104
Vernalis 6/3/94				.049			.067	.14			.026			.015		.008	109
Duck Sl. 7/12/94									.018					.018			107
Paradise Cut 7/19/94				.046			.14	.41		.015				.041		.031	107
Ulatis Ck. 9/1/94		.029					.065	.04						.068			105
French Camp 9/2/94							1.5	.3						.02			108
French Camp 9/7/94				.031			.41	.21	.01					.03			104
Ulatis Ck. 9/12/94	.01	.044					.045	.028						.06			115
Ulatis Ck. 9/18/94		.029					.021	.009						.06			108
Ulatis Ck. 11/7/94		.8			.005		.16	.019			.011		.066	.55			108

ID	Analyte
Ala	Alachlor
Atr	Atrazine
But	Butylate
Cya	Cyanazine
DCP	DCPA
DeA	Deethyl-Atrazine

ID	Analyte
EPT	EPTC
Met	Metolachlor
Mol	Molinate
Nap	Napropamide
Peb	Pebulate
Prn	Pronamide

ID	Analyte
Prm	Prometon
Sim	Simazine
Teb	Tebuthiuron
Tri	Trifluralin
TeS	Terbuthylazine Surrogate

Table E-3. Chemical Analysis by APPL Inc. using Gas or Liquid Chromatograph.

	Pesticide Analysis in µg/L					
Sample	Chlorpyrifos	Diazinon	Diuron	Carbofuran	Simazine	Carbaryl[1]
Sycamore Slough 2/28/95			ND		ND	
Paradise Cut 3/9/95			0.4		1.2	
Mosher Slough 3/9/95	0.10	0.27				
Sycamore Slough 3/13/95			1.8		2.1	
Paradise Cut 3/15/95	0.08					
Duck Slough 3/21/95	0.49		0.8		2	
Mosher Slough 2/21/95	0.05	0.19				
Ulatis Creek 3/21/95	0.10	0.04[1]	0.4[1]	0.8		
Sycamore Slough 3/21/95			1.0		0.9	
Ryer 5/31/95					0.9	7.0

1. Estimated value below detection limit.
ND= non detect.

Table E-4. Organic Chemical Analysis associated with Paradise Cut conducted by USGS using Gas Chromatography.

	Organic Chemical Analysis in µg/L							
Sample	Eptam	Butylate	Simazine	Carbofuran	Diuron	Atrazine	Fonofos	Metoalchlor
Duck Slough 1/9/95			0.2		9.1			
Victoria Island 1/9/95			6.6		5.2			
Paradise Cut 3/1/95			0.5		2.4			
Paradise Cut 3/9/95			0.5		1.1			
Ulatis Creek 3/9/95			2.7		4.9			
MacArthur Blvd. 6/14/94	0.213	0.0	0.064	0.0		0.0	0.589	0.210
Drain from Alfalfa field 6/22/94	0.0	0.0	0.0	0.146		0.0	0.0	0.043
Eastern Stewart's Tract 6/14/94	0.152	0.050	0.070	0.055		0.024	0.0	0.329
Tile Drain into Paradise Cut 6/22/94	2.237	0.0	0.0	0.0		0.0	0.0	0.007

APPENDIX F

INDIVIDUAL *CERIODAPHNIA* TIE SUMMARIES

Table F-1
Paradise Cut 7/12/94 3-day *Ceriodaphnia* Dilution Series
Set up on 7/15/94
The results of this experiment show that toxicity remained down to a 25% dilution.

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Initial pH	Final pH
	x	s.e.			
Laboratory Control	4.7[P]	0.4	0[P]	7.75	9.2
Paradise Cut 25%	0.0	0.0	100 (4)	7.46	8.2
Paradise Cut 50%	0.0	0.0	100 (4)	7.91	8.2
Paradise Cut 100%	0.0	0.0	100 (1)	7.96	9.1

P. The laboratory control met all EPA criteria for test acceptability.
1. Highlighted areas indicate an increase in mortality relative to the laboratory control water. The reproductive endpoint was not analyzed because of the short testing period. The mortality endpoint was analyzed using Fisher's Exact Test.
(#) Number in parentheses represents days to 100% mortality.

Table F-2

Paradise Cut 7/12/94 96-hour *Ceriodaphnia* Phase I TIE[1]

Set up on 7/17/94

The results of this experiment and chemical analysis imply that toxicity was due to the presence of chlorpyrifos.

Treatment[3]	% Mortality for each day of the test[2,3]				Conclusions	Chlorpyrifos (µg/l)		Diazinon (µg/l)		Final pH
	1	2	3	4		ELISA	GC/MS	ELISA	GC/MS	
Laboratory Control				0	Control met EPA criteria for test acceptability.					8.65
Laboratory Control C8 Blank				15	No artifactual toxicity present in control blanks.					8.53
Laboratory Control w/ .5% MeOH				0						8.35
Laboratory Control w/ 5 mg/l EDTA*				0						8.40
Laboratory Control w/ 30 mg/l $Na_2S_2O_3$*				0						8.42
Laboratory Control w/ 200 ppb PBO				5						8.59
Laboratory Control w/ .5% Eluate (1.6X)	50	100	100	100	High mortality confirms toxicity is due to an organic					8.40
Paradise Cut	100	100	100	100	Toxicity detected	0.550	0.444	ND	0.043	8.16
Paradise Cut .45 µm Filtered	75	100	100	100	Toxicant is dissolved					7.69
Paradise Cut PCCA				0	Low mort. suggests that an organic is responsible for toxicity					8.03
Paradise Cut w/ 1.25 mg/l EDTA*	100	100	100	100	Toxicant remaining suggests that the toxicant is not a metal					8.19
Paradise Cut w/ 2.5 mg/l EDTA*	100	100	100	100						8.22
Paradise Cut w/ 5.0 mg/l EDTA*	47	100	100	100						8.02
Paradise Cut w/ 10.0 mg/l EDTA*	100	100	100	100						8.23
Paradise Cut w/ 7.5 mg/l $Na_2S_2O_3$*	100	100	100	100						8.30
Paradise Cut w/ 15.0 mg/l $Na_2S_2O_3$*	80	100	100	100						8.25
Paradise Cut w/ 30.0 mg/l $Na_2S_2O_3$*	87	100	100	100						7.93
Paradise Cut w/ 60.0 mg/l $Na_2S_2O_3$*	100	100	100	100						8.32
Paradise Cut w/ 200 ppb PBO	0	0	80	100	Delayed mort. suggests that a metabolically activated compound is responsible for toxicity					7.70

1. Four replicates (except three where noted *) each containing 20 mls of sample and five Ceriodaphnia. Animals were transferred into fresh water every 48 hours. The standard food concentrations were added at these times.
2. Highlighted cells indicate areas of significant interest. No statistics were done.
3. 1000 ml of Paradise Cut water was run through a C8 SPE column at a rate of 5 to 6 ml/min. The column was extracted using 3.1 ml of MeOH to produce each fraction 322 times as concentrated as the ambient water.

PCCA Post C8 Column Application

Table F-3
Paradise Cut 7/12/94 8-day[4] *Ceriodaphnia* Phase II TIE[1], Paradise Cut 7/19/94
Set up on 7/19/94
The results of this experiment and chemical analysis imply that toxicity was due to the presence of chlorpyrifos.

Treatment[3]	% Mortality for each day of the test[2,3]								Conclusions	Final pH
	1	2	3	4	5	6	7	8		
Laboratory Control								0	Control met EPA criteria for test acceptability.	8.28
Laboratory Control w/ .5% MeOH								0	No artifactual toxicity present in control blanks.	8.25
Laboratory Control w/ 1% MeOH								0		
Laboratory Control w/ 50% Fraction (1.67X)								0	These fractions tested non-toxic.	8.00
Laboratory Control w/ 70% Fraction (1.67X)								0		7.94
Laboratory Control w/ 75% Fraction (1.67X)								0		7.97
Laboratory Control w/ 80% Fraction (1.67X)	100	100	100	100	100	100	100	100	Toxicant present in this fraction.	8.50
Laboratory Control w/ 85% Fraction (1.67X)								0	These fractions tested non-toxic.	8.02
Laboratory Control w/ 90% Fraction (1.67X)								0		8.05
Laboratory Control w/ 95% Fraction (1.67X)			60	70	80	80	80	80	Toxicant present in this fraction.	8.07
Laboratory Control w/ 100% Fraction (1.67X)								0	These fractions tested non-toxic.	8.06
Laboratory Control w/ 50% Fraction (3.3X)[5]					10					
Laboratory Control w/ 70% Fraction (3.3X)[5]					0					
Laboratory Control w/ 75% Fraction (3.3X)[5]					0					
Laboratory Control w/ 80% Fraction (3.3X)[5]	100	100	100	100	100				Toxicant present in these fractions.	
Laboratory Control w/ 85% Fraction (3.3X)[5]	30	100	100	100	100					
Laboratory Control w/ 90% Fraction (3.3X)[5]					0				These fractions tested non-toxic.	
Laboratory Control w/ 95% Fraction (3.3X)[5]					0					
Laboratory Control w/ 100% Fraction (3.3X)[5]					0					
Paradise Cut 7/12/94 6.25%[5]					30				Acute toxicity detected down to a 12.5% dilution	
Paradise Cut 7/12/94 12.5%[5]					100					
Paradise Cut 7/12/94 25%[5]	30	100	100	100	100					
Paradise Cut 7/12/94 50%[5]	100	100	100	100	100					
Paradise Cut 7/12/94 100%[5]	100	100	100	100	100					
Paradise Cut 7/19/94 100%*					53	89	95	100	Chronic toxicity detected	7.68

1 Two replicates (except where noted *, there are 4) each containing 20 mls of sample and five Ceriodaphnia Daphnids were exposed to food for four hours a day
2 Highlighted cells indicate areas of significant interest No statistics were done
3 1000 ml of Paradise Cut water was run through a C8 SPE columnat a rate of 5 to 6 ml/min The column was extracted using 3.0 ml of MeOH to produce each fraction 333 times as concentrated as the ambient water
4. The Paradise Cut dilution series and the 3 3X fraction series was terminated at 48 hours
5. These treatments were scored and taken down at 120 hours.

Table F-4
Duck Slough 7/12/94 7-Day *Ceriodaphnia* Primary Phase I TIE[1]
Set up on 7/22/94
The results of this experiment imply that toxicity was **not** due to a non polar organic chemical.

Treatment[3]	Reproduction[2] (neonates/adult)		Mortality(%)[3]	Conclusions	Final pH	Final EC (µmhos)
	x	s.e.				
Laboratory Control	27.2	0.9	0.0	Control met EPA criteria for test acceptability.	7.77	215
Laboratory Control C8 Blank	27.8	0.8	0.0	No artifactual toxicity in control blank.	7.89	210
Laboratory Control w/.5% MeOH	18.5	1.7	0.0	Manipulation okay.	8.12	210
Laboratory Control w/.5% Elu. (1.5X)	21.8	1.8	0.0	Eluate non-toxic at 1.5X.	8.19	205
Duck Slough	5.7	0.4	0.0	Toxicity detected.	7.46	170
Duck Slough C8 Solid Phase Extracted Water	9.1	1.1	0.0	Toxicity remaining suggests an organic was not responsible for toxicity.	7.57	170

1. Ten replicates with 11 mls of sample and one Ceriodaphnia each.
2. Highlighted areas indicate a significant reduction in reproduction relative to the Dilute EI control water. The reproductive endpoint was analyzed using Dunnett's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
3. 1200 ml of Duck Slough water was run through a C8 SPE column at a rate of 5 to 6 ml/min.The column was extracted using 4.0 ml of MeOH to produce an eluate 300 times as concentrated as the ambient water.

Table F-5

Duck Slough 7/12/94 7-Day *Ceriodaphnia* Secondary Phase I TIE[1]
Set up on 8/2/94

Treatment	Reproduction[2] (neonates/adult)		Mortality(%)[2]	Conclusions	Final pH @ 24 hrs	EC (µmhos)
	x	s.e.				
Laboratory Control	29.2	0.6	0.0	Control met EPA criteria for test acceptability.	8.39	205
Laboratory Control w/ 8 mg/l EDTA	18.9	1.6	10.0	EDTA concentration too high.	8.50	205
Laboratory Control Special Feeding	0.7	0.3	0.0	Four hour feeding does not support daphnid reproduction.	8.47	205
Duck Slough	9.1	0.6	0.0	Sample still toxic after extensive storage time.	8.02	170
Duck Sl. w/ 3 mg/l EDTA	4.4	0.9	0.0	Toxicity remaining suggests the toxicant was not a metal. Also, EDTA concentrations might be acting additively with toxicant..	8.13	170
Duck Sl. w/ 8 mg/l EDTA	1.0	0.4	10.0		8.24	170

1. Standard EPA feeding procedures were used during this test except for the special feeding treatment which was exposed to food for four hours a day.
2. Highlighted areas indicate a significant reduction of reproduction relative to the Dilute EI control water. The reproductive endpoint was analyzed using Dunnett's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table F-6
Paradise Cut 7/19/94 6-day *Ceriodaphnia* Phase I TIE[1,2]
Set up on 8/4/94
The results of this experiment imply that toxicity was due to a non polar organic chemical.

Treatment[4]	% Mortality for each day of the test[3]						Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 24 hrs	Final EC (µmhos)
	1	2	3	4	5	6					
Laboratory Control						0	Control met EPA criteria for test acceptability.			8.63	230
Laboratory Control C8 Blank						0	No artifctual toxicity present in control blanks.			8.50	230
Laboratory Control w/ .5% MeOH						10				8.48	205
Laboratory Control w/ 3 mg/l EDTA					10	10				8.45	230
Laboratory Control w/ 8mg/l EDTA						0				8.49	230
Laboratory Control w/ .5% Eluate (3X)			100	100	100	100	High mortality confirms toxicity is due to an organic			8.44	230
Paradise Cut			20	100	100	100	Toxicity detected.	ND	ND	7.72	1400
Paradise Cut C8 Solid Phase Extracted Water						0	Low mortality suggests toxicant is an organic			7.93	1400
Paradise Cut w/ 3 mg/l EDTA			60	100	100	100	Toxicity remaining suggests that a metal was not responsible for toxicity.			7.98	1400
Paradise Cut w/ 8mg/l EDTA			60	100	100	100				8.07	1400

1. Five replicates each containing 20 mls of sample and two Ceriodaphnia.
2. Daphnids only were fed for four hours daily at the standard EPA suggested concentration.
3. Highlighted cells indicate areas of significant interest. No statistics were done.
4. 1800 ml of Paradise Cut water was run through each of two C8 SPE columns at a rate of 5 to 6 ml/min. The column was extracted using 3.0 ml of MeOH to produce an eluate 600 times as concentrated as the ambient water. The post C8 column application waters and eluates of each column were combined to provide sufficient testing volumes.

ND Non Detect: Detection limitis for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-7

Paradise Cut 7/19/94 6-day[5] *Ceriodaphnia* Preliminary Phase II TIE[1,2]

Set up on 8/12/94

The results of this experiment and of chemical analysis imply that toxicity was due to the presence of chlorpyrifos.

Treatment[4]	% Mortality for each day of the test[3]						Conclusions	Final pH @ 48 hrs
	1	2	3	4	5	6		
Laboratory Control*						0	Control met EPA criteria for test acceptability.	8.30
Laboratory Control w/ 100 ppb PBO				7	7	7	No artifactual toxicity present in control blanks.	8.28
Laboratory Control w/ 1% MeOH					7			8.34
Laboratory Control w/ 50% Fraction (6X)			7	7	7			8.32
Laboratory Control w/ 70% Fraction (6X)					0		Toxicant not present in these fractions.	8.43
Laboratory Control w/ 75% Fraction (6X)					0			8.36
Laboratory Control w/ 80% Fraction (6X)		57	100	100	100		Toxicant present in this fraction.	8.41
Laboratory Control w/ 85% Fraction (6X)					0			8.40
Laboratory Control w/ 90% Fraction (6X)					7		Toxicant not present in these fractions.	8.50
Laboratory Control w/ 95% Fraction (6X)				7	7			8.45
Laboratory Control w/ 100% Fraction (6X)	7	21	36	50	64		Second toxicant present in this fraction.	8.47
Paradise Cut*			53	73	100	100	Toxicity detected.	7.90
Paradise Cut w/100 ppb PBO			7	14	14	14	Low mortality suggests toxicant is an OP pesticide.	8.04

1. Three replicates (except four where noted *) each containing 20 mls of sample and five Ceriodaphnia.
2. Daphnids only were fed for four hours daily at the standard EPA suggested concentration.
3. Highlighted cells indicate areas of significant interest. No statistics were done.
4. 1800 ml of Paradise Cut water was run through a C8 SPE column at a rate of 5 to 6 ml/min. The column was extracted using 3.0 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.
5. Due to the limited amount of eluate, the fraction series and MeOH control were run only 5 days.

Table F-8
Paradise Cut 7/19/94 96-Hour *Ceriodaphnia* Secondary Phase II TIE[1,2]
Set up on 8/18/94
The results of this experiment and of chemical analysis imply that toxicity was due to the presence of chlorpyrifos.

Treatment[4]	% Mortality for each day of the test[3]			Conclusions	Final pH
	1	2	3		
Laboratory Control			10	Control met EPA criteria for test acceptability.	7.87
Laboratory Control w/ 1% MeOH			0	No artifactual toxicity present in control blanks.	7.84
Laboratory Control w/ 1% MeOH and 200 ppb PBO			10		7.85
Laboratory Control w/ 1% 80% Fraction		100	100	Eluate contains toxicant.	
Laboratory Control w/ 1% 80% Fraction and 200 ppb PBO			0	Low mortality relative to 80% fraction suggests an OP pesticide is responsible for toxicity	7.85

1. Two replicates each containing 20 mls of sample and five *Ceriodaphnia*.
2. Daphnids only were fed for four hours daily at the standard EPA suggested concentration.
3. Highlighted cells indicate a significant areas of interest. No statistics were done.
4. 1800 ml of Paradise Cut water was run through a C8 SPE column at a rate of 5 to 6 ml/min. The column was extracted using 3.0 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

Table F-9
French Camp 9/7/94 follow-up *Ceriodaphnia* Test[1]
Set up on 9/7/94
The results of this experiment imply that toxicity persisted in the field for at least five days.

Treatment	Mortality (%)	Initial pH	Final pH @ 24 hrs	EC (µmhos)
Laboratory Control	0.0[P]	8.48	8.26	202
French Camp Slough	100(2)	8.38	8.19	265

P. The laboratory control met all EPA criteria for test acceptability.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the Dilute EI control water. The reproductive endpoint was analyzed using Dunnett's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
Number in parentheses represents day to 100% mortality.

Table F-10
French Camp Slough 9/2 & 9/7/94 4-day *Ceriodaphnia* Phase I + PBO TIE[1,2]
Set up on 9/9/94
The results of this experiment and chemical analysis imply that toxicity was due to the presence of chlorpyrifos.

Treatment[4]	% Mortality for each day of the test[3]				Conclusions	Final pH @ 48 hrs
	1	2	3	4		
Laboratory Control *				0	Control met EPA criteria for test acceptability.	7.88
Laboratory Control C8 blank				0	No artifactual toxicity present in control blanks.	7.80
Laboratory Control + 0.5% MeOH				0		7.81
Laboratory Control + 200ppb PBO			7	7		7.87
Laboratory Control + 0.5% eluate @ 3X	100	100	100	100	High mortality confirms that toxicity is due to a non polar organic chemical.	-
Laboratory Control + 0.25% eluate @ 1.5X		100	100	100		7.85
French Camp Slough 9/2		100	100	100	Toxicity detected.	7.82
French Camp 9/2 C8 Solid Phase Extracted Water				0	Decrease in mortality suggests that toxicity is due to a non polar organic chemical.	7.89
French Camp 9/2 + 200ppb PBO				0	Decrease in mortality suggests that toxicity is due to a metabolically activated pesticide.	8.08
French Camp 9/7*	5	100	100	100	Toxicity detected.	7.95
French Camp 9/7 + 200ppb PBO*				0	Decrease in mortality suggests that toxicity is due to a metabolically activated pesticide.	8.00
50% French Camp 9/7*			95	95	Toxicity detected at a 50% dilution.	8.09
50% French Camp 9/7 + PBO*			5	5	Decrease in mortality suggests that toxicity is due to a metabolically activated pesticide.	8.17

1. Three replicates each (except four where noted *) containing 20 mls of sample and five *Ceriodaphnia*.
2. Daphnids only were fed for four hours daily at the standard EPA suggested concentration.
3. Highlighted cells indicate areas of significant interest. No statistical analysis were done.
4. 1800 ml of Sample water was run through a C8 SPE columns at a rate of 10 ml/min. The column was extracted using 3.0 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

Table F-11
French Camp 9/2 & 9/7/94, Ulatis 9/13/94 4-day *Ceriodaphnia* Phase II TIE[1,2]
Set up on 9/14/94
The results of this experiment and chemical analysis imply that toxicity in the French Camp Slough samples was due to the presence of chlorpyrifos.

Treatment[4]	% Mortality for each day of the test[3]				Conclusions	Final pH
	1	2	3	4		@ 48 hrs
Laboratory Control		5	5	5	Control met EPA criteria for test acceptability.	8.01
Laboratory Control C8 blank for French Camp (FC) 9/2				0	No artifactual toxicity present in control blanks.	8.04
Laboratory Control C8 blank for French Camp 9/7			25	25		8.04
Laboratory Control + 0.5% MeOH	20	40	40	40	Artifactual toxicity due to addition of MeOH.	8.06
FC 9/2 50% fraction @ 3X				0	Absence of toxicity in most fractions demonstrates that the control	8.05
FC 9/2 70% fraction @ 3X				0	MeOH blank toxicity is artifactual.	8.05
FC 9/2 75% fraction @ 3X				0		8.00
FC 9/2 80% fraction @ 3X	100	100	100	100	Toxicant present in the 80% fraction.	-
FC 9/2 85% fraction @ 3X				0		8.05
FC 9/2 90% fraction @ 3X	40	40	40	40		8.09
FC 9/2 95% fraction @ 3X		5	5	10		8.19
FC 9/2 100% fraction @ 3X				0		8.14
FC 9/7 50% fraction @ 3X				0		8.08
FC 9/7 70% fraction @ 3X				0		8.07
FC 9/7 75% fraction @ 3X		5	10	10		8.03
FC 9/7 80% fraction @ 3X	100	100	100	100	Toxicant present in the 80 and 85% fractions.	-
FC 9/7 85% fraction @ 3X		35	65	65		8.10
FC 9/7 90% fraction @ 3X*				0		7.98
FC 9/7 95% fraction @ 3X	10	15	15	15		7.94
FC 9/7 100% fraction @ 3X			5	10		7.94
Ulatis Creek 9/13		37	95	100	Toxicity detected.	7.99

1. Four replicates each (except three where noted *) containing 20 mls of sample and five *Ceriodaphnia*.
2. Daphnids only were fed for four hours daily at the standard EPA suggested concentration.
3. Highlighted cells indicate areas of significant interest. No statistical analysis were done.
4. 1800 ml of Sample water was run through a C8 SPE columns at a rate of 10 ml/min. The column was extracted using 3.0 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

Table F-12
French Camp 9/2 and 9/7/94 5-day *Ceriodaphnia* Phase II TIE[1,2]
Set up on 9/17/94
The results of this experiment imply that toxicity in the French Camp samples was due to a metabolically activated pesticide.

Treatment[4]	% Mortality for each day of the test[3]					Conclusions	Final pH @ 48 hrs
	1	2	3	4	5		
Laboratory Control				5	5	Control met all EPA criteria for test acceptability.	8.43
Laboratory Control +0.5% MeOH					0	No artifactual toxicity in the control blanks.	8.37
Laboratory Control +0.5% MeOH + 200 ppb PBO					0		8.36
French Camp 9/2 80% fraction @ 3x	100	100	100	100	100	Toxicity detected.	-
French Camp 9/2 80% fraction @ 3x + PBO					0	Decrease in mortality relative to ambient water suggests an metabolically activated OP pesticide is responsible for toxicity.	8.34
French Camp 9/7 80% fraction @ 3x	100	100	100	100	100	Toxicity detected.	-
French Camp 9/7 80% fraction @ 3x + PBO					0	Decrease in mortality relative to ambient water suggests an metabolically activated OP pesticide is responsible for toxicity.	8.35

1. Four replicates with 20 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml os Sample water was run through a C8 SPE column at a rate of 10 ml/min. The column was extracted using 3.0 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/Lfor Diazinon.

Table F-13
Ulatis 9/1, 9/13 & 9/18/94 7-day *Ceriodaphnia* PBO TIE[1,2]
Set up on 9/19/94
The results of this experiment imply that toxicity was due to a metabolically activated pesticide.

Treatment	% Mortality for each day of the test[3]							Conclusions	Final pH @ 48 hrs
	1	2	3	4	5	6	7		
Laboratory Control *							0	Control did not meet all EPA criteria for test acceptability.	8.03
Laboratory Control + 200ppb PBO						5	5	No artifactual toxicity present in control blanks.	8.03
Ulatis Creek 9/1			5	60	100	100	100	Toxicity detected.	7.77
Ulatis Creek 9/1 + 200ppb PBO							0	Decrease in mortality suggests that toxicity was due to a metabolically activated OP pesticide.	8.02
Ulatis Creek 9/13		20	100	100	100	100	100	Toxicity detected.	7.86
Ulatis Creek 9/13 + 200ppb PBO			5	5	10	10	10	Decrease in mortality suggests that toxicity was due to a metabolically activated OP pesticide.	8.06
Ulatis Creek 9/18			20	30	75	75	75	Toxicity detected.	7.92
Ulatis Creek 9/18 + 200ppb PBO							0	Decrease in mortality suggests that toxicity was due to a metabolically activated OP pesticide.	8.10

1. Four replicates each (except three where noted *) containing 20 mls of sample and five Ceriodaphnia.
2. Daphnids only were fed for four hours daily at the standard EPA suggested concentration.
3. Highlighted cells indicate areas of significant interest. No statistical analysis were done.

Table F-14
Ulatis Creek 11/7/94 and 11/11/94 7-Day *Ceriodaphnia* Preliminary PBO TIE[1,2]
Set up on 11/12/94
The results of this experiment imply that toxicity in the Ulatis 7 November 1996 sample was due to a metabolically activated pesticide.

Treatment	% Mortality for each day of the test							Conclusions	Chlorpyrifos (µg/L) ELISA	Diazinon (µg/L) ELISA	Final pH @ 24 hrs
	1	2	3	4	5	6	7				
Laboratory Control							6.7	Control met EPA criteria for test acceptability.			8.57
Laboratory Control + PBO							0	No artifactual toxicity present in control blanks.			8.47
Ulatis Cr. 11/7		100	100	100	100	100	100	100% mortality detected in 48 hours suggests acute toxicity	0.103	0.119	8.39
Ulatis Cr. 11/7 + PBO			7	7	13	13	33	Delay in mortality suggests a metabolically activated pesticide is responsible for toxicity.			8.31
Ulatis Cr. 11/11							0	No toxicity detected.	ND	ND	8.52
Ulatis Cr. 11/11 + PBO							0	No artifactual toxicity resulting from addition of PBO.			8.50

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statitistical analyses were done.

Table F-15
Ulatis 9/13/94 and 11/7/94 7-day *Ceriodaphnia* Phase II TIE[1,2]
Set up on 11/16/94
The results of this experiment and chemical analysis imply that toxicity was due to the presence of chlorpyrifos. Analyses by GC/MS revealed chlorpyrifos concentrations at 0.090 µg/L and 0.047 µg/L for 13 September and 7 November, respectively.

Treatment[4]	% Mortality for each day of the test[3]							Conclusions	Final pH
	1	2	3	4	5	6	7		@ 48 hrs
Laboratory Control							0	Control met EPA criteria for test acceptability.	7.44
Laboratory Control + 1% MeOH							0	No artifactual toxicity present in control blanks.	8.26
Laboratory Control C8 blank for Ulatis 11/7					7	7	7		8.41
Ulatis 11/7 C8 Solid Phase Extracted Water				7	7	7	7		8.22
Ulatis 9/13 50% fraction @ 6X							0		8.12
Ulatis 9/13 70% fraction @ 6X							0		8.25
Ulatis 9/13 75% fraction @ 6X							0		8.20
Ulatis 9/13 80% fraction @ 6X	20	100	100	100	100	100	100	Toxicant present in the 80 and 85% fractions.	8.19
Ulatis 9/13 85% fraction @ 6X						10	40		8.18
Ulatis 9/13 90% fraction @ 6X		20	30	30	30	30	30		8.19
Ulatis 9/13 95% fraction @ 6X					10	10	10		8.29
Ulatis 9/13 100% fraction @ 6X		10	10	10	10	10	10		8.24
Ulatis 11/7 50% fraction @ 5X							0		8.22
Ulatis 11/7 70% fraction @ 5X	10	30	90	100	100	100	100		8.20
Ulatis 11/7 75% fraction @ 5X			20	100	100	100	100		8.22
Ulatis 11/7 80% fraction @ 5X	100	100	100	100	100	100	100	Toxicant present in the 70, 75 and 80% fractions.	7.85[+]
Ulatis 11/7 85% fraction @ 5X			10	10	10	10	10		8.24
Ulatis 11/7 90% fraction @ 5X							0		8.22
Ulatis 11/7 95% fraction @ 5X	10	11	11	11	44	44	44		8.32
Ulatis 11/7 100% fraction @ 5X			10	10	20	20	40		8.27

1. Three replicates each containing 20 mls of sample and five *Ceriodaphnia*.
2. Daphnids only were fed for four hours daily at the standard EPA suggested concentration.
3. Highlighted cells indicate areas of significant interest. No statistical analysis were done.
4. 1800 ml of Sample water was run through a C8 SPE columns at a rate of 10 ml/min. The column was extracted using 3 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

\+ pH taken at 24 hours.

Table F-16
Ulatis Creek 12/4/94 4-Day *Ceriodaphnia* PBO Test[1,2]
Set up on 12/10/94
The results of this experiment and chemical analysis imply that toxicity was due to the presence of a metabolically activated pesticide.

Treatment	% Mortality for each day of the test[3]				Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 48hrs
	1	2	3	4				
Laboratory Control				0	Control met all EPA criteria for test acceptability.			7.73
Laboratory Control + 200 ppb PBO			20	53	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Ulatis sample with the addition of PBO suggests the presence of a metabolically activated pesticide(s).			7.74
Ulatis Creek		47	100	100	Toxicity detected.	ND	.133	7.99
Ulatis Creek + 200 ppb PBO								8.07

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-17
Mosher Slough 12/4/94 and Ulatis Creek 12/12/94 7-Day *Ceriodaphnia* PBO Test[1,2]
Set up on 12/15/94
The results of this experiment and chemical analysis imply that toxicity was due to the presence of diazinon.

Treatment	% Mortality for each day of the test[3]							Conclusions	Chlorpyrifos (µg/L) ELISA	Diazinon (µg/L) ELISA	Final pH @ 48 hrs
	1	2	3	4	5	6	7				
Laboratory Control							0	Control met all EPA criteria for test acceptability.			8.03
Laboratory Control + 200 ppb PBO							0	No artifactual toxicity in control blank.			8.06
Mosher Sl. 12/4/94		100	100	100	100			Toxicity detected	ND	.403	8.01
Mosher + 200 ppb PBO					0			Significant decrease in mortality relative to unblank water suggests that the pesticide responsible for toxicity.			7.94
Ulatis Cr. 12/12/94							0	Sample non toxic.	ND	ND	8.10
Ulatis + 200 ppb PBO							0	No artifactual toxicity resulting from the addition of PBO.			8.12

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.

\+ Treatment taken down at 120 hours.
(#) Number in parentheses represents the CV% for the ELISA run which exceeds the acceptable value according to the lab QA manual.
ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-18
Ulatis Creek 12/4/94 4-Day *Ceriodaphnia* Phase II TIE[1,2]
Set up on 1/5/95
The results of this experiment and chemical analysis imply that toxicity was due to the presence of diazinon and chlorpyrifos.

Treatment[4,5]	# of Reps	% Mortality for each day of the test[3]				Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 48hrs
		1	2	3	4		ELISA	ELISA	
Laboratory Control	3				0	Control met all EPA criteria for test acceptability.			7.57
Laboratory Control C8 Blank for Ulatis Creek	3				0	No artifactual toxicity in control blanks.			7.91
Laboratory Control C8 Blank for Haas Slough	3				0				7.98
Laboratory Control + .83% MeOH	3				0				7.45
Ulatis Creek C8 Solid Phase Extracted Water	3				0	Significant decrease in mortality relative to ambient water suggests			7.96
Ulatis 50% fraction @ 5X	2				0	Toxicant(s) present in the 80%, 85%, 90% and 95% fractions.			7.36
Ulatis 70% fraction @ 5X	2				0				7.34
Ulatis 75% fraction @ 5X	2		10	10	10				7.83*
Ulatis 80% fraction @ 5X	2	100	100	100	100		ND	.224	7.41+
Ulatis 85% fraction @ 5X	2	100	100	100	100		.099	.091	7.56+
Ulatis 90% fraction @ 5X	2		10	40	40		.101	ND	7.42
Ulatis 95% fraction @ 5X	2				56		ND	ND	7.44
Ulatis 100% fraction @ 5X	2				0				7.47

1. 18 mls of sample and five *Ceriodaphnia* in each replicate.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analysis were done.
4. 1800 ml of ambient sample was run through a C8 SPE column at a rate of 10 ml/min. The column was then eluted to produce each fraction 600 times as concentrated as the ambient water.
* pH taken at 72 hours.
+ pH taken at 24 hours

ND Non Detect. Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-19
Ulatis Creek 12/4/94 4-Day *Ceriodaphnia* Test
Mosher 1/9/95 4-Day *Ceriodaphnia* PBO Test[1,2]
Set up on 1/15/95
The results of this experiment and chemical analysis imply that toxicity was due to the presence of diazinon.

Treatment	% Mortality for each day of the test[3]				Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 48hrs
	1	2	3	4				
Laboratory Control				0	Control met all EPA criteria for test acceptability.			8.32
Laboratory Control + 200 ppb PBO				0	No artifactual toxicity in control blank.			8.27
Ulatis Creek 12/4		100	100	100		.045(10.3)	.133	7.91
Mosher Slough 1/9		100	100	100	Toxicity detected.		.422	7.96
Mosher Slough 1/9 + 200 ppb PBO				0	Significant decrease in mortality relative to ambient water suggests that a metabolically activated pesticide is responsible for toxicity.			8.01

1. Four replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.

(#) Number in parentheses represents the CV% for the ELISA run which exceeds the accetable value according to the lab QA manual.
ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-20
Ulatis Creek 3/9/95 4-Day *Ceriodaphnia* Dilution Series[1,2]
Set up on 3/13/95
The results of this experiment show that toxicity remained at a 50% dilution of the sample.

Treatment	% Mortality for each day of the test[3]				Final pH @ 48hrs
	1	2	3	4	
Laboratory Control				0	8.10
Ulatis Creek 12.5%				0	8.07
Ulatis Creek 25%				0	8.02
Ulatis Creek 50%	45	100	100	100	8.00
Ulatis Creek 100%	100	100	100	100	8.17*

1. Four replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
* Final pH taken at 24 hours.

Table F-21
Ulatis Creek 3/9/95, Paradise Cut 3/9/95 and 3/15/95, Vernalis 3/15/95 4-Day *Ceriodaphnia* PBO Test[1,2]
Set up on 3/17/95
The results of this experiment imply that toxicity in the Ulatis Creek and Paradise Cut samples was due to a metabolically activated pesticide.

Treatment	% Mortality for each day of the test				Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 48 hrs
	1	2	3	4		ELISA	ELISA	
Laboratory Control				0	Control met all EPA criteria for test acceptability.			7.97
Laboratory Control + 200 ppb PBO		10	80	95	Increase in mortality relative to control water suggests that the addition of PBO may be negatively affecting the organisms.			7.96
Ulatis Creek (3/9/95)	100	100	100	100	Toxicity detected.	0.137	.293	8.11*
Ulatis Creek (3/9/95) + 200 ppb PBO				0	Decrease in mortality relative to ambient water suggests an metabolically activated OP pesticide is responsible for toxicity.			7.88
Paradise Cut (3/9/95)	25	100	100	100	Toxicity detected.	0.146	ND	7.64
Paradise Cut (3/9/95) + 200 ppb PBO				0	Decrease in mortality relative to ambient water suggests an metabolically activated OP pesticide is responsible for toxicity.			7.73
Paradise Cut (3/15/95)			10	90	Toxicity detected.	0.145	.125	7.91
Paradise Cut (3/15/95) + 200 ppb PBO	30	35	40	40	Decrease in mortality relative to ambient water suggests an metabolically activated OP pesticide is responsible for toxicity.			7.96
Vernalis (3/15/95)				0	Sample non toxic.			8.44
Vernalis (3/15/95) 200 ppb PBO				0	No artifactual toxicity resulting from manipulation.			8.37

1. Three replicates with 18 mls of sample and five Ceriodaphnia each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.

ND Non Detect: Detection limits for ELISA kits are .080 µg/l for Chlorpyrifos and .030 µg/l for Diazinon.

* Final pH taken at 24 hours.

Table F-22
Paradise Cut 3/15/95, Duck Slough 3/21/95, Mosher Slough 3/21/95 and Ulatis Creek 3/21/95 4-Day *Ceriodaphnia* Phase I TIE[1,2]
Set up on 3/24/95
The results of this experiment and chemical analysis imply that toxicity was due to the presence of chlorpyrifos.

Treatment	# of Reps	% Mortality for each day of the test[3]				Conclusions	Chlorpyrifos (µg/L) ELISA	Diazinon (µg/L) ELISA	Final pH @ 48hrs
		1	2	3	4				
Laboratory Control	4			11	16	Control met laboratory criteria for test acceptability.			7.87
Laboratory Control + 200 ppb PBO	4			50	75	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low er mortality in the samples with the addition of PBO suggests the presence of a metabolically activated pesticide(s).			7.90
Laboratory Control C8 Blank	3				0	No artifactual toxicity in control blank.			8.33
Laboratory Control C8 Blank + 200 ppb PBO	3			20	40	See conclusion above for Dilute EI + PBO.			8.32
Paradise Cut 3/15/95	3	33	87	100	100	Toxicity detected.	.145	.125	7.60
Paradise Cut + 200 ppb PBO	3	8	15	15	15	Significant decrease in mortality relative to ambient water suggests that a metabolically activated pesticide is responsible for toxicity.			7.75
Duck Slough 3/21/95 100%	3	100	100	100	100	The ambient water was acutely toxic up	.896	ND	7.28*
Duck Slough 100% + 200 ppb PBO	3	93	100	100	100	to a 12.5% dilution. Addition of PBO			7.40*
Duck Slough 50%	3	100	100	100	100	significantly reduced mortality at the 50%			7.67*
Duck Slough 50% + 200 ppb PBO	3		7	7	7	dilution, suggesting toxicity due to a			8.23
Duck Slough 25%	3	100	100	100	100	metabolically activated pesticide.			7.83*
Duck Slough 12.5%	3	7	100	100	100				8.44
Mosher Slough 3/21/95	3	93	100	100	100	Toxicity detected.	.053	.316	8.27
Mosher Slough + 200 ppb PBO	3				0	Significant decrease in mortality relative to ambient water suggests that a metabolically activated pesticide is responsible for toxicity.			8.24
Ulatis Creek 3/21/95 100%	3	100	100	100	100	The ambient water was acutely toxic up	.134	.046(11.5)	-
Ulatis Creek 100% + 200 ppb PBO	3				0	to a 50% dilution. Addition of PBO			8.01
Ulatis Creek 50%	3		80	100	100	significantly reduced mortality, suggesting			8.19
Ulatis Creek 50% + 200 ppb PBO	3				0	toxicity due to a metabolically			8.23
Ulatis Creek 25%	3				0	activated pesticide.			8.35
Ulatis Creek 12.5%	3				0				8.38

1. Each replicate with 18 mls of sample and five *Ceriodaphnia*.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.
(#) The number in parentheses represents the CV% for the ELISA run which exceeds the acceptable value according to the lab QA manual but is within the manufacturer's recommended range.
* Final pH taken at 24 hours

Table F-23
SR @ Greene's Landing 3/22/95, Mosher Slough 3/24/95 and Duck Slough 3/25/95 4-Day *Ceriodaphnia* Phase I TIE[1,2]
Set up on 3/31/95
The results of this experiment imply that toxicity in the Mosher and Duck Slough samples was due to a metabolically activated pesticide.

Treatment[4]	% Mortality for each day of the test[3]				Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 48hrs
	1	2	3	4				
Laboratory Control				0	Control met all EPA criteria for test acceptability.			8.51
Laboratory Control + 200 ppb PBO		55	100	100	The PBO blank exhibited high mortality relative to the control. Based on the blank's performance a similar elevated mortality would be expected in the ambient water + PBO. However, the low mortality in the Duck and Mosher samples with the addition of PBO suggests the presence of a metabolically activated pesticide(s).			8.37
SR @ Greene's Landing 3/22/95				0	Sample non toxic.			8.47
SR @ Greene's Landing + 200 ppb PBO		20	20	30	Increase in mortality relative to ambient water suggests that the addition of PBO may be negatively affecting the organims.			8.42
Mosher Slough 3/24/95 100 % •	100	100	100	100	The ambient water was acutely toxic up to a	0.116	.110	7.69*
Mosher Slough 100% + 200 ppb PBO	93	100	100	100	50% dilution. Addition of PBO to the 50%			7.91*
Mosher Slough 50%		20	100	100	dilution significantly reduced mortality,			8.37
Mosher Slough 50% + 200 ppb PBO	13	20	20	20	suggesting toxicity due to a metabolically			8.27
Mosher Slough 25%				0	activated pesticide.			8.23
Mosher Slough 12.5%		7	7	7				8.26
Duck Slough 3/25/95 25%	100	100	100	100	The ambient water was acutely toxic up to a	0.511	ND	7.86*
Duck Slough 25% + 200 ppb PBO		5	5	5	12.5% dilution. Addition of PBO			8.08
Duck Slough 12.5%		100	100	100	sgnificantly decreased the mortality			8.21
Duck Slough 12.5% + 200 ppb PBO				5	relative to the ambient water, suggesting			8.24
Duck Slough 6.25%			5	15	toxicity due to a metabolically			8.25
Duck Slough 3.13%				0	activated pesticide.			8.30

1. Each replicate with 18 mls of sample and five *Ceriodaphnia*.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. All Mosher waters and its manipulations had three replicates per treatment. All other treatments had four replicates each.
* Final pH taken at 24 hours.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-24
Duck Slough 3/21/95 3-Day *Ceriodaphnia* Phase III TIE[1,2]
Set up on 4/12/95
The results of this experiment suggest that chlorpyrifos was responsible for toxicity.

Treatment[4]	% Mortality for each day of the test[3]			Conclusions	Chlorpyrifos (µg/L) ELISA	Diazinon (µg/L) ELISA	Final pH @ 48hrs
	1	2	3				
Laboratory Control			6.7	Control met all EPA criteria for test acceptability.			8.04
Laboratory Control C8 Blank for Duck Slough			0	No artifactual toxicity present in the control blanks.			8.05
Duck Slough @ 25%	100	100	100		198	ND	8.38+
Spiked C8 Solid Phase Extracted Water (CSPEW) @ 25%	100	100	100	Similar organism responses suggest that chlorpyrifos was responsible for the toxicity.	182		8.35+
Duck Slough @ 12.5%		100	100				8.04
Spiked CSPEW @ 12.5%		100	100				7.94
Duck Slough @ 6.25%		6.7	13				8.11
Spiked CSPEW @ 6.25%			0				8.02
Duck Slough @ 3.13%		6.7	20				8.13
Spiked CSPEW @ 3.13%			6.7				7.99
Unspiked CSPEW			0	Significant decrease in mortality relative to ambient water suggests that an organic is responsible for toxicity.			8.01

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were not fed.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml of Sample water was run through a C8 SPE column at a rate of 10 ml/min.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.
\+ Final pH taken at 24 hours.

Table F-25
Paradise Cut 3/15/95 3-Day *Ceriodaphnia* Phase III TIE[1,2]
Set up on 4/20/95
The results of this experiment confirms that chlorpyrifos was responsible for toxicity.

Treatment[4]	% Mortality for each day of the test[3]			Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 48hrs
	1	2	3		ELISA	ELISA	
Laboratory Control			13	Control met laboratory criteria for test acceptability.			8.40
Laboratory Control C8 Blank for Paradise Cut			6.7	No artifactual toxicity present in control blank.			8.41
Spiked C8 Solid Phase Extracted Water (CSPEW) @ 200%	100	100	100				8.13+
Paradise Cut @ 100%	100	100	100		0.145	0.125	8.05+
Spiked CSPEW @ 100%	33	100	100	Similar organism responses confirm that chlorpyrifos	0.151		7.93
Paradise Cut @ 75%	20	100	100	was responsible for the toxicity.			7.98
Spiked CSPEW @ 75%	0	100	100				8.02
Paradise Cut @ 50%	0	100	100				8.13
Spiked CSPEW @ 50%	0	7.1	14				8.13
Paradise Cut @ 25%			0				8.27
Spiked CSPEW @ 25%			0				8.14
Unspiked CSPEW			0	Significant decrease in mortality relative to ambient water suggests that an organic is responsible for toxicity.			7.87

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were not fed.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml of Sample water was run through a C8 SPE column at a rate of 10 ml/min.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.
\+ Final pH taken at 24 hours.

Table F-26
Ulatis Creek 3/21/95 3-Day *Ceriodaphnia* Phase III TIE[1,2]
Set up on 4/20/95
The results of this experiment confirm that chlorpyrifos was responsible for toxicity.

Treatment[4]	% Mortality for each day of the test[3]			Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 48hrs
	1	2	3		ELISA	ELISA	
Laboratory Control			0	Control met all EPA criteria for test acceptability.			8.02
Laboratory Control C8 Blank for Ulatis Creek			0	No artifactual toxicity present in control blank.			8.10
Ulatis Creek @ 100%	100	100	100		0.134	ND	7.77+
Spiked C8 Solid Phase Extracted Water (CSPEW) @ 100%	100	100	100		0.191		7.76+
Ulatis Creek @ 75%	80	100	100	Similar organism responses confirm that chlorpyrifos			8.16
Spiked CSPEW @ 75%	13	93	100	was responsible for the toxicity.			8.08
Ulatis Creek @ 50%		100	100				8.23
Spiked CSPEW @ 50%			67				8.12
Ulatis Creek @ 25%			0				8.31
Spiked CSPEW @ 25%			7.1				8.21
Unspiked CSPEW			0	Significant decrease in mortality relative to ambient water suggests that an OP pesticide is responsible for toxicity.			7.83

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were not fed.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml of Sample water was run through a C8 SPE column at a rate of 10 ml/min.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.
\+ Final pH taken at 24 hours.

Table F-27
Mosher Slough 5/1/95 3-Day *Ceriodaphnia* Phase III TIE[1,2]
Set up on 5/17/95
The results of this experiment confirm that chlorpyrifos was responsible for toxicity.

Treatment[4]	% Mortality for each day of the test[3]			Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 48hrs
	1	2	3		ELISA	ELISA	
Laboratory Control			20	Control met laboratory criteria for test acceptability.			8.02
Laboratory Control C8 Blank for Mosher Slough			13	No artifactual toxicity present in the control blank.			8.18
Spiked C8 Solid Phase Extracted Water (CSPEW) @ 200%	100	100	100				7.92*
Mosher 5/1 @ 100%	20	100	100		0.120	0.416	7.62
Spiked CSPEW @ 100%	33	100	100	Similar organism responses confirm that chlorpyrifos	0.107	0.498	7.55
Mosher 5/1 @ 75%		13	100	was responsible for the toxicity.			8.04
Spiked CSPEW @ 75%		26	100				7.93
Mosher 5/1 @ 50%			13				8.11
Spiked CSPEW @ 50%			0				7.79
Mosher 5/1 @ 25%			6.7				8.10
Spiked CSPEW @ 25%			0				7.94
Unspiked CSPEW			0	Significant decrease in mortality relative to ambient water suggests that an organic is responsible for toxicity.			7.99
Unspiked CSPEW + ppb PBO			0	No artifactual toxicity present in manipulation blank.			8.21

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were not fed.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml of Sample water was run through a C8 SPE column at a rate of 10 ml/min.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.
+ Final pH taken at 24 hours.

Table F-28
Ryer Island Drain 6/4/95 7-Day *Ceriodaphnia* PBO Test[1,2]
Set up on 6/6/95
The results of this experiment show that the sample was not toxic and that toxicity did not persist in the field.

Treatment	Reproduction[3] (neonates/adult) x	s.e.	Mortality (%)	Conclusions	Chlorpyrifos (µg/L)	Diazinon (µg/L)	Final pH @ 24 hrs	EC (µmhos)
Laboratory Control	19.1	1.7	0.0	Control met all EPA criteria for test acceptability.			8.34	210
Laboratory Control + 100 ppb PBO	11.3	2.0	30	No artifactual toxicity present in control blanks.			8.41	210
Laboratory Control + 200 ppb PBO	0.0	0.0	0.0				8.45	210
Ryer Island 6/4/95	27.1	1.3	0.0		ND	ND	8.34	200
Ryer Island + 100 ppb PBO	20.2	1.8	0.0	Sample non toxic.			8.31	200
Ryer Island Drain + 200 ppb PBO	0.0	0.0	11.1				8.31	200

1. Ten replicates with 15 mls of sample and one *Ceriodaphnia* each.
2. Standard EPA feeding procedures were used during this test.
3. The reproductive endpoint was analyzed using Dunnett's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-29
Ryer Island Drain 5/31/95 3-Day *Ceriodaphnia* Phase I TIE[1,2]
Set up on 6/7/95
The results of this experiment imply that toxicity was due to a non polar organic chemical but not due to a metabolically activated pesticide.

Treatment[4]	% Mortality for each day of the test[3]			Conclusions	Final pH @ 48hrs
	1	2	3		
Laboratory Control			0.0	Control met all EPA criteria for test acceptability.	7.57
Laboratory Control C8 Blank for Ryer Island Drain	13	33	40	Artifactual toxicity resulting from solid phase extraction.	7.78
Laboratory Control + 1% MeOH		6.7	6.7	Artifactual toxicity present in control blanks.	7.93
Laboratory Control + 100 ppb PBO			13		8.28
Ryer Island Drain 5/31/95	100	100	100	Toxicity detected.	7.75+
Ryer Island Drain 5/31/95 C8 Solid Phase Extracted Water			0.0	Decrease in mortality suggests that toxicity was due to a non polar organic chemical.	8.07
Laboratory Control + 1% Ryer Island Drain eluate @ 6x	100	100	100	Hish mortality confirms that toxicity was due to a non polar organic chemical.	8.02+
Laboratory Control + 0.5% Ryer Island Drain eluate @ 3x	100	100	100		8.20+
Ryer Island Drain + 100 ppb PBO	100	100	100	No decrease in mortality suggests that toxicity was not due to a metabolically activated pesticide.	8.07+

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml of Sample water was run through a C8 SPE column at a rate of 10 ml/min. The column was extracted using 3 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

\+ Final pH taken at 24 hours
ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-30
Ryer Island Drain 5/31/95 4-Day *Ceriodaphnia* Phase II TIE[1,2]
Set up on 6/19/95
The results of this experiment imply that toxicity was due to a non polar organic chemical.

Treatment[4]	% Mortality for each day of the test[3]				Conclusions	Final pH @ 48hrs
	1	2	3	4		
Laboratory Control				0	Control met all EPA criteria for test acceptability.	7.81
Laboratory Control + 0.5% MeOH				0	No artifactual toxicity detected in control blanks.	7.92
Laboratory Control C8 Blank for Ryer Is. Drain				0		8.06
Ryer Is. Drain 5/31/95 C8 Solid Phase Extracted Water				0	Significant decrease in mortality suggests that an organic is responsible for toxicity.	8.12
Ryer 50% Fraction @ 3X	100	100	100	100	Toxicant(s) present in the 50% and 70% fractions.	7.77*
Ryer 70% Fraction @ 3X	93	100	100	100		7.84*
Ryer 75% Fraction @ 3X				0		8.04
Ryer 80% Fraction @ 3X			6.7	6.7		8.11
Ryer 85% Fraction @ 3X				0		8.07
Ryer 90% Fraction @ 3X				0		8.02
Ryer 95% Fraction @ 3X				0		8.10
Ryer 100% Fraction @ 3X				0		8.06

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml of Sample water was run through a C8 SPE column at a rate of 10 ml/min. The column was extracted using 3 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

* Final pH taken at 24 hours

ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-31
Ryer Island Drain 5/31/95 3-Day *Ceriodaphnia* Phase II TIE[1,2]
Set up on 6/30/95
The results of this experiment imply that toxicity was not due to a metabolically activated pesticide.

Treatment[4]	% Mortality for each day of the test[3]			Conclusions	Final pH @ 48hrs
	1	2	3		
Laboratory Control			0	Control met all EPA criteria for test acceptability.	7.96
Laboratory Control + 0.5% MeOH			0	No artifactual toxicity in PBO control blank.	8.15
Laboratory Control + 0.5 % MeOH + 100 ppb PBO			20		8.11
Ryer 50% fraction @ 3X	100	100	100		8.33*
Ryer 50% fraction @ 3X + 100 ppb PBO	100	100	100		8.32*
Ryer 50% fraction @ 1.5X	60	100	100	No decrease in mortality with the	8.12
Ryer 50% fraction @ 1.5X + 100 ppb PBO	40	100	100	addition of PBO suggests that toxicity	8.10
Ryer 70% fraction @ 3X	53	100	100	was not due to a metabolically	8.09
Ryer 70% fraction @ 3X + 100 ppb PBO	33	100	100	activated pesticide.	8.07
Ryer 70% fraction @ 1.5X			100		8.04
Ryer 70% fraction @ 1.5X + 100 ppb PBO		40	60		8.00

1. Two replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml of Sample water was run through a C8 SPE column at a rate of 10 ml/min. The column was extracted using 3 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

* Final pH taken at 24 hours
ND Non Detect: Detection limits for ELISA kits are .080 µg/L for Chlorpyrifos and .030 µg/L for Diazinon.

Table F-32
Ryer Island 5/31/95 4-Day *Ceriodaphnia* Phase III TIE[1,2]
Set up on 10/3/95
The results of this experiment and chemical analyses confirm that the toxicity was due to the presence of carbaryl.

Treatment[4]	% Mortality for each day of the test[3]				Conclusions	Carbaryl (µg/L)	Final pH @ 24hrs
	1	2	3	4			
Laboratory Control		6.7	6.7	6.7	Control met all EPA criteria for test acceptability.		8.34
Laboratory Control + .25% MeOH			6.7	6.7	No artifactual toxicity in control blank.		8.40
Laboratory Control + Ryer Is. eluate @ 1.5X	100	100	100	100	Similar organism responses confirm that carbaryl was responsible for the toxicity.		8.41
Laboratory Control spiked with 10.5 ppb carbaryl (1.5X)	100	100	100	100			8.46
Laboratory Control + Ryer Is. eluate @ 1.25X	100	100	100	100			8.42
Laboratory Control spiked with 8.75 ppb carbary (1.25X)	60	100	100	100			8.46
Laboratory Control + Ryer Is. eluate @ 1.0X	93	100	100	100		7.0	8.45
Laboratory Control spiked with 7.0 ppb carbaryl (1.0X)	53	100	100	100		7.0	8.48
Laboratory Control + Ryer Is. eluate @ 0.75X	53	100	100	100			8.46
Laboratory Control spiked with 5.25 ppb carbaryl (0.75X)		87	93	100			8.48
Laboratory Control + Ryer Is. eluate @ 0.50X		53	60	66.7			8.43
Laboratory Control spiked with 3.5 ppb carbaryl (0.50X)		6.7	6.7	6.7			8.47

1. Three replicates with 18 mls of sample and five *Ceriodaphnia* each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
4. 1800 ml of Sample water was run through a C8 SPE column at a rate of 10 ml/min. The column was extracted using 3 ml of MeOH to produce each fraction 600 times as concentrated as the ambient water.

APPENDIX G

CERIODAPHNIA ROUTINE MONITORING

Table G-1
Routine Delta 6/3/94 8-day *Ceriodaphnia* Test[1]
Set up on 6/4/94

Treatment	Reproduction[2] (neonates/adult)		Mortality (%)[2]	Final pH
	x	s.e.		
Lab Control	30.8[P]	1.6	0.0[P]	8.54
SJR @ Vernalis	30.1	4.4	10.0	8.56
SR @ Greene's Landing (n=9)	33.1	2.6	0.0	8.45
Duck Slough	13.5	0.4	0.0	8.52
Prospect Slough	10.8	0.8	0.0	8.53
French Camp Slough	29.8	1.0	0.0	7.92
Ulatis Creek	38.1	2.4	0.0	8.72
Paradise Cut	41.3	3.3	0.0	8.57
Wathall Slough	46.8	1.3	0.0	8.64
Sugar Cut (n=9)	38.6	2.5	0.0	8.60

P. The Lab Control met EPA criteria for test acceptability with 100% and 80% of the daphnids having a third brood respectively.
1. Ten replicates, except where indicated by n=9, with 15 mls of sample and one *Ceriodaphnia* each.
2. Highlighted areas indicate a significant reduction of reproduction relative to the Lab Control control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table G-2
Routine Delta 7/12/94 8-day *Ceriodaphnia* Test
Set up on 7/14/94

Treatment	Reproduction[2] (neonates/adult)		Mortality (%)[2]	Final pH
	x	s.e.		
Laboratory Control	33.7[P]	2.6[P]	0.0[P]	8.18
SJR @ Vernalis	49.8	5.7	10.0	7.60
SR @ Greene's Landing	39.9	2.7	0.0	8.24
Duck Slough	11.8	0.4	0.0	8.12
Prospect Slough	18.8	1.8	10.0	8.25
French Camp Slough	43.1	4.1	10.0	8.03
Ulatis Creek	53.3	2.8	0.0	8.13
Paradise Cut	0.0	0.0	100.0	7.44
Hog Slough	50.9	2.1	10.0	8.08
Sycamore Slough	57.0	3.3	10.0	8.29
Wathall Slough	48.7[1]	1.1[1]	0.0[1]	7.29
Ryer Island	36.7	3.7	0.0	8.14

P. The Lab Control met EPA criteria for test acceptability with 100% of the daphnids having a third brood. The test was run 8 days in order to meet this criteria in the Lab Control control water.
1. Only nine replicates existed in these samples due to mishandling of the organisms.
2. Highlighted areas indicate a significant reduction of reproduction or increase in mortality relative to the Lab Control control water. The reproductive endpoint was analyzed using Dunnett's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table G-3
Routine Delta 8/9/94 7-day *Ceriodaphnia* Test
Set up on 8/11/94

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH
	x	s.e.		
Laboratory Control	28.4[P]	0.7	0.0[P]	8.33
SJR @ Vernalis	26.8	1.3	0.0	8.20
SR @ Greene's Landing	14.5	1.3	0.0	8.49
Duck Slough	7.4	1.05	0.0	8.68
Prospect Slough	5.6	0.6	10.0	8.57
French Camp Slough	26.3	1.7	0.0	8.65
Ulatis Creek	29.0	1.0	0.0	8.40
Paradise Cut	27.8	2.1	0.0	8.21
Haas Slough	27.1	0.9	0.0	8.44
Sycamore Slough	30.1	0.9	0.0	8.80
Wathall Slough	31.4	0.6	0.0	8.43
Ryer Island	19.8	1.3	0.0	8.55

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction of reproduction relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table G-4
Routine Delta 9/1-9/2/94 7-day *Ceriodaphnia* Test
Set up on 9/3/94

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Lab control	22.6[P]	2.0	0.0[P]	8.07
Lab control A/E Filtered	26.0	0.8	0	8.76
Lab control .22µm Filtered	25.0	0.9	0	8.75
SJR @ Vernalis	28.4	0.9	0	8.55
SR @ Greene's Landing	28.3	1.1	0	8.83
Duck Slough	8.9	1.2	0	8.75
Duck Slough A/E Filtered	16.6	1.2	0	8.80
Duck Sl. .22µm Filtered	23.4	0.9	0	8.77
Prospect Slough	7.6	0.7	0	8.10
French Camp Slough	0	0	100(6)#	8.60
Ulatis Creek	18.9	2.1	90	8.11
Paradise Cut	30.0	1.0	0	8.38
Haas Slough	27.7	0.8	0	8.53
Sycamore Slough	26.8	1.7	10	8.76
Ryer Island	20.5	1.1	0	8.81

P. The laboratory control met all EPA criteria for test acceptability. 90% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the Lab control control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
Number in parentheses represents days to 100% mortality.

Table G-5
Routine Delta 10/5-10/6/94 7-day *Ceriodaphnia* Test[1]
Set up on 10/7/94

Treatment	Reproduction[2] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control[1]	25.8[P]	1.3	10.0[P]	8.35
SJR @ Vernalis	35.3	0.7	0	8.50
SR @ Greene's Landing	28.7	3.5	10	8.46
Duck Slough	22.9	1.2	0	8.43
Prospect Slough	17.7	0.5	0	8.56
French Camp Slough	36.7	1.6	0	8.23
Ulatis Creek	27.0	0.8	0	8.41
Paradise Cut	35.3	0.9	0	8.33
Haas Slough	29.5	1.0	0	8.51
Sycamore Slough	30.0	0.5	0	8.49
Ryer Island	27.0	0.9	0	8.38

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Only nine replicates existed in these samples due to mishandling of the organisms.
2. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table G-6
Routine Delta 11/7-11/8/94 7-day *Ceriodaphnia* Test
Set up on 11/9/94

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	19.8[P]	1.4	0.0[P]	8.42
SJR @ Vernalis	27.0	2.6	0	8.57
SR @ Greene's Landing	37.0	1.1	0	8.28
Duck Slough	22.2	1.6	0	8.18
Prospect Slough	17.6	2.4	0	8.60
French Camp Slough	38.1	0.9	0	8.43
Ulatis Creek	0	0	100(2)	8.24
Paradise Cut	27.5	3.0	0	8.48
Sycamore Slough	31.9	0.9	0	8.37
Ryer Island	29.6	3.9	10	8.18

P. The laboratory control met all EPA criteria for test acceptability. 90% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
Number in parentheses represents day to 100% mortality.

Table G-7
Routine Delta Monitoring 12/4/94 and 12/5/94 7-day *Ceriodaphnia* Test
Set up on 12/7/94

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	26.6[P]	1.3	0.0[P]	8.62
SJR @ Vernalis	35.9	2.3	0	8.44
SR @ Greene's Landing	33.1	1.7	0	8.33
Ulatis Creek	0	0	100(3)	8.24
French Camp Slough	34.2	1.5	0	8.36
Walthall Slough	30.9	1.0	0	8.51
Prospect Slough	27.5	0.8	0	8.53
Haas Slough	0	0	100(3)	7.86
Paradise Cut	29.2	1.3	0	8.49
Rock Slough	33.7	0.7	0	8.28
White Slough	32.0	0.5	0	8.22
Ryer Is. Main Drain	41.9	2.6	0	8.49
Duck Slough	30.8	1.7	0	8.13
Pierson Tract	40.9	3.5	0	8.50
Victoria Is. Drain	30.7	1.8	0	8.05
Upper Jones Is. Drain	35.8	1.4	0	8.25
Middle Roberts Is. Drain	25.2	0.9	0	8.52
Mosher Slough	0	0	100(4)	8.36

P. The laboratorycontrol met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the Dilute EI control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
(#) Number in parentheses represents days to 100% mortality.

Table G-8
Routine Delta Monitoring 1/9/95 7-day *Ceriodaphnia* Test
Set up on 1/11/95

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	31.6[P]	2.6	0[P]	8.21
Ulatis Creek	16.9	0.6	0	8.21
French Camp Slough	40.3	3.1	0	8.08
Haas Slough	15.9	1.0	0	8.05
Paradise Cut	36.4	1.1	0	7.85
Ryer Is. Main Drain	21.7	0.4	0	8.31
Duck Slough	21.7	0.4	0	8.23
Pierson Tract	16.7	0.5	0	8.41
Victoria Is. Drain	23.4	1.5	0	8.42
Upper Jones Is. Drain	31.2	1.7	0	8.40
Middle Roberts Is. Drain	19.8	0.3	10	7.50
Mosher Slough	0.0	0.0	100(3)	8.24

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
(#) Number in parentheses represents days to 100% mortality.

Table G-9
Routine Delta Monitoring 2/28/95 and 3/1/95 7-day *Ceriodaphnia* Test
Set up on 3/2/95

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	24.5[P]	0.9	0[P]	8.85
SJR @ Vernalis	26.5	3.0	10	8.91
SR @ Greene's Landing	22.5	2.8	0	8.78
Ulatis Creek	30.3	1.1	0	8.67
French Camp Slough	28.2	2.5	0	8.88
Prospect Slough	21.5	1.0	0	7.61
Haas Slough	30.8	0.8	0	8.47
Paradise Cut	29.5	2.3	0	8.12
Rock Slough	20.7	2.2	0	8.74
Sycamore Slough (n=9)	0.1	0.1	90	8.50
White Slough (n=9)	32.8	1.6	0	8.74
Ryer Is. Main Drain	23.8	0.9	0	8.64
Duck Slough	5.2	0.5	0	8.59
Pierson Tract	22.9	0.9	0	8.53
Victoria Is. Drain	28.2	0.8	0	8.46
Upper Jones Is. Drain	15.5	1.9	0	8.60
Middle Roberts Is. Drain	8.4	1.2	0	8.05
Mosher Slough	27.5	1.2	10	8.74

P. The laboratorycontrol met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table G-10
Routine Delta Monitoring 3/21/95 7-day *Ceriodaphnia* Test
Set up on 3/22/95

Treatment[1]	Reproduction[2] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	23.7[P]	2.9	10[P]	8.24
SJR @ Vernalis	37.3	0.8	0	8.10
SR @ Greene's Landing	28.9	1.0	0	7.95
Mokelumne River	31.6	1.5	0	8.77
Ulatis Creek	0	0.0	100 (1)	7.73
French Camp Slough	28.7	2.7	50	8.15
Old River @ Tracy	32.4	0.8	0	8.17
Prospect Slough	12.0	0.0	0	8.25
Cache Creek	1.0	0.0	0	7.68
Paradise Cut (n=9)	29.8	1.2	0	8.04
Sycamore Slough (n=9)	34.3	1.4	0	8.37
Ryer Is. Main Drain	20.7	2.4	0	8.31
Duck Slough	0	0.0	100 (1)	8.07
Victoria Is. Drain	23.5	0.9	0	7.86
Upper Jones Is. Drain	26.4	0.9	0	8.24
Mosher Slough	0	0.0	100 (2)	8.43

P. The laboratorycontrol met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Ten replicates with 15 mls of sample and one Ceriodaphnia each except where indicated by n= number of replicates.
2. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
(#) Number in parenthesis denotes days to 100% mortality.

Table G-11
Routine Delta Monitoring 5/1/95 7-day *Ceriodaphnia* Test
Set up on 5/2/95

Treatment[1]	Reproduction[2] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control (n=9)	19.9[P]	2.0	0[P]	8.22
SJR @ Vernalis	22.0	3.3	20	8.22
SR @ Greene's Landing (n=9)	20.5	3.0	10	8.28
Ulatis Creek	27.3	1.3	0	8.64
French Camp Slough (n=9)	27.4	0.9	0	8.25
Prospect Slough	21.6	1.0	0	8.74
Haas Slough	26.8	3.3	10	8.78
Paradise Cut	27.3	0.6	0	8.26
Rock Slough	23.9	0.6	0	8.28
Sycamore Slough	18.1	3.1	10	7.98
Ryer Is. Main Drain (n=9)	22.2	0.8	10	8.38
Duck Slough (n=9)	28.3	0.9	0	8.75
Pierson Tract	23.9	0.8	0	8.55
Victoria Is. Drain (n=9)	24.5	0.8	0	8.21
Upper Jones Is. Drain (n=9)	20.6	4.6	20	8.35
Middle Roberts Is. Drain (n=9)	13.6	1.1	0	8.35
Mosher Slough	0.0	0.0	100(2)	7.97
Cache Creek @ 102 (5/2/95)	17.0	0.9	0	8.60

P. The laboratory control met all EPA criteria for test acceptability. 88.9% of the daphnids had a third brood.
1. Ten replicates with 15 mls of sample and one Ceriodaphnia each except where indicated by n= number of replicates.
2. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratorycontrol water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
(#) Number in parenthesis represents days to 100% mortality.

Table G-12
Routine Delta Monitoring 5/31/95 7-day *Ceriodaphnia* Test
Set up on 6/2/95

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	23.8[P]	2.9	0[P]	8.4
SJR @ Vernalis	43.8	0.9	0	8.44
SR @ Greene's Landing	30.7	2.8	10	8.27
Ulatis Creek	42.2	7.1	0	8.53
French Camp Slough	39.3	5.0	0	8.36
Prospect Slough	20.2	4.3	10	8.62
Cache Creek	40.4	4.7	0	8.59
Haas Slough	34.4	5.0	44.4	8.56
Paradise Cut	41.7	1.7	0	8.31
Rock Slough	39.9	1.6	0	8.22
Sycamore Slough	34.0	5.8	0	8.22
White Slough	45.6	2.4	0	8.38
Ryer Is. Main Drain	0	0	100	8.39
Duck Slough	32.7	2.2	0	8.65
Pierson Tract	34.4	1.3	0	8.44
Victoria Is. Drain	34.9	1.5	0	8.21
Upper Jones Is. Drain	30.1	1.6	0	8.24
Middle Roberts Is. Drain	24.3	5.6	60	8.29
Mosher Slough	36.9	1.9	0	8.3

P. The laboratorycontrol met all EPA criteria for test acceptability. 90% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Kruskall Wallis Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table G-13
Routine Delta Monitoring 6/27/95 7-day *Ceriodaphnia* Test
Set up on 6/28/95

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	17.0[P]	2.0	10[P]	8.20
SJR @ Vernalis	21.8	2.6	0	8.01
SR @ Greene's Landing	18.0	1.1	0	7.86
Ulatis Creek	27.2	2.9	0	8.54
French Camp Slough	16.9	2.4	10	8.22
Prospect Slough	11.0	1.3	0	8.47
Haas Slough	24.4	0.6	0	8.42
Paradise Cut	31.0	2.4	0	8.08
Rock Slough	19.7	0.7	0	8.36
Sycamore Slough	26.1	0.9	0	8.16
White Slough	30.3	1.0	0	8.23
Ryer Is. Main Drain	21.5	1.1	0	8.34
Duck Slough	15.3	0.4	0	8.22
Pierson Tract	24.1	0.8	0	8.12
Victoria Is. Drain	21.7	0.9	0	8.05
Upper Jones Is. Drain	18.4	0.8	0	8.17
Middle Roberts Is. Drain	14.2	0.5	0	8.09
Mosher Slough	22.9	1.2	0	8.18

P. The laboratory control met all EPA criteria for test acceptability. 90% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table G-14
Routine Delta Monitoring 7/17/95 8-day *Ceriodaphnia* Test
Set up on 7/18/95

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	9.1[NP]	2.6	20[P]	8.58
SJR @ Vernalis	43.0	1.2	0	8.52
SR @ Greene's Landing	28.2	3.7	10	8.62
Ulatis Creek	45.1	2.3	0	8.34
French Camp Slough	42.3	1.3	0	8.43
Prospect Slough	26.2	1.0	0	8.62
Haas Slough	40.6	4.4	11	8.47
Paradise Cut	39.8	3.2	0	7.55
Rock Slough	33.9	2.7	10	8.47
Sycamore Slough	47.0	1.6	0	8.63
White Slough	42.8	1.4	0	8.44
Ryer Is. Main Drain	38.7	2.0	0	7.89
Duck Slough	10.5	0.8	0	8.49
Pierson Tract	31.5	2.0	0	8.40
Victoria Is. Drain	26.6	0.6	0	8.40
Upper Jones Is. Drain	32.4	3.7	10	8.39
Middle Roberts Is. Drain	21.6	1.1	0	8.15
Mosher Slough	36.5	1.3	0	8.53

NP. The laboratory control did not meet all EPA criteria for test acceptability. 40% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Kruskall Wallis Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table H-1. Rainfall data, in inches, at City of Stockton, California for time period of June 1, 1994-July 30, 1995.

Year	1994							1995						
Month	June	July	August	September	October	November	December	January	February	March	April	May	June	July
Day														
1						0.03		0.07		0.04		0.04		
2							0.04	0.09	0.02	0.05				
3							0.06	0.59		0.12				
4					0.42		0.05	0.65		0.07				
5						0.03		0.02		T				
6						0.09	0.05	0.13			0.01			
7						0.23		0.05			0.08			
8								0.21	0.02	0.20				
9						0.73		0.99		0.24		0.04		
10						T		0.71		1.14				
11							0.09	0.02		0.74				
12						0.06	0.34	0.28				0.16		
13								T	0.28	0.35	0.13	0.12		
14							0.29	0.44		0.07			0.03	
15						0.26		0.21			0.13	0.19	0.05	
16								0.06			0.04			
17						0.01								
18										0.13	0.20			
19										T	T			
20								0.03		0.51	0.14			
21								0.07		0.19				
22								0.19		0.87				
23				0.01				0.12		0.18				
24							0.16	0.65						
25						0.60		0.15						
26						0.11		0.51						
27								0.62			0.03			
28				0.23			0.07		0.06		0.04			
29											0.03			
30								0.02			0.33			
31														
Total				0.24	0.42	2.15	1.15	6.88	0.38	4.90	1.16	0.55	0.08	

Note: T = Trace, blanks indicate no precipitation.

Table H-2
Delta Rain Event 1/9/95-1/14/95 7-day *Ceriodaphnia* Test
Set up on 1/15/95

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	27.8[P]	1.6	10.0[P]	8.27
SJR @ Vernalis 1/9	31.4	1.0	0	7.72
SJR @ Vernalis 1/10	18.0	0.4	0	7.79
SJR @ Vernalis 1/11	16.4	1.6	0	7.88
SJR @ Vernalis 1/12	27.4	1.4	0	80.7
SJR @ Vernalis 1/13	26.6	1.1	0	8.09
SJR @ Vernalis 1/14	27.4	1.3	10.0	8.24
SR @ Greene's Landing 1/10	19.7	0.8	0	7.99
SR @ Greene's Landing 1/11	19.6	0.8	0	7.99
SR @ Greene's Landing 1/12	20.1	0.8	0	8.01
SR @ Greene's Landing 1/13	18.2	0.5	0	8.01
SR @ Greene's Landing 1/14	17.9	0.5	0	8.63

P. The laboratory control met all EPA criteria for test acceptability. 90% of the daphnids had a third brood.
I. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table H-3
Delta Rain 1/23/95-1/25/95 7-day *Ceriodaphnia* Test
Set up on 1/26/95

Treatment	Reproduction[1]		Mortality	Final pH
	x	s.e.	(%)	@ 24 hrs
Laboratory Control	27.9[P]	0.8	0.0[P]	7.56
SJR @ Vernalis 1/23	31.5	1.0	0.0	7.21
SJR @ Vernalis 1/24	31.9	1.0	0.0	7.41
SJR @ Vernalis 1/25	27.2	1.1	0.0	7.44
Old River @ Tracy 1/23	31.4	0.7	0.0	7.64

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunnett's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table II-4
Delta Rain Event 3/8/95 to 3/11/95, Duck Slough 3/1/95 7-day *Ceriodaphnia* Test
Set up on 3/11/95

Treatment[1]	Reproduction[2] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	23.4[P]	2.9	0[P]	8.22
SR @ Greene's Landing 3/9/95	30.2	3.5	0	8.64
SR @ Greene's Landing 3/11/95	24.1	4.1	0	7.89
SJR @ Vernalis 3/8/95	27.7	3.2	0	8.05
SJR @ Vernalis 3/9/95	27.8	3.2	0	8.15
SJR @ Vernalis 3/10/95	13.9	2.6	0	8.17
SJR @ Vernalis 3/11/95	22.1	2.6	0	8.19
Paradise Cut 3/9/95	0	0	100 (4)	7.44
Ryer Island Drain 3/9/95 (n=9)	24.6	0.8	0	7.88
Mosher Slough 3/9/95	0	0	100 (2)	8.33
Ulatis Creek 3/9/95	0	0	100 (3)	8.34
French Camp Slough 3/9/95	28.4	4.8	0	8.28
Duck Slough 3/1/95	15.1	2.8	0	8.60
Duck Slough (settled) 3/1/95	18.2	2.3	0	8.75
Duck Slough 3/9/95	23.2	0.7	0	8.09
Duck Slough (settled) 3/9/95	28.0	3.2	0	8.34

P. The laboratory control met all EPA criteria for test acceptability. 90% of the daphnids had a third brood.
1. Ten replicates with 15 mls of sample and one Ceriodaphnia each except where indicated by n= number of replicates.
2. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.
(#) Number in parentheses denotes days to 100% mortality.

Table H-5

Haas Slough, Sycamore Slough and Ulatis Creek 3/13/95 7-Day *Ceriodaphnia* Test[1,2]
Set up on 3/14/95

Treatment	% Mortality for each day of the test[3]							Conclusions	Chlorpyrifos (µg/l)	Diazinon (µg/l)	Final pH @ 48 hrs
	1	2	3	4	5	6	7				
Laboratory Control							5	Control met all EPA criteria for test acceptability.	-	-	8.05
Haas Slough							0	Samples non toxic		-	7.90
Sycamore Slough							0			-	7.81
Ulatis Creek							0		ND	.044	7.68

1. Four replicates with 18 mls of sample and five Ceriodaphnia each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.

ND Non Detect Detection limits for ELISA kits are .080 µg/l for Chlorpyrifos and .030 µg/l for Diazinon.

Table H-6

San Joaquin River at Vernalis 3/21/95-3/24/95 7-Day *Ceriodaphnia* Test[1,2]
Set up on 3/24/95

Treatment	% Mortality for each day of the test[3]							Conclusions	Chlorpyrifos (µg/l)	Diazinon (µg/l)	Final pH @ 24 hrs
	1	2	3	4	5	6	7				
Laboratory Control							16	Control met all EPA criteria for test acceptability.	-	-	7.87
SJR at Vernalis 3/21/95				5	5	5	5	Samples non toxic	.042	ND	8.38
SJR at Vernalis 3/22/95						0*			.042	ND	8.32
SJR at Vernalis 3/23/95							0		.029	ND	8.27
SJR at Vernalis 3/24/95							0		.024	-	8.27

1. Four replicates with 18 mls of sample and five Ceriodaphnia each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.

ND Non Detect Detection limits for ELISA kits are .080 ug/l for Chlorpyrifos and .030 ug/l for Diazinon.

* This treatment was taken down at 144 hours.

Table H-7
Greene's Landing 3/22/95-3/24/95, Mosher Slough 3/24/95, Duck Slough 3/25/95 and Ulatis Creek 3/25/95, SJR at Vernalis 3/25/95
7-Day *Ceriodaphnia* Test[1,2]
Set up on 3/29/95

Treatment	% Mortality for each day of the test[3]							Conclusions	Chlorpyrifos(µg/l)	Diazinon (µg/l)	Final pH @ 48hrs
	1	2	3	4	5	6	7				
Laboratory Control						35	60[NP]	Control did not meet EPA criteria for test acceptability.			7.70
SR @ Greene's Landing 3/22/95							0.0	Samples non toxic.			8.02
SR @ Greene's Landing 3/23/95							0.0				8.23
SR @ Greene's Landing 3/24/95							0.0				8.24
Mosher Slough 3/24/95	100	100	100	100	100	100	100	Toxicity detected.	0.116	.110	7.57*
Duck Slough 3/25/95	100	100	100	100	100	100	100		0.677	.037(10.1)	7.86*
Ulatis Creek 3/25/95							0.0	Samples non toxic.		.056	7.79
SJR at Vernalis 3/25/95							0.0				7.86

NP *This test did not meet the criteria for test acceptability.* The mortality exceeded 20%.
1. Four replicates with 18 mls of sample and five Ceriodaphnia each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day.
3. Highlighted cells indicate areas of significant interest. No statistical analyses were done.
* Final pH taken at 24 hours
(#) Number in parentheses represents CV% for the ELISA run which exceeds the acceptable value according to the lab QA manual.
ND Non Detect Detection limits for ELISA kits are .080 µg/l for Chlorpyrifos and .030 µg/l for Diazinon.

Table H-8
Duck Slough 3/31/95 8-Day *Ceriodaphnia* Test[1,2]
Set up on 4/5/95
The results of this experiment imply that toxicity persisted in the field for at least 10 days.

Treatment[4]	% Mortality for each day of the test[3]								Conclusions	Chlorpyrifos (µg/l)	Final pH @ 48 hrs
	1	2	3	4	5	6	7	8			
Laboratory Control								0	Control met all EPA criteria for test acceptability.		7.93
Duck Slough 3/31/95[5]	100	100	100	100	100	100	100	100	Toxicity detected.	0.303(25.2)	8.18*

1. Three replicates with 18 mls of sample and five Ceriodaphnia each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day
3. Highlighted areas idicate a significant increase in mortality relative to the laboratory control water. The mortality endpoint was anayzed using Fisher's Exact Test.
4. Waters were not renewed on day 7.
5. Duck Slough 3/31/95 was tested with Cache Creek water samples. Data for the Cache Creek water samples are summarized in a separate table.

ND Non Detect Detection limits for ELISA kits are .080 µg/l for Chlorpyrifos and .030 µg/l for Diazinon.
(#) Number in parentheses represents the CV% for the ELISA run which exceeds the acceptable value according to the lab QA manual.
* Final pH at 24 hours.

APPENDIX I

CERIODAPHNIA CACHE CREEK MONITORING

Table I-1
Cache Creek 3/21/95 7-day *Ceriodaphnia* Test
Set up on 3/22/95

Treatment	Reproduction[1] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control	23.7[P]	2.9	10[P]	8.24
Cache Creek @ 102	4.5	0.3	0	7.68

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

Table I-2
Cache Creek 3/9/95 to 3/21/95, Bear Creek 3/10/95 and 3/13/95 8-Day *Ceriodaphnia* Test[1,2]
Set up on 4/5/95

Treatment[3]	% Mortality for each day of the test[4]								Final pH @ 48 hrs
	1	2	3	4	5	6	7	8	
Laboratory Control								0.0[P]	7.93
Cache Creek @ 102 3/9/95			6.7	6.7	13.3	13.3	13.3	33.3	7.84
Cache Creek @ 102 3/10/95				20	60	66.7	73.3	80	7.89
Cache Creek @ 102 3/13/95			13.3	53.3	100	100	100	100	7.83
Cache Creek @ 102 3/21/95			13.3	13.3	20.0	73.3	80	80	8.58
Cache Creek @ Rumsey 3/13/95			6.7	6.7	46.7	73.3	93.3	93.3	8.59
North Fork Cache Creek 3/10/95			13.3	33.3	53.3	100	100	100	8.12
North Fork Cache Creek 3/13/95			13.3	33.3	40	40	53.3	53.3	8.10
Bear Creek 3/10/95			6.7	13.3	40	46.7	66.7	73.3	8.04
Bear Creek 3/13/95							20	66.7	8.54

P. The laboratory control met all EPA criteria for test acceptability.
1. Three replicates with 18 mls of sample and five Ceriodaphnia each.
2. Daphnids were fed the standard EPA amount of food for only four hours a day
3. Waters were not renewed on day 7.
4. Highlighted areas indicate a significant increase in mortality relative to the laboratory control water. The mortality endpoint was analyzed using Fisher's Exact Test.

Table I-3
Cache Creek 5/2/95 7-day *Ceriodaphnia* Test
Set up on 5/2/95

Treatment[1]	Reproduction[2] (neonates/adult)		Mortality (%)	Final pH @ 24 hrs
	x	s.e.		
Laboratory Control (n=9)	19.9[P]	2.0	0[P]	8.49
Cache Creek @ 102	17.0	0.9	0	8.60

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.
1. Ten replicates, except where indicated by n=9, 15 mL of sample and one *Ceriodaphnia* each.
2. Highlighted areas indicate a significant reduction in reproduction or increase in mortality relative to the laboratory control water. The reproductive endpoint was analyzed using Dunn's Test ($p<.05$) and the mortality endpoint was analyzed using Fisher's Exact Test.

APPENDIX J

SELENASTRUM ROUTINE MONITORING

Table J-1
Routine Delta 6/3/94 96-Hour *Selenastrum* Test[1]
Set up on 6/4/94

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	66.4[P]	2.3	9.12
SJR @ Vernalis	124.7	4.5	8.71
SR @ Green's Landing	294.3	7.9	9.46
Duck Slough	133.6	7.4	8.34
Prospect Slough	229.5	2.1	9.17
French Camp Slough	203.5	7.6	9.61
Ulatis Creek	230.3	3.5	9.45
Paradise Cut	36.3	4.3	8.49

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 6.9% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunn's Test ($p<.05$).

Table J-2
Routine Delta 7/12/94 96-Hour *Selenastrum* Test[1]
Set up on 7/14/94

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	42.8[P]	2.7	8.83
SJR @ Vernalis	68.2	3.5	8.37
SR @ Greene's Landing	119.6	12.2	8.54
Rock Slough	203.5	6.0	9.49
Prospect Slough	205.5	5.1	8.77
Sycamore Slough	189.0	2.5	9.66
White Slough	145.4	5.8	8.85
Paradise Cut	26.8	2.7	8.57
Hog Slough	246.8	5.8	9.53
Skag Slough	131.8	6.8	8.48
Old River @ Tracy	118.4	2.6	8.73
Lindsay Slough	192.6	7.8	9.08

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 12.5 % in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

Table J-3
Routine Delta 8/9/94 96-Hour *Selenastrum* Test[1]
Set up on 8/11/94

Treatment[3]	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	36.9[P]	1.5	9.44
Dilute EI	100.0	5.0	9.25
Dilute EI C8 Blank	134.4	14.4	8.88
SJR @ Vernalis	293.0	4.4	9.26
SR @ Greene's Landing	287.7	6.5	9.26
Rock Slough	287.8	5.1	9.60
Prospect Slough	296.5	6.6	9.58
White Slough	302.7	7.6	9.74
Lindsay Slough	311.9	8.8	9.71
Paradise Cut	147.8	10.2	8.65
Paradise Cut C8 Solid Phase Extracted Water	99.3	6.5	8.94
Haas Slough	275.3	7.1	9.95
Snag Slough	291.0	8.4	9.33
Old River @ Tracy	281.1	4.0	9.09
Sycamore Slough	264.7	3.4	9.90

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 8% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).
3. Two C8 SPE columns were used to generate the Paradise Cut rinsate water. One column plugged up after 1350 ml had run through and the second column had 1800 ml run through.

Table J-4
Routine Delta 9/1-9/2/94 96-Hour *Selenastrum* Test[1]
Set up on 9/3/94

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	87.1[P]	1.6	9.36
SJR @ Vernalis	252.3	3.5	9.37
SR @ Greene's Landing	249.6	3.8	9.30
Paradise Cut	192.6	17.0	8.87
Prospect Slough	221.6	13.6	9.25
Haas Slough	234.2	6.9	9.63
Snag Slough	242.0	4.3	9.18
Rock Slough	249.8	6.3	9.36
White Slough	254.6	6.3	9.58
Sycamore Slough	255.5	7.1	9.87
Old River @ Tracy	224.2	10.8	9.06
Lindsey Slough	286.9	7.0	9.52
Dilute EI w/.25% MeOH	14.5	0.4	8.71

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 3.7% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

Table J-5
Routine Delta 10/5-10/6/94 96-Hour *Selenastrum* Test[1]
Set up on 10/7/94

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	62.8[NP]	7.4	8.99
SJR @ Vernalis	188.8	7.9	9.17
SR @ Greene's Landing	214.9	7.6	9.25
Paradise Cut	85.5	8.9	8.63
Prospect Slough	114.9	6.2	8.87
Lindsay Slough	186.8	17.0	9.22
Snag Slough	173.4	14.9	9.04
Rock Slough	186.4	3.3	9.30
White Slough	204.0	6.8	9.29
Old River @ Tracy	159.2	6.8	8.93

NP The laboratory control did not meet all EPA criteria for test acceptability. The coefficient of variation was 23.6% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

Table J-6
Routine Delta 11/7-11/8/94 96-Hour *Selenastrum* Test[1]
Set up on 11/9/94

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	66.0[P]	1.6	9.38
SJR @ Vernalis	213.7	9.5	9.49
SR @ Greene's Landing	212.5	4.2	9.71
Paradise Cut	244.7	2.1	9.07
Prospect Slough	204.7	6.6	9.30
Lindsay Slough	244.1	10.7	9.50
Snag Slough	225.0	14.4	9.16
Rock Slough	234.8	5.3	9.61
Haas Slough	196.7	5.4	9.69
White Slough	246.6	8.1	9.61
Old River @ Tracy	240.5	6.9	9.55

P The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 4.8% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

Table J-7
Routine Delta Monitoring 12/4/94 and 12/5/94 96-Hour *Selenastrum* Test[1]
Set up on 12/6/94

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	55.0[P]	4.6	7.70
SJR @ Vernalis	224.0	7.9	9.72
SR @ Greene's Landing	238.0	7.3	9.70
White Slough	247.7	8.0	9.82
Prospect Slough	169.7	7.7	9.81
Lindsay Slough	219.1	15.0	9.78
Mosher Slough	202.8	5.8	9.51
Paradise Cut	234.3	6.5	8.97
Rock Slough	149.9	9.1	9.55
Old River @ Tracy	256.2	8.9	9.63

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 16.8% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

Table J-8
Routine Delta Monitoring 1/9/95 96-Hour *Selenastrum* Test[1]
Set up on 1/11/95

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	36.7[P]	0.8	9.70
Ulatis Creek	132.5	5.2	9.05
French Camp Slough	137.7	4.3	9.13
Haas Slough	78.6	3.7	9.02
Paradise Cut	131.4	8.8	8.77
Ryer Is. Main Drain	147.7	6.9	9.21
Duck Slough	40.3	1.9	8.96
Pierson Tract	130.2	5.5	9.13
Victoria Is. Drain	49.7	1.9	8.91
Old River @ Tracy	67.0	0.9	8.62
Upper Jones Is. Drain	185.3	8.7	9.29
Middle Roberts Is. Drain	92.2	4.5	8.24
Mosher Slough	142.9	15.3	9.26

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 4.3% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

Table J-9

Routine Delta Monitoring 2/28/95 and 3/1/95 96-Hour *Selenastrum* Test[1]
Set up on 3/2/95

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs.
Laboratory Control	83.9[P]	1.9	9.56
SR @ Greene's Landing	170.8	14.4	9.42
SJR @ Vernalis	136.4	10.1	9.36
Prospect Slough	165.2	11.1	9.27
Paradise Cut	77.4	1.7	7.88
Rock Slough	129.0	12.2	9.17
Sycamore Slough	34.0	0.6	8.96
White Slough	145.2	12.3	9.35
Old River @ Tracy	128.2	9.8	9.12
Mosher Slough	137.9	4.4	8.89
Ryer Island	127.4	13.4	8.87
Duck Slough	133.0	9.5	9.03
Pierson Tract	122.7	10.9	9.06
Upper Jones Island	163.7	5.6	9.25
Victoria Island	130.0	4.0	8.92
Lindsay Slough	136.6	2.7	9.25

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 4.6% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunn's Test ($p<.05$).

Table J-10
Routine Delta Monitoring 5/1/95 96-Hour *Selenastrum* Test[1]
Set up on 5/2/95

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	81.1[P]	3.1	8.44
SJR @ Vernalis	150.1	15.6	9.20
SR @ Greene's Landing	220.2	6.8	8.82
Prospect Slough	160.8	10.2	9.16
Victoria Island Drain	159.2	12.1	9.30
Sycamore Slough	135.3	4.9	9.32
Ulatis Creek	162.0	12.5	9.34
Paradise Cut	169.8	12.2	9.14
Rock Slough	178.4	11.7	9.19
Lindsay Slough	182.6	10.3	9.19
Old River @ Tracy	185.0	13.4	9.15

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 7.7% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunn's Test ($p<.05$).

Table J-11
Delta Routine Monitoring 5/31/95 96-Hour *Selenastrum* Test[1]
Set up on 6/1/95

Treatment	Cell Count[2] (x 10^4)		Initial pH
	x	s.e.	
Laboratory Control	73.7[P]	2.7	8.79
SR @ Greene's Landing	161.0	10.5	8.21
SJR @ Vernalis	150.4	6.7	8.49
Prospect Slough	115.0	6.7	8.49
Cache Creek	89.7	1.3	8.66
Paradise Cut	154.8	7.3	8.22
Rock Slough	169.6	10.8	8.29
Sycamore Slough	180.8	11.0	7.84
White Slough	140.2	7.3	8.23
Old River @ Tracy	169.2	10.9	8.04
Lindsay Slough	172.5	13.5	8.06
Mosher Slough	151.1	8.3	8.26

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 7.4% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunn's Test ($p<.05$).

Table J-12
Routine Delta Monitoring 6/27/95 96-Hour *Selenastrum* Test[1]
Set up on 6/28/95

Treatment	Cell Count[2] (x 10^4)		Final ph
	x	s.e.	@ 96 hrs
Laboratory Control	64.2[NP]	7.6	8.05
SR @ Greene's Landing	230.3	14.3	8.43
SJR @ Vernalis	235.4	6.0	9.50
Prospect Slough	130.6	15.5	8.83
Mosher Slough	257.7	4.4	9.82
Paradise Cut	142.1	8.5	8.58
Rock Slough	269.2	7.1	9.52
Sycamore Slough	223.8	6.8	9.77
White Slough	265.4	7.3	9.83
Old River @ Tracy	219.1	4.1	9.68
Lindsay Slough	218.8	11.3	9.30

NP The laboratory control did not meet all EPA criteria for test acceptability. The coefficient of variation was 23.8% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

Table J-13
Routine Delta Monitoring 7/17/95 96-Hour *Selenastrum* Test[1]
Set up on 7/18/95

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	63.6[P]	3.8	8.01
SR @ Greene's Landing	243.5	13.9	9.43
SJR @ Vernalis	239.6	8.0	9.58
Prospect Slough	247.2	7.9	9.38
Paradise Cut	228.2	12.0	9.30
Rock Slough	188.5	6.2	9.72
Sycamore Slough	261.0	6.6	9.80
White Slough	242.6	8.8	9.81
Mosher Slough	185.7	8.6	9.95
Old River @ Tracy	237.8	16.2	9.69
Lindsay Slough	189.1	15.6	9.56

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 12.0% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

APPENDIX K

SELENASTRUM RAIN EVENTS

Table K-1
Delta Rain Event 3/8/95, 3/9/95 96-Hour *Selenastrum* Test[1]
Set up on 3/10/95

Treatment	Cell Count[2] (x 10^4)		Final pH
	x	s.e.	@ 96 hrs
Laboratory Control	49.7[P]	2.4	8.53
SR @ Greene's Landing 3/9/95 (n=3)	198.9	18.0	9.04
SJR @ Vernalis 3/8/95	143.1	6.4	9.17
SJR @ Vernalis 3/9/95	143.1	7.6	9.13
Ulatis Creek 3/9/95	70.3	3.9	8.29
Ryer Island Drain 3/9/95	152.8	5.8	8.90
Duck Slough 3/9/95	145.4	4.3	8.92
Mosher Slough 3/9/95	211.8	9.0	9.24
Old River @ Tracy 3/9/95	153.9	18.1	9.00
French Camp Slough 3/9/95	162.0	6.0	9.05
Paradise Cut 3/9/95	94.5	5.6	8.55

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 9.6% in this treatment.
1. Four replicate flasks, except where indicated by n=x, with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

Table K-2

Delta Rain Event 3/13/95 and 3/15/95 96-Hour *Selenastrum* Test[1]
Set up on 3/17/95

Treatment	Cell Count[2] (x 10^4)		Final pH @ 96 hours
	x	s.e.	
Laboratory Control	35.0[P]	1.4	9.14
Sycamore Slough 3/13/95	67.0	2.2	8.90
Ulatis Creek 3/13/95	205.0	7.1	8.93
Paradise Cut 3/15/95	111.1	3.5	8.31

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 8.0% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$).

APPENDIX L

SELENASTRUM SPECIAL STUDIES

Table L-1
Paradise Cut Special Study 6/3/94 96-Hour *Selenastrum* Test[1]
Set up on 6/4/94

Treatment	Cell Count[2] (x 10^4)		Rationale for Site Location
	x	s.e.	
Laboratory Control	66.4[P]	2.3	
Paradise Cut	36.3	4.3	Original site of historical toxicity detection. Influenced by several sources.
Sugar Cut	79.5	2.9	Influenced by groundwater recharge and Tracy Wastewater Treatment Plant
Grantline	64.6	3.6	Potential downstream impact from Paradise Cut. Influenced by agricultural runoff.
Old River @ Tracy	69.2	5.2	Historical toxicity and potential downstream impact from Paradise Cut.
Tom Payne Slough	62.1	4.0	Potential source water into Paradise Cut. Influenced by agricultural runoff.
Upstream Paradise Cut	44.6	5.6	Potential source water into Paradise Cut.
Tracy Wastewater Treatment Plant outfall	223.2	18.6	Outfall of Tracy Wastewater Treatment Plant discharge.

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 6.9% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunn's Test ($p<.05$).

Table L-2
Paradise Cut Special Study 6/14/94 96-Hour *Selenastrum* Test[1]
Set up on 6/15/94

Treatment	Cell Count[2] (x 10^4)		Rationale for Site Location
	x	s.e.	
Laboratory Control	86.3[P]	2.2	
Paradise Cut	112.8	2.9	These sites isolate different agriculture sources including specific land tracts, water sources, and crops.
Paradise Cut at Paradise Dam	185.5	9.1	
Stewart's Tract West Drain	206.9	2.2	
Agricultural drain at Mac Arthur Blvd.	60.5	0.3	
Agricultural drain at Pescadero	125.7	8.4	
San Joaquin River	163.9	17.4	
Agricultural drain at Delta Ave.	154.4	7.2	
Stewart's Tract East Drain	86.9	8.7	
Duel Vocational Institute (NPDES)	190.5	7.4	NPDES discharge source.

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 5.1% in this treatment.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunn's Test ($p<.05$).

Table L-3
Paradise Cut Agricultural Inputs 6/22/94 96-Hour *Selenastrum* Test[1]
Set up on 6/23/94

Treatment	Cell Count[2] (x 10^4)		Rationale for Site Location
	x	s.e.	
Laboratory Control	52.1[P]	2.6	
Paradise Cut *	171.9	5.1	Historical toxicity.
Stewart's Tract East drain*	172.3	8.2	These sites isolate different agriculture sources including specific land tracts, water sources, and crops.
Agricultural drain at Mac Arthur Blvd.*	166.4	8.3	
Alfalfa @ Tom Payne Slough*	199.1	4.8	This site represents drainage from a specific type of crop.
El Rancho South Drain	151.4	13.3	This site isolates different agriculture sources including specific land tracts, water sources, and crops.
Corn	152.4	12.8	These sites represent drainage from different types of crops.
Safflower	224.8	11.8	
Alfalfa	56.1	0.4	
Sullivan's Tile Drain	17.5	1.6	Representative of a tile drain input.
Upstream Tom Payne Slough @ Paradise Reclamation District Office	165.0	7.3	Representative of a tile drain input.

P. The laboratory control met all EPA criteria for test acceptability. The coefficient of variation was 9.8% in this treatment.
1. Four replicate flasks (except two where noted *) with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Kruskall-Wallis Test ($p<.05$).
* These samples were pumped through C8 SPE columns but the C8 solid phase extracted water did not alleviate the toxicity.

APPENDIX M

INDIVIDUAL *SELENASTRUM* TIE SUMMARIES

Table M-1
Paradise Cut and Inputs 6/3/94 96-hour *Selenastrum* Phase I TIE[1]
Set up on 6/10/94

Treatment[3]	Cell Count (x 10^4)		Conclusions[2]	Final pH
	x	s.e.		@ 96 hrs
Laboratory Control	31.2[NP]	3.4	Control did not meet all EPA criteria for test acceptability .	9.06
Dilute EI (Secondary Control)	203.4	23.9		8.49
Dilute EI C8 Blank for Paradise Cut	179.1	21.6	No artifactual enhancement detected in control blank.	8.64
Paradise Cut	178.2	8.7	Improvement of CSPEW relative to the ambient water	8.52
Paradise Cut C8 Solid Phase Extracted Water (CSPEW)	259.4	9.7	may suggest the presence of an organic..	8.77

NP. The laboratory control did not meet all EPA criteria for test acceptability. The coefficient of variation was 21.6% in this treatment.

1. All replicate flasks contained 100 ml of sample in each flask.
2. Comparisons between an ambient water and it's C8 solid phase extracted water were also made with a two taled unpaired t-test (p0.05)
3. 1000 ml of each water was run through a C8 SPE column at a rate of 10.0 ml/min.

Table M-2
Mac Arthur and Stewart's Tract East 6/14/94 96-hour *Selenastrum* Phase I TIE[1]
Set up on 6/25/94
The results of this experiment imply that toxicity in the MacArthur sample was due to a non polar organic chemical.

Treatment[3]	Cell Count[2] (x 10^4)		Conclusions	Final pH @ 96 hrs
	x	s.e.		
Laboratory Control	64.2[P]	5.4	Control met EPA criteria for test acceptability (CV=16.8%).	7.81
Dilute EI (Secondary Control)	186.5	10.9		8.25
Dilute EI C8 Blank for Mac Arthur	135.8	5.6	No artifactual enhancement in control blank.	8.61
Dilute EI C8 Blank for Stewart's T.E.	204.8	7.1	Artifactual enhancement in control blank.	8.66
Mac Arthur	72.1	3.4	Toxicity detected.	8.81
Mac Arthur C8 Solid Phase Extracted Water (CSPEW)	297.5	9.8	Significant increase in cell counts relative to ambient water suggests that a non polar organic chemical is responsible for toxicity.	9.27
Stewart's Tract East	226.5	6.1	Due to enhancement in control blank no conclusions	8.50
Stewart's Tract East CSPEW	285.2	3.3	can be made.	8.94

P. The laboratory control met all EPA criteria for test acceptability.
1. Four replicate flasks with 100 ml of sample in each flask.
2. Highlighted areas show a significant reduction in growth compared to the laboratory control. Cell counts were analyzed using Dunnett's Test ($p<.05$). Comparisons between ambient water and C8 solid phase extracted waters were done using a two tailed unpaired t-test (p0.05)..
3. 1000 ml of Mac Arthur and Stewart's Tract East waters were run through C8 SPE columns at a rate of 5 to 6 ml/min.

Table M-3
Duck Slough and Victoria Island 1/9/95 96-hour *Selenastrum* Phase I TIE[1]
Set up on 1/23/95
The results of this experiment imply that toxicity was due to a non polar organic chemical.

Treatment[3]	# of Reps.	Cell Count[2] (x 10^4)		Conclusions	Final pH @ 96 hrs
		x	s.e.		
Laboratory Control	4	53.6[P]	2.1	Control met all EPA criteria for test acceptability.(CV=7.7%)	7.85
Dilute EI	4	95.0	1.2		8.23
Dilute EI C8 Blank for Duck Sl.	4	43.4	2.5	No artifactual enhancement in control blanks.	8.25
Dilute EI C8 Blank for Victoria Is.	4	51.0	4.5		8.23
Duck Sl.	3	63.4	2.9	Toxicity detected	8.86
Duck Sl. C8 Solid Phase Extracted Water (CSPEW)	4	302.9	9.5	Significant increase in cell counts relative to ambient water suggests that a non polar organic chemical is responsible for toxicity	9.58
Victoria Is.	3	84.0	1.6	Toxicity detected	8.55
Victoria Is. CSPEW	4	268.5	4.2	Significant increase in cell counts relative to the ambient water suggests that a non polar organic chemical is responsible for toxicity	9.50

P. The laboratory control met all EPA criteria for test acceptability.
1. All replicate flasks contained 100 ml of sample in each flask.
2. Comaprisons between ambient water and C8 solid phase extracted water were made with a two tailed umpaired t-test ($p<.05$).
3. 1200 ml of each water was run through a C8 SPE column at a rate of 10.0 ml/min.

Table M-4
Paradise Cut 3/9/95 and Ulatis Creek 3/9/95 96-hour *Selenastrum* Phase I TIE[1]
Set up on 3/17/95
The results of this experiment imply that toxicity in the Ulatis Creek sample might have been due to a non polar organic chemical.

Treatment[3]	# of reps.	Cell Count[2] (x 10^4)		Conclusions	Final pH @ 96 hrs
		x	s.e.		
Laboratory Control	4	35.0[P]	1.4	Control met all EPA criteria for test acceptability.(CV=8.0%)	9.14
Dilute EI (Secondary Control)	4	37.5	5.7		8.52
Dilute EI C8 Blank for Paradise Cut	4	35.2	5.5	No artifactual enhancement in control blanks.	8.59
Dilute EI C8 Blank for Ulatis Creek	4	24.9	1.4		8.68
Paradise Cut 3/9/95	3	117.7	5.5		8.59
Paradise Cut 3/9/95 C8 Solid Phase Extracted Water (CSPEW)	4	134.1	4.1		8.64
Ulatis Creek 3/9/95	3	90.7	7.7	Toxicity detected	8.93
Ulatis Creek 3/9/95 CSPEW	4	217.9	7.0	Significant recovery of cell growth relative to control. Water treatment + non polar organic chemical is responsible for toxicity.	9.27

P. The laboratory control met all EPA criteria for test acceptability.
1. Each replicate flask with 100 ml of sample in each flask.
2. Highlighted cells indicate areas of significant interest. Cell counts were analyzed using Dunnett's Test ($p<.05$).
3. 1200 ml of each water was run through a C8 SPE column at a rate of 10.0 ml/min.

Table M-5
Paradise Cut 7/12/94 96-hour *Selenastrum* Phase I TIE[1]
Set up on 7/23/94

Treatment[2]	Cell Count (x $10^{4)}$		Conclusions	Final pH
	x	s.e.		@ 96 hrs
Laboratory Control	45.3[P]	2.0	Control met EPA criteria for test acceptability (CV=8.6%).	8.06
Dilute EI (Secondary Control)	224.2	21.2		8.78
Dilute EI C8 Blank for Paradise Cut (n=3)	252.5	36.1	No artifactual toxicity detected in the control blank.	8.84
Paradise Cut	338.0	5.7	Toxicity lost due to storage time.	9.47
Paradise Cut C8 Solid Phase Extracted Water	309.9	7.7	No artifactual enhancement resulting from manipulation.	9.36

P. The laboratory control met all EPA criteria for test acceptability.
1. Four replicate flasks, except where noted by n=x, with 100 ml of sample in each flask.
2. Control C8 Blank and Paradise Cut C8 solid phase extracted waters were generated from the daphnid experiment.

Table M-6
Sycamore Slough 2/28/95 and Paradise Cut 3/1/95 96-hour *Selenastrum* Phase I TIE[1]
Set up on 3/10/95
The results of this experiment imply that a toxicity in the Paradise Cut sample was due to a non polar organic chemical.

Treatment[3]	# of reps.	Cell Count (x 10^4)		Conclusions[2]	Final pH @ 96 hrs
		x	s.e.		
Laboratory Control	4	49.7[P]	2.4	Control met all EPA criteria for test acceptability.(CV=9.6%)	8.53
Dilute EI (Secondary Control)	4	33.2	3.1		8.87
Dilute EI C8 Blank for Sycamore Slough	2	45.3	2.1	No artifactual enhancement in control blanks.	8.41
Dilute EI C8 Blank for Paradise Cut	2	42.0	0.5		8.40
Sycamore Slough 2/28/95	4	35.7	0.5	No toxicity detected.	8.75
Sycamore Slough C8 Solid Phase Extracted Water (CSPEW)	4	46.1	3.7		8.78
Paradise Cut 3/1/95	3	93.7	5.5	No toxicity detected.	8.56
Paradise Cut CSPEW	4	128.4	7.1		8.52

P. The laboratory control met all EPA criteria for test acceptability.
1. Each replicate flask with 100 ml of sample.
2. Comparisons between ambient samples and C8 solid phase extracted waters were made with a two tailed, unpaired t-test $p<.05$).
3. 1200 ml of each water was run through a C8 SPE column at a rate of 10.0 ml/min.

APPENDIX N

PIMEPHALES ROUTINE MONITORING

Table N-1
Routine Delta Monitoring 12/4/94 and 12/5/94 7-Day *Pimephales* Test[1,2]
Set up on 12/7/94

Treatment	Growth (mg)[3]		Mortality (%)		Final pH @ 24 hrs
	x	se	x	s.e.	
Laboratory Control	.287[P]	.009	0.0[P]	0.0	7.77
SR @ Greene's Landing	.313	.009	6.7	6.7	7.95
SJR @ Vernalis	.320	.010	10.0	5.8	8.20
Ulatis Creek	.313	.015	0.0	0.0	8.18
French Camp Slough	.333	.020	3.3	3.3	8.12
Ryer Is. Main Drain	.327	.009	3.3	3.3	8.40

P. The SSEPAMH and Dilute EI controls both met the EPA criteria for test acceptability. Dilute EI is used as a secondary control in this experiment since it had only two replicate beakers.
1. Three replicate beakers, except Dilute EI which had two replicate beakers, with 250 ml of sample and 10 minnows in each replicate.
2. Minnows were fed three times daily.
3. Highlighted areas indicate a significant increase in mortality or decrease in growth when compared to the Dilute EI control. he growth and mortality endpoints were analyzed with Dunnett's Test ($p<.05$).

APPENDIX O

PIMEPHALES RAIN EVENTS

Table O-1
Delta Rain Event 1/9/95-1/14/95 *Pimephales* Test[1,2]
Set up on 1/14/95

Treatment	Growth (mg)		Mortality (%)[3]		Final pH @ 24 hrs
	x	se	x	s.e.	
Laboratory Control	0.280[P]	0.010	0.0[P]	0	8.22
SJR @ Vernalis 1/9	0.298	0.010	13.3	8.8	7.98
SJR @ Vernalis 1/10	0.330	0.009	15.5	10.9	7.97
SJR @ Vernalis 1/11	0.310	0.006	3.03	3.0	8.02
SJR @ Vernalis 1/12	0.290	0.006	0.0	0.0	8.11
SJR @ Vernalis 1/13	0.313	0.009	0.0	0.0	8.06
SJR @ Vernalis 1/14	0.281	0.029	3.7	3.7	7.90
SR @ Greene's Landing 1/10	0.295	0.010	6.7	6.7	8.30
SR @ Greene's Landing 1/11	0.297	0.024	3.3	3.3	8.30
SR @ Greene's Landing 1/12	0.285	0.019	2.8	2.8	8.18
SR @ Greene's Landing 1/13	0.282	0.009	13.3	8.8	8.09
SR @ Greene's Landing 1/14	0.282	0.016	0.0	0.0	8.21

P. The laboratory control met all EPA criteria for test acceptability.
1. Three replicate beakers with 250 ml of sample and 10 minnows in each replicate.
2. Minnows were fed three times daily.
3. Highlighted areas indicate a significant increase in mortality or decrease in growth when compared to the laboratory control The growth and mortality endpoints were analyzed with Dunnett's Test ($p<.05$).

Table O-2
SR @ Greene's Landing 5/1/95 7-day *Pimephales* Test[1,2]
Set up on 5/3/95

Treatment	Growth (mg)		Mortality (%)[3]		Final pH
	x	se	x	s.e.	@ 24 hrs
Laboratory Control	0.25[P]	0.01	0[P]	0	8.29
SR @ Greene's Landing	0.22	0.003	0	0	7.69

P. The laboratory control met all EPA criteria for test acceptability.
1. Three replicate beakers with 250 ml of sample and 10 minnows in each replicate.
2. Minnows were fed three times daily.
3. Highlighted areas indicate a significant increase in mortality or decrease in growth when compared to the laboratory control. The growth and mortality endpoint were analyzed with Dunnett's Test ($p<.05$).