

Dissolved Pesticide and Organic Carbon Concentrations Detected in Surface Waters, Northern Central Valley, California, 2001–2002

By James L. Orlando, Lisa A. Jacobson, and Kathryn M. Kuivila

In cooperation with the California Bay-Delta Authority

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Conversion Factors, Datum, and Abbreviations

Multiply		By	To obtain
	liter (L)	0.2642	gallon
	microliter (μ L)	0.0002642	gallon
	micrometer (μ m)	0.0000394	inch
	millimeter (mm)	0.03937	inch
	millimeter per day (mm/day)	0.03937	inch per day

Temperature in degrees Celsius ($^{\circ}$ C) may be converted to degrees Fahrenheit ($^{\circ}$ F) as follows:

$$^{\circ}\text{F}=1.8\text{ }^{\circ}\text{C}+32$$

Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness $[(\text{ft}^3/\text{d})/\text{ft}^2]\text{ft}$. In this report, the mathematically reduced form, foot squared per day (ft^2/d), is used for convenience.

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviations

DOC	dissolved organic carbon
GS/MS	gas chromatograph-mass spectrometer
L	liter
mm	millimeter
μ L	microliter
μ m	micrometer
NPOC	nonpurgeable organic carbon
PVC	polyvinyl chloride

Organizations

FWS U.S. Fish and Wildlife Service

USGS U.S. Geological Survey

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Abstract

Field and laboratory studies were conducted to determine the effects of pesticide mixtures on Chinook salmon under various environmental conditions in surface waters of the northern Central Valley of California. This project was a collaborative effort between the U.S. Geological Survey (USGS) and the University of California. The project focused on understanding the environmental factors that influence the toxicity of pesticides to juvenile salmon and their prey. During the periods January through April 2001 and January through May 2002, water samples were collected at eight surface water sites in the northern Central Valley of California and analyzed by the USGS for dissolved pesticide and dissolved organic carbon concentrations. Water samples were also collected by the USGS at the same sites for aquatic toxicity testing by the Aquatic Toxicity Laboratory at the University of California Davis; however, presentation of the results of these toxicity tests is beyond the scope of this report. Samples were collected to characterize dissolved pesticide and dissolved organic carbon concentrations, and aquatic toxicity, associated with winter storm runoff concurrent with winter run Chinook salmon out-migration. Sites were selected that represented the primary habitat of juvenile Chinook salmon and included major tributaries within the Sacramento and San Joaquin River Basins and the Sacramento–San Joaquin Delta. Water samples were collected daily for a period of seven days during two winter storm events in each year. Additional samples were collected weekly during January through April or May in both years. Concentrations of 31 currently used pesticides were measured in filtered water samples using solid-phase extraction and gas chromatography-mass spectrometry at the U.S. Geological Survey's organic chemistry laboratory in Sacramento, California. Dissolved organic carbon concentrations were analyzed in filtered water samples using a Shimadzu TOC-5000A total organic carbon analyzer.

Introduction

Background

The study area within the northern Central Valley of California encompasses nearly 25 million acres and is drained by two major river systems, the Sacramento and the San Joaquin Rivers ([fig. 1](#)). Over five million acres within these two watersheds are devoted primarily to agriculture and produce a wide variety of crops. The area also contains numerous urban centers of varying size with a combined area of over half a million acres that support a population of over five and a half million people (U.S. Census Bureau, 2000).

During 2001, nearly 42 million pounds of pesticide active ingredient were applied in the Central Valley (California Department of Pesticide Regulation, 2001). Much of this application occurred during the winter and early spring and coincided with the region's peak annual rainfall–runoff, as well as the local, winter–spring migration of Chinook salmon. This coincidence of high use, rainfall–runoff, and salmon migration raises concern for the potential environmental effects of these pesticides.

In the Central Valley, previous studies have shown that the first significant rainfall (greater than 12.7 mm/day [0.5 in./day]) and subsequent runoff following the winter application of dormant-spray pesticides is accompanied by a rise in the detected concentrations of these same pesticides in downstream surface waters (Kuivila and Foe, 1995; Kratzer, 1997; Dubrovsky, and others, 1998). Studies have also shown these pulses of multiple pesticides to be acutely toxic to the aquatic invertebrate *Ceriodaphnia dubia* (Foe and Connor, 1991; Kuivila and Foe, 1995). However, little is known about the potential toxic effects of mixtures of pesticides on juvenile Chinook salmon or their prey.

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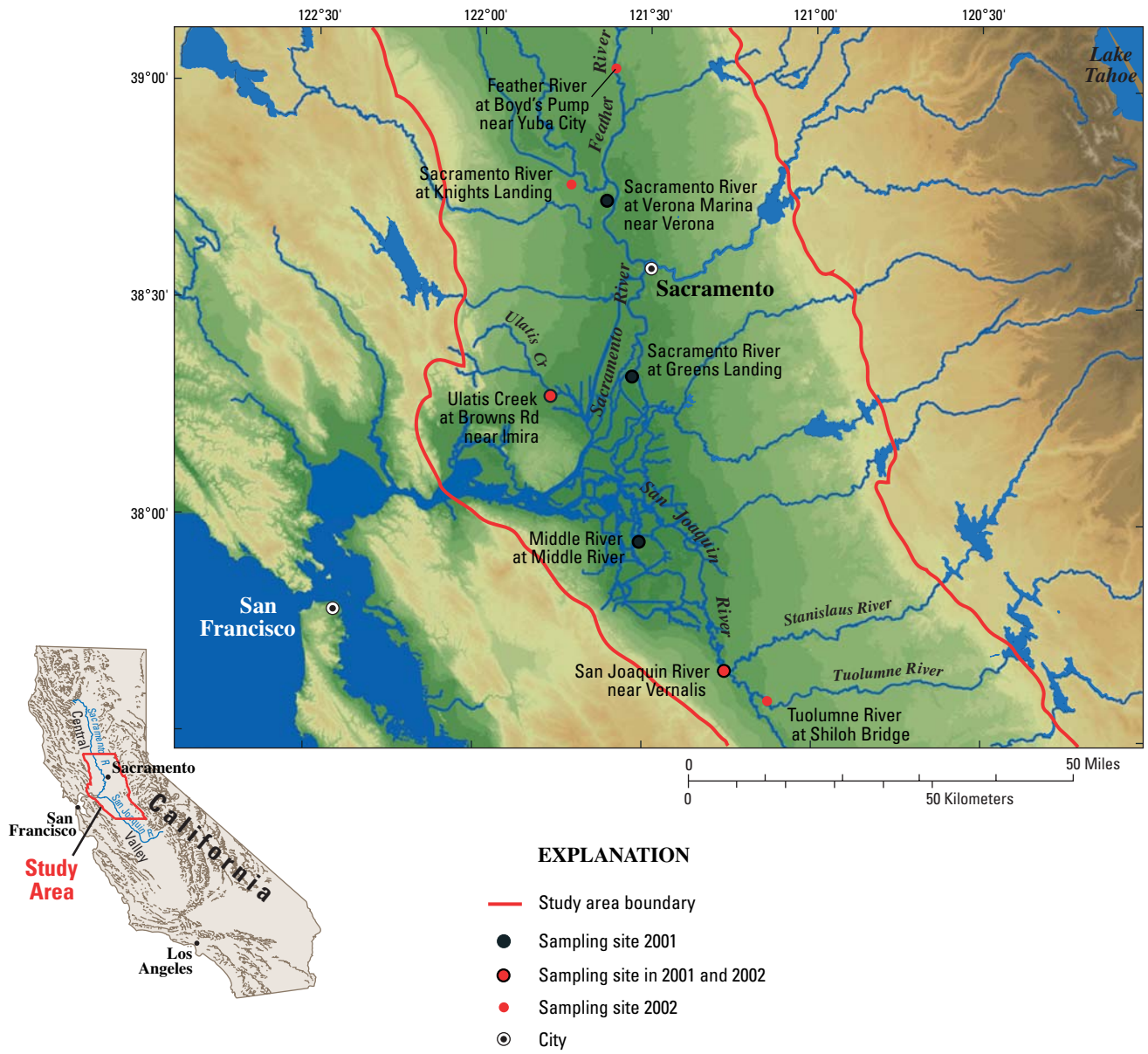


Figure 1. Study area and sampling sites in the northern Central Valley, California.

In addition, the toxicity of pesticides and other organic pollutants to aquatic species is influenced by environmental factors such as dissolved organic matter found in natural waters (Haitzer, and others, 1998). Dissolved organic matter is most commonly quantified in terms of dissolved organic carbon (DOC). The concentration and type of dissolved organic matter can influence the toxicity of the contaminant by increasing or decreasing its bioavailability to aquatic species (Kukkonen and Oikari, 1987; Benson and Long, 1991; Day, 1991; Kadlec and Benson, 1995). It is, therefore, beneficial to measure DOC concentrations when relating pesticide concentrations in natural waters to observed toxicity.

Purpose and Scope

This report describes the methods and procedures used during sample collection and analysis, and presents analysis results for water samples collected during this study. Concentrations of 31 currently (2002) used pesticides analyzed in 234 water samples are presented. DOC concentrations analyzed in 82 water samples are also presented, as are method detection limits for pesticides analyzed in this study. During the field study, the USGS was responsible for selection of sampling sites, initiation of field sampling, collection of water samples, and chemical analysis of water samples. DeltaKeeper, a nonprofit environmental monitoring group in Stockton, California, assisted with sample collection. Water samples were analyzed for dissolved pesticides and DOC at the USGS organic chemistry laboratory in Sacramento, California.

Project Design

The overall project was designed to determine the toxicity to juvenile Chinook salmon and their prey of storm-runoff events that contained elevated concentrations of multiple pesticides. Laboratory and field studies were developed to understand both the effects of exposure to mixtures of pesticides that occurred in repeated pulses and the influence of environmental factors on pesticide toxicity. This research project was a collaborative effort among the U.S. Geological Survey (USGS), the University of California at Berkeley, the University of California at Davis, and the U.S. Fish and Wildlife Service (FWS) from 2000 to 2004.

The laboratory experiments focused on understanding factors that influence toxicity to salmon and their prey. Toxicity testing protocols were developed and employed to test toxicity of pesticide mixtures to juvenile salmon and native invertebrate species that are important food sources for salmon. Other laboratory studies explored the interaction between dissolved organic matter and pesticides, and the influence of dissolved organic matter on bioavailability and toxicity.

The field study consisted of pesticide analyses and laboratory toxicity testing of surface waters collected during January through April 2001 and January through May 2002. Water samples were collected at eight sites ([fig. 1](#)) in the Sacramento and San Joaquin River Basins and the Sacramento–San Joaquin Delta and analyzed for pesticide and DOC concentrations. Water samples collected for laboratory toxicity testing were used in laboratory bioassays by U.C. Davis's Aquatic Toxicology Laboratory; however, presentation of the results of these analyses are beyond the scope of this report and are not included. The timing of field sampling corresponded with the winter–spring migration of Chinook salmon.

Acknowledgements

The authors gratefully acknowledge Patricia von Phul of the USGS and DeltaKeeper personnel for assistance with sample collection and logistical support during this project. The authors also wish to acknowledge Jacqueline Houston, Lupe Herrera, Patrick Nicholas, and Theresa Pedersen of the USGS for their many hours of laboratory work and pesticide analyses. This project was funded by the California Bay-Delta Authority (project # 99-N08) and the U.S. Geological Survey's Toxic Substances Hydrology Program.

Study Design and Methodology

Selection of Sampling Sites

Sampling sites were selected to be representative of Chinook salmon habitats. Other criteria for site selection included local agricultural practices, past and current use of pesticides, previous surface water detections of dissolved pesticides, proximity to FWS fish collection sites, and the safety of field personnel during storm conditions. In 2001, five sites were sampled: three sites within the Delta (Greens Landing, Ulatis Creek, and Middle River) and one each within the San Joaquin (Vernalis) and Sacramento River Basins (Verona) ([fig. 1](#); table 1, at the back of this report). Samples collected at three of these sites (Verona, Greens Landing, and Middle River) contained only low concentrations of pesticides and did not cause toxicity to invertebrate test organisms; therefore, these sites were replaced in 2002 by three other sites (Boyd's Pump, Knight's Landing, and Tuolumne River at Shiloh) located farther upstream in the respective watersheds, closer to areas of current pesticide application. The locations are shown in [fig. 1](#), and site information is given in table 1. Because water samples collected at Vernalis and Ulatis Creek contained elevated pesticide concentrations and caused toxicity in laboratory bioassays, these sites were sampled again in 2002.

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Sample Collection

Field sampling was conducted beginning in early January each year and continued through the end of April in 2001 and the end of May in 2002. Samples were collected daily during the first two major storms (rainfall greater than 12.7 mm/day [0.5 in./day]) after local application of dormant spray pesticides, and weekly during the balance of the sampling periods. Water samples were collected for analysis of dissolved pesticides and DOC and used in aquatic toxicity testing. Tables 2 and 3 show a matrix of the dates and types of samples collected at each sampling site during 2001 and 2002, respectively. The matrix shows samples collected for blanks, DOC, pesticides, and aquatic toxicity.

Pesticide Samples

Samples were collected for pesticide analysis at all sites on each sample date during the course of the study (tables 2 and 3). At all of the sites except Boyd's Pump, water samples were collected as mid-channel grabs from bridges using a weighted 3-L Teflon bottle sampler. At each site, a pre-cleaned Teflon bottle was used after having been rinsed three times with native water. All samples were collected at a depth of approximately 0.5 m. Following collection, the samples were split into fractions by manually shaking the Teflon bottle and pouring into two 1-L baked, amber glass bottles. At Boyd's Pump, 2 L of sample water were collected from the shore by using an extendable pole to submerge single 1-L amber glass bottles. All samples were immediately placed on ice and transported to the U.S. Geological Survey's organic chemistry laboratory in Sacramento.

DOC Samples

To assess the effects of dissolved organic matter on pesticide toxicity, samples were analyzed for DOC concurrently with pesticide analysis and toxicity testing. Water samples collected for pesticide and DOC analysis were split from a single grab sample with DOC samples placed into 250-mL baked, amber glass bottles and preserved on ice. Although all five sites were analyzed for DOC concentration in 2001, water samples from only one site (Ulati Creek) were determined to be acutely toxic to a test organism (*Ceriodaphnia dubia*) in laboratory bioassays and had the highest DOC concentrations. Therefore, in 2002, samples for

DOC analysis were collected only at Ulati Creek and on nearly every sampling date (table 3).

Toxicity Samples

Water samples for toxicity testing were collected generally biweekly at all eight sampling sites, but under varying schedules in order to accommodate testing schedules at the U.C. Davis Aquatic Toxicology Laboratory (tables 2 and 3). Samples were collected more frequently during storms, and collection methods varied depending on streamflow conditions. During periods of moderate streamflow, samples were collected using a specially designed, weighted polyvinyl chloride (PVC) sampler capable of submerging a 4-L, acid washed, glass container. After rinsing the sample containers three times with native water, samples were collected at a depth of approximately 0.5 m as mid-channel grabs from bridges. During periods of very low flow (water depth too shallow to submerge PVC sampler), or high flow (stream velocity too high for safe deployment of PVC sampler), samples were collected in multiple grabs using a weighted 3-L Teflon bottle sampler and then poured directly into 4-L acid washed glass containers. All samples were preserved on ice and delivered within 6 hours of collection to the U.C. Davis Aquatic Toxicology Laboratory. Samples were tested for toxicity to three aquatic invertebrates *Ceriodaphnia dubia*, *Simocephalus sp.*, and *Chironomus tentans*. Presentation of the results of these analyses is beyond the scope of this report.

Sample Processing and Analysis

Pesticide Analysis

Water samples collected for pesticide analysis were filtered through baked, 0.7- μ m glass fiber filters within 24 hours of sampling, and a surrogate compound, terbutylazine, was added to provide quantitative data on extraction efficiency. Samples were then extracted onto C8 solid-phase extraction cartridges. The cartridges were then dried using compressed carbon dioxide, frozen, and stored for up to 6 months. For analysis, the cartridges were thawed and then eluted with 9 mL of ethyl-acetate. The eluant was concentrated and analyzed for 31 pesticides using a Varian Saturn gas chromatograph-mass spectrometer (GC/MS) with ion-trap detection. Details of the analytical method are described in Kuivila and Pedersen (2003).

Four types of quality control data were collected: field equipment blanks, replicate samples, matrix spikes, and surrogate recovery. Equipment blanks accounted for 7 percent of the total number of samples analyzed in 2001 and 2 percent in 2002. None of the pesticides were detected in the blanks. Replicate samples accounted for 9 percent of the samples analyzed in 2001 and 8 percent in 2002, and the differences were less than 25 percent for all the pesticides detected. As part of the method validation, recoveries of matrix spikes were determined in 12 percent of the samples analyzed in 2001 and 11 percent in 2002, and details are listed in the method reports (Kuivila and Houston, 2003; Kuivila and Pedersen, 2003). Recovery of the surrogate, terbuthylazine, was used to assess the efficiency of each extraction. The average percent recovery and standard deviation for terbuthylazine was calculated for each year. Sample data were excluded if the recovery of terbuthylazine was outside the control limit of the annual mean plus or minus two standard deviations (K.M. Kuivila and J.R. Houston, unpub. data, 2003; K.M. Kuivila and T.L. Pedersen, unpub. data, 2003).

DOC Analysis

Water samples collected for DOC analysis were filtered in series through a 2.7- μm (Whatman GF/A) glass fiber filter, a 0.7- μm (Whatman GF/F) glass fiber filter, and a 0.45- μm polypropylene (Pall Gelman GH Polypro Membrane) filter within 24 hours of sample collection. Filtered samples were stored in baked amber glass bottles at 4°C for no longer than 1 week until analysis. DOC concentrations were analyzed using a Shimadzu TOC-5000A total organic carbon analyzer. The instrument was calibrated with potassium-hydrogen-phthalate standards prepared in organic-free water, with standard concentrations bracketing the concentrations of the samples. Aliquots of filtered sample water (4.5 mL) were acidified with 30- μL of 2N HCl and sparged with N_2 for 3 minutes to remove inorganic carbon as CO_2 . The nonpurgeable organic carbon (NPOC) was analyzed by direct injection of liquid sample into a high-temperature (680°C) combustion tube packed with Pt catalyst. The CO_2 produced by oxidation of the NPOC was detected with a nondispersive infrared photometric cell. Each value reported represents the mean of three injections of the same sample. Details of the analytical method are described in Bird and others, 2003.

No quality control samples were taken during the field study in 2001. Replicate samples and field blanks were analyzed for all sampling days in 2002. Results showed replicates to be within 10 percent agreement for all samples. Values for field blank samples were less than 3 percent of the total DOC concentration for all samples.

Dissolved Pesticide and DOC Concentrations

This report presents dissolved pesticide and DOC concentrations analyzed in water samples collected during January through April 2001 and January through May 2002. Samples were collected at eight surface water sites within the Central Valley (fig. 1). During the study, 117 water samples were analyzed in each year for 31 pesticides by GC/MS at the U.S. Geological Survey's organic chemistry laboratory in Sacramento, California. DOC concentrations were analyzed in 64 field samples in 2001 and 14 samples in 2002. Results of these analyses are presented in tables 4–15. Pesticides that were detected at concentrations below the method detection limits listed in table 16 are shown in parentheses because the values are estimates. Significant figures were determined on the basis of the rounding method as described in American Society for Testing and Materials (1993).

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Tables

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Table 1. Pesticide sampling sites, Northern Central Valley, California

[Horizontal datum is NAD 83]

Official site name (Abbreviated site name)	USGS site identification No.	Latitude (degree/minute/second)	Longitude (degree/minute/second)	Years sampled
Feather River at Boyds Pump near Yuba City (Boyds Pump)	390328121363901	39° 03' 28"	121° 36' 39"	2002
Sacramento River at Knights Landing (Knights Landing)	11391000	38° 48' 11"	121° 42' 59"	2002
Sacramento River at Verona Marina near Verona (Verona)	384701121370401	38° 47' 01"	121° 37' 04"	2001
Sacramento River at Greens Landing (Greens Landing)	11447810	38° 20' 45"	121° 32' 46"	2001
Ulati Creek at Browns Road near Elmira (Ulati Creek)	11455261	38° 18' 24"	121° 47' 41"	2001, 2002
Tuolumne River at Shiloh Bridge (Tuolumne)	11290200	37° 36' 12"	121° 07' 53"	2002
San Joaquin River near Vernalis (Vernalis)	11303500	37° 40' 34"	121° 15' 59"	2001, 2002
Middle River at Middle River (Middle River)	11312676	37° 56' 34"	121° 32' 03"	2001

Table 2. Matrix of samples collected at each sampling site during 2001

[B, equipment blank samples; D, samples collected for dissolved organic carbon analysis; P, samples collected for pesticide analysis; T, samples collected for aquatic toxicity analysis; areas marked with an asterisk (*) denote storm sampling periods]

	Date (mm/dd/yy)	Verona	Greens Landing	Ulatis Creek	Vernalis	Middle River
	01/04/01	P	P	P,T	P	P
*	01/09/01	D,P,T	D,P,T	D,P,T	P,T	P,T
*	01/10/01	P	P	P,T	P	
*	01/11/01	D,P,T	D,P,T	D,P,T	D,P,T	D,P
*	01/12/01	P	P	P	P	
*	01/13/01	D,P,T	D,P,T	D,P	D,P,T	D,P,T
*	01/14/01	P	P	P	P	
*	01/15/01	P	P	P	P	
*	01/16/01	D,P,T	D,P,T	D,P,T	D,P,T	D,P,T
	01/18/01					P
	01/23/01	D,P,T	D,P,T	D,P,T	D,P,T	D,P,T
	01/26/01	T				
	01/28/01	T				
	01/30/01	D,P,T	D,P	D,P,T		D,P
	02/06/01	D,P,T	D,P,T	D,P,T	D,P,T	D,P,T
*	02/11/01	D,P,T	D,P,T	D,P,T	D,P,T	D,P,T
*	02/12/01	P	B,P	B,D,P,T	P	P
*	02/13/01	D,P,T	D,P,T	D,P,T	D,P,T	D,P,T
*	02/14/01	P	P	P	P	P
*	02/15/01	D,P,T	D,P,T	B,D,P	D,P,T	D,P,T
*	02/16/01	P	P	P	P	P
*	02/17/01	D,P,T	B,D,P,T	B,P	D,P,T	D,P,T
	02/20/01	P	B,P	D,P,T	P	P
	02/27/01	D,P,T	B,D,P,T	B,D,P,T	D,P,T	D,P,T
	03/06/01	P	P	D,P,T	P	P
	03/13/01	D,P,T	B,D,P,T	B,D,P,T	D,P,T	D,P,T
	03/20/01	P	P		P	
	03/27/01	D,P,T	B,D,P,T		D,P,T	
	04/03/01				P	
	04/10/01				P,T	
	04/17/01				P,T	
	04/24/01				P,T	

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Table 3. Matrix of samples collected at each sampling site during 2002

[B, equipment blank samples; D, samples collected for dissolved organic carbon analysis; P, samples collected for pesticide analysis; T, samples collected for aquatic toxicity analysis; areas marked with an asterisk (*) denote storm sampling periods]

Date (mm/dd/yy)	Boyd's Pump	Knight's Landing	Ulatis Creek	Tuolumne	Vernalis
01/02/02	P,T	P,T	D,P,T	P,T	P,T
01/09/02	P		B,P,T	P	P
01/16/02	P,T	P,T	D,P,T	P,T	P,T
01/23/02	P	P	P	P	P
01/30/02	P,T	P,T	D,P,T	P,T	P,T
02/06/02	P	P	P	P	P
02/13/02	P,T	P,T	D,P,T	P,T	P,T
* 02/20/02	P,T	P,T	B,D,P,T	P,T	P,T
* 02/21/02	P	P	P,T	P,T	P
* 02/22/02	P,T	P,T	D,P,T	P,T	P,T
* 02/23/02	P	P	D,P,T	P,T	P
* 02/24/02	P,T	P,T	D,P,T	P	P,T
* 02/25/02	P	P	D,P,T	P	P
* 03/06/02	P,T	P,T	P,T	P,T	P,T
* 03/07/02	P	P	D,P,T	P,T	P
* 03/08/02	P,T	P,T	D,P,T	P,T	P,T
* 03/09/02	P	P	D,P,T	P,T	P
* 03/10/02	P,T	P,T	D,P,T	P	P,T
* 03/11/02	P	P	D,P,T	B,P	B,P
03/20/02	P,T	P,T	D,P,T	P,T	P,T
03/27/02				P,T	
04/03/02				P	
04/10/02				P,T	
04/17/02				P	
04/24/02				P,T	
05/01/02				P	
05/08/02				P,T	
05/15/02				P	
05/22/02				P,T	
05/29/02				P	

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Table 4. Pesticide concentrations detected in water samples collected at Verona during 2001—Continued

Date (mm/dd/yy)	Time	Metolachlor	Molinate	Napro- pamide	Oxyfluorfen	Pendi- methalin	Piperonyl butoxide	Simazine	Thiobencarb	Trifluralin
01/04/01	0910	nd	15.8	nd	35.7	nd	nd	nd	nd	nd
01/09/01	0800	nd	24.9	nd	nd	nd	nd	nd	12.2	nd
01/10/01	0800	nd	27.8	nd	nd	nd	nd	120	nd	15.5
01/11/01	0815	nd	25.2	12.4	nd	nd	nd	44.6	10.9	23.5
01/12/01	0740	nd	39.4	nd	nd	nd	nd	91.7	17.1	15.7
01/13/01	1450	9.0	38.4	12.7	nd	21.8	nd	88.5	13.4	25.6
01/14/01	0740	nd	32.9	12.9	nd	2.7	nd	70.1	12.5	nd
01/15/01	1630	13.5	20.8	16.9	nd	22.7	nd	48.5	15.5	nd
01/16/01	0800	23.9	37.0	24.8	nd	35.8	22.4	44.1	23.3	35.4
01/23/01	0750	nd	13.0	nd	nd	nd	nd	17.2	14.3	14.8
01/30/01	0900	nd	14.9	nd	nd	nd	nd	22.7	nd	14.8
02/06/01	0815	14.7	16.4	nd	nd	nd	nd	21.7	14.3	17.4
02/11/01	1815	nd	24.6	nd	nd	nd	nd	23.1	10.1	7.8
02/12/01	0815	nd	17.8	nd	nd	20.1	nd	35.2	11.5	10.7
02/13/01	0745	nd	13.8	nd	nd	nd	nd	32.8	18.0	nd
02/14/01	0800	17.0	24.4	nd	nd	10.3	nd	28.0	20.1	8.8
02/15/01	0800	nd	12.6	nd	nd	nd	nd	21.6	nd	nd
02/16/01	0800	22.3	29.0	nd	49.8	nd	25.4	26.4	20.8	nd
02/17/01	0915	12.9	10.7	nd	nd	nd	nd	10.8	nd	nd
02/27/01	0845	22.4	22.7	nd	nd	18.3	nd	51.6	nd	18.0
03/06/01	0745	17.9	21.7	nd	nd	19.0	nd	52.6	15.9	17.9
03/13/01	0830	11.5	11.7	nd	nd	19.0	nd	25.7	11.5	10.4
03/20/01	0715	nd	6.2	nd	nd	nd	nd	19.0	8.4	10.2
03/27/01	0830	nd	6.5	nd	nd	nd	nd	nd	nd	5.9

Table 5. Pesticide concentrations detected in water samples collected at Greens Landing during 2001

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected at this site during 2001: Alachlor, Azinphos-Methyl, Butylate, Chlorpyrifos, Cyanazine, EPTC, Ethalfuralin, Fonofos, Malathion, Methyl parathion, Pebulate, Phosmet, Sulfotep; nd, nondetection; (), concentrations detected below the method detection limit]

Date (mm/dd/yy)	Time	Atrazine	Carbaryl	Carbofuran	Cycloate	Dacthal	Diazinon	Diethyl- Ethyl	Hexazinone	Methi- dathion
01/04/01	1015	6.4	nd	nd	nd	nd	7.5	nd	37.8	nd
01/09/01	1609	nd	nd	nd	nd	nd	27.2	nd	47.6	nd
01/10/01	0630	nd	15.4	nd	nd	nd	21.2	nd	16.1	nd
01/11/01	0940	nd	nd	nd	nd	nd	21.0	nd	34.0	nd
01/12/01	1533	nd	nd	nd	nd	nd	28.8	nd	35.5	nd
01/13/01	1340	nd	nd	18.1	nd	nd	30.1	nd	36.5	nd
01/14/01	1000	nd	nd	nd	nd	nd	32.0	nd	42.0	22.2
01/15/01	0900	nd	nd	6.5	nd	nd	31.9	nd	45.0	nd
01/16/01	1000	nd	6.0	6.2	nd	nd	37.8	nd	43.8	nd
01/23/01	0930	nd	nd	nd	nd	nd	5.2	nd	30.9	nd
01/30/01	1045	nd	nd	nd	nd	nd	39.4	nd	23.7	23.2
02/06/01	1600	nd	nd	nd	nd	nd	26.8	nd	nd	nd
02/11/01	1135	10.8	nd	nd	nd	nd	29.9	nd	20.0	nd
02/12/01	1115	nd	nd	nd	nd	nd	31.4	nd	nd	nd
02/13/01	0930	nd	nd	nd	nd	nd	28.6	nd	nd	nd
02/14/01	1055	7.8	nd	nd	nd	nd	22.7	nd	16.6	nd
02/15/01	1315	nd	nd	nd	nd	nd	13.6	nd	32.9	nd
02/16/01	1145	nd	22.0	nd	20.5	7.7	8.1	31.6	47.8	27.1
02/17/01	1220	nd	nd	nd	nd	nd	7.0	nd	nd	6.5
02/20/01	1130	nd	nd	nd	nd	nd	7.8	nd	nd	nd
02/27/01	1200	nd	nd	nd	nd	nd	10.8	nd	14.2	nd
03/06/01	1300	14.8	nd	nd	nd	nd	26.6	nd	24.7	nd
03/13/01	1300	nd	nd	nd	nd	nd	14.8	nd	20.0	nd
03/20/01	1050	10.6	nd	nd	nd	nd	11.5	nd	nd	nd
03/27/01	1230	nd	7.2	nd	nd	nd	15.4	nd	nd	nd

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Table 5. Pesticide concentrations detected in water samples collected at Greens Landing during 2001—Continued

Date (mm/dd/yy)	Time	Metolachlor	Molinate	Napro- pamide	Oxyfluorfen	Pendi- methalin	Piperonyl butoxide	Simazine	Thiobencarb	Trifluralin
01/04/01	1015	7.8	14.8	nd	nd	nd	22.2	nd	8.6	nd
01/09/01	1609	11.5	13.8	12.0	nd	22.6	22.5	18.4	10.4	nd
01/10/01	0630	12.4	19.5	12.6	nd	29.8	18.1	nd	12.9	17.4
01/11/01	0940	nd	19.9	nd	nd	nd	23.4	22.0	15.7	nd
01/12/01	1533	11.1	25.0	11.2	nd	22.7	26.5	34.5	11.5	26.2
01/13/01	1340	10.9	28.8	16.2	31.9	4.9	19.8	52.9	16.2	20.7
01/14/01	1000	15.7	24.4	15.2	nd	23.8	19.8	144	13.7	nd
01/15/01	0900	31.3	36.5	nd	nd	28.5	nd	66.7	20.1	15.0
01/16/01	1000	32.0	39.2	nd	nd	28.3	35.9	64.0	20.3	16.0
01/23/01	0930	12.5	18.1	nd	nd	nd	25.1	20.6	15.9	nd
01/30/01	1045	11.9	19.4	13.1	36.5	30.8	15.2	84.9	13.4	17.2
02/06/01	1600	20.8	20.2	nd	nd	19.5	23.6	19.3	20.8	18.1
02/11/01	1135	16.4	22.5	nd	19.9	19.0	16.2	22.6	17.0	17.8
02/12/01	1115	8.8	19.4	nd	nd	13.6	5.9	26.0	10.5	8.4
02/13/01	0930	9.9	21.8	nd	nd	nd	14.1	46.2	nd	10.8
02/14/01	1055	14.7	15.2	nd	nd	22.3	4.4	53.5	18.3	9.9
02/15/01	1315	nd	16.0	nd	nd	15.5	15.9	(5.4)	nd	5.1
02/16/01	1145	25.2	29.2	23.5	50.5	37.2	28.3	29.5	22.3	35.3
02/17/01	1220	16.3	22.6	nd	nd	11.9	nd	30.7	20.1	9.0
02/20/01	1130	16.0	24.8	nd	nd	12.9	9.8	17.8	21.2	9.2
02/27/01	1200	nd	7.8	nd	nd	nd	7.0	48.8	nd	6.1
03/06/01	1300	27.2	21.1	nd	23.5	21.2	18.0	44.8	21.4	18.7
03/13/01	1300	16.0	15.8	nd	nd	nd	16.1	24.2	16.0	17.7
03/20/01	1050	11.0	4.2	nd	nd	nd	11.1	17.8	nd	nd
03/27/01	1230	9.2	nd	nd	nd	nd	12.3	9.7	nd	10.3

Table 6. Pesticide concentrations detected in water samples collected at Ulatis Creek during 2001

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected at this site during 2001: Alachlor, Azinphos-Methyl, Carbofuran, Cyanazine, Cycloate, Dacthal, EPTC, Ethalfuralin, Fonofos, Methidathion, Methyl parathion, Pebulate, Phosmet, Sulfotep, Thiobencarb; nd, nondetection; (), concentration detected below the method detection limit]

Date (mm/dd/yy)	Time	Atrazine	Butylate	Carbaryl	Chlorpyrifos	Diazinon	Diethyl- Ethyl	Hexazinone	Malathion
01/04/01	1200	nd	nd	nd	nd	nd	nd	nd	nd
01/09/01	1415	17.4	nd	nd	nd	119	nd	38.4	nd
01/10/01	1100	22.8	nd	nd	nd	107	nd	nd	nd
01/11/01	1145	25.1	nd	32.6	13.6	237	nd	409	nd
01/12/01	1300	19.9	nd	14.4	145	206	nd	503	nd
01/14/01	1400	18.6	nd	nd	157	74.5	nd	657	nd
01/15/01	1515	26.2	nd	nd	67.2	46.7	nd	241	nd
01/16/01	1150	18.3	nd	nd	56.3	30.6	nd	199	nd
01/23/01	1130	nd	nd	nd	16.9	nd	nd	54.8	nd
01/30/01	1215	24.2	nd	27.4	24.5	48.7	nd	222	nd
02/06/01	1100	28.7	nd	nd	nd	52.0	nd	49.3	nd
02/12/01	1015	19.1	nd	nd	19.5	110	nd	1,976	nd
02/14/01	0945	6.2	nd	nd	23.0	12.3	nd	431	nd
02/15/01	1015	5.9	nd	nd	30.1	(3.0)	32.7	191	nd
02/16/01	0930	17.8	nd	nd	nd	15.8	nd	114	nd
02/17/01	1130	16.0	nd	nd	nd	nd	nd	93.3	nd
02/20/01	0945	24.7	6.1	nd	40.9	113	nd	307	13.0
02/27/01	1045	22.3	nd	nd	19.0	44.6	nd	155	nd
03/06/01	1000	22.1	nd	nd	13.8	60.0	nd	237	nd
03/13/01	1045	33.3	nd	nd	7.9	20.4	nd	62.9	nd

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Table 6. Pesticide concentrations detected in water samples collected at Ulatis Creek during 200—Continued

Date (mm/dd/yy)	Time	Metolachlor	Molinate	Napropamide	Oxyfluorfen	Pendimethalin	Piperonyl butoxide	Simazine	Trifluralin
01/04/01	1200	nd	16.2	nd	nd	nd	nd	43.2	nd
01/09/01	1415	nd	nd	nd	nd	nd	nd	286	nd
01/10/01	1100	nd	nd	nd	nd	33.4	nd	159	nd
01/11/01	1145	15.8	nd	nd	nd	130	nd	783	17.8
01/12/01	1300	40.5	nd	121	75.8	125	36.6	401	17.4
01/14/01	1400	52.0	nd	62.1	84.2	83.0	22.0	245	nd
01/15/01	1515	31.8	nd	nd	46.0	45.2	15.3	188	15.1
01/16/01	1150	39.6	9.2	nd	nd	45.5	36.1	151	nd
01/23/01	1130	12.6	nd	nd	nd	35.3	20.3	45.0	17.4
01/30/01	1215	nd	nd	90.2	42.7	49.5	19.8	48.1	15.7
02/06/01	1100	nd	nd	nd	nd	23.3	23.3	36.1	17.7
02/12/01	1015	19.8	nd	87.1	91.8	173	nd	258	17.1
02/14/01	0945	23.3	nd	51.6	60.5	79.0	nd	306	10.7
02/15/01	1015	28.2	nd	nd	73.8	69.5	26.4	186	35.7
02/16/01	0930	17.2	nd	nd	32.0	37.7	nd	141	9.6
02/17/01	1130	3.5	nd	nd	nd	26.5	nd	104	6.7
02/20/01	0945	13.1	nd	462	44.2	114	10.2	315	11.1
02/27/01	1045	18.2	nd	19.3	36.5	48.5	nd	59.9	7.0
03/06/01	1000	41.6	nd	35.5	65.3	93.1	nd	79.3	13.3
03/13/01	1045	14.1	nd	nd	nd	24.5	nd	22.5	nd

Table 7. Pesticide concentrations detected in water samples collected at Vernalis during 2001

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected at this site during 2001: Alachlor, Azinphos-Methyl, Butylate, Cyanazine, Cycloate, Ethalfluralin, Fonofos, Methyl parathion, Molinate, Napropamide, Pebulate, Phosmet Sulfotep, Thiobencarb.; (), concentrations detected below the method detection limit; nd, nondetection]

Date (mm/dd/yy)	Time	Atrazine	Carbaryl	Carbofuran	Chlor- pyrifos	Dacthal	Diazinon	Diethatyl- Ethyl	EPTC	Hexazinone	Malathion
01/04/01	1445	(2.0)	nd	nd	nd	nd	nd	nd	nd	38.4	nd
01/09/01	1032	9.9	20.2	nd	nd	nd	32.9	nd	nd	21.9	nd
01/10/01	0915	(2.4)	nd	nd	nd	nd	13.1	nd	nd	39.1	nd
01/11/01	1405	nd	45.8	nd	nd	nd	34.4	nd	nd	54.9	nd
01/12/01	1105	nd	21.8	nd	nd	49.2	40.3	nd	nd	58.4	nd
01/13/01	1005	nd	34.4	nd	nd	12.8	35.4	nd	nd	43.8	nd
01/14/01	1130	nd	14.6	nd	nd	nd	26.2	nd	nd	42.9	nd
01/15/01	1030	nd	nd	nd	nd	nd	17.8	nd	nd	33.3	nd
01/16/01	1545	10.4	nd	nd	10.2	3.2	18.7	10.2	nd	34.6	nd
01/23/01	1515	9.1	nd	nd	8.1	nd	15.6	nd	nd	27.4	nd
02/06/01	1005	15.9	nd	nd	13.2	nd	21.7	nd	nd	34.7	nd
02/11/01	1315	9.3	15.2	nd	nd	nd	22.8	nd	nd	38.1	nd
02/12/01	0845	11.3	nd	nd	nd	nd	24.1	nd	7.1	24.2	nd
02/13/01	1230	nd	nd	nd	nd	nd	0.0	nd	nd	34.2	nd
02/14/01	0845	11.9	nd	nd	nd	nd	21.5	nd	nd	43.1	nd
02/15/01	0945	nd	nd	nd	nd	nd	22.2	nd	nd	31.9	nd
02/16/01	0900	nd	nd	nd	14.1	nd	13.2	nd	16.4	31.0	nd
02/17/01	0920	nd	8.9	nd	nd	nd	5.4	nd	16.6	9.1	nd
02/20/01	0930	(3.6)	nd	nd	nd	nd	6.5	nd	nd	19.3	nd
02/27/01	0900	nd	nd	nd	nd	nd	(1.4)	nd	nd	34.9	nd
03/06/01	0940	19.2	nd	nd	13.7	13.7	23.5	nd	nd	55.9	nd
03/13/01	0915	10.0	nd	nd	nd	nd	13.7	nd	nd	65.3	nd
03/20/01	0930	12.0	nd	11.1	nd	nd	11.0	nd	nd	54.9	nd
03/27/01	0945	11.4	nd	10.0	nd	nd	10.4	nd	nd	34.4	nd
04/03/01	0930	nd	nd	7.7	nd	5.2	14.6	nd	nd	26.1	17.3
04/10/01	1000	nd	nd	nd	nd	nd	14.2	nd	6.5	29.4	nd
04/17/01	1030	nd	nd	28.6	nd	nd	nd	nd	11.9	64.5	nd
04/24/01	1000	nd	nd	nd	nd	nd	nd	nd	101	33.0	nd

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Table 7. Pesticide concentrations detected in water samples collected at Vernalis during 2001—Continued

Date (mm/dd/yy)	Time	Methidathion	Metolachlor	Oxyfluorfen	Pendimethalin	Piperonyl butoxide	Simazine	Trifluralin
01/04/01	1445	nd	29.2	nd	nd	nd	23.8	nd
01/09/01	1032	nd	6.6	nd	23.4	13.2	220	7.8
01/10/01	0915	nd	29.5	nd	33.9	34.5	59.5	16.0
01/11/01	1405	nd	15.5	68.3	37.8	24.4	848	27.2
01/12/01	1105	nd	26.4	60.9	47.5	20.6	382	26.6
01/13/01	1005	21.3	16.4	49.4	44.3	20.1	274	24.1
01/14/01	1130	nd	12.5	nd	45.5	21.7	454	17.2
01/15/01	1030	nd	14.1	nd	35.0	34.0	682	21.4
01/16/01	1545	24.7	10.4	nd	9.6	21.5	97.6	21.7
01/23/01	1515	nd	4.5	nd	23.5	12.3	75.9	7.5
02/06/01	1005	nd	26.6	nd	20.6	19.1	73.5	18.3
02/11/01	1315	nd	23.6	nd	33.1	nd	47.7	19.2
02/12/01	0845	nd	17.4	nd	32.9	nd	81.3	10.6
02/13/01	1230	nd	17.2	38.5	48.4	nd	62.2	19.4
02/14/01	0845	nd	17.0	nd	38.4	nd	149	15.2
02/15/01	0945	nd	22.6	nd	35.2	nd	297	12.9
02/16/01	0900	nd	24.8	nd	21.8	nd	242	13.7
02/17/01	0920	nd	26.3	nd	14.2	nd	124	14.1
02/20/01	0930	nd	(1.8)	14.7	15.8	nd	88.8	10.6
02/27/01	0900	nd	(2.3)	nd	15.9	nd	103	10.0
03/06/01	0940	nd	33.9	31.7	39.6	nd	269	23.2
03/13/01	0915	nd	18.9	nd	20.8	nd	97.9	20.6
03/20/01	0930	nd	12.0	nd	18.0	nd	48.5	12.6
03/27/01	0945	nd	13.2	nd	25.0	nd	34.8	10.7
04/03/01	0930	nd	27.3	nd	13.4	nd	35.2	17.3
04/10/01	1000	nd	12.2	nd	20.7	nd	90.3	17.8
04/17/01	1030	nd	nd	nd	17.5	nd	8.0	11.3
04/24/01	1000	nd	nd	21.4	14.9	nd	(5.7)	11.9

Table 8. Pesticide concentrations detected in water samples collected at Middle River during 2001

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected at this site during 2001: Alachlor, Azinphos-Methyl, Butylate, Carbofuran, Chlorpyrifos, Cyanazine, Cycloate, Dacthal, EPTC, Ethalfluralin, Fonofos, Malathion, Methyl parathion, Napropamide, Pebulate, Phosmet, Sulfotep. (), concentrations detected below the method detection limit; nd, nondetection]

Date (mm/dd/yy)	Time	Atrazine	Carbaryl	Diazinon	Diethyl- ethyl	Hexazinone	Methidathion	Metolachlor	Molinate
01/04/01	1305	13.1	nd	7.8	nd	34.8	nd	11.8	13.7
01/09/01	1206	nd	nd	nd	nd	18.3	nd	11.6	15.0
01/11/01	1545	10.2	nd	7.9	nd	32.0	nd	8.7	13.8
01/13/01	1135	5.2	nd	(0.7)	nd	40.8	nd	29.5	23.3
01/16/01	1400	6.7	nd	(1.4)	nd	39.1	nd	9.9	12.3
01/18/01	1420	13.3	nd	11.8	nd	38.2	nd	12.4	13.1
01/23/01	1345	5.5	nd	6.6	nd	33.6	nd	13.2	13.0
01/30/01	0925	6.4	nd	13.5	nd	43.2	nd	31.3	24.7
02/06/01	1200	19.1	nd	29.4	nd	31.4	nd	23.2	16.9
02/11/01	1500	12.9	nd	31.6	nd	29.1	nd	19.2	18.2
02/12/01	1000	13.3	nd	26.3	nd	23.1	nd	9.8	13.8
02/13/01	1050	nd	20.9	11.7	31.6	51.2	26.0	24.7	25.9
02/14/01	0940	14.1	nd	27.9	nd	22.0	nd	11.5	9.8
02/15/01	1115	14.3	nd	27.1	nd	31.9	nd	12.2	11.2
02/16/01	1015	(2.9)	nd	18.1	nd	17.6	nd	(1.5)	8.2
02/17/01	1045	(3.0)	nd	17.2	nd	17.9	nd	(1.5)	9.7
02/20/01	1020	nd	nd	14.5	nd	11.5	nd	17.9	20.0
02/27/01	1030	7.9	nd	25.1	nd	29.0	nd	8.4	10.8
03/06/01	1110	6.2	nd	27.6	nd	34.5	nd	10.3	8.1
03/13/01	1050	nd	nd	10.2	nd	40.8	nd	nd	nd

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Table 8. Pesticide concentrations detected in water samples collected at Middle River during 2001—Continued

Date (mm/dd/yy)	Time	Oxyfluorfen	Pendimethalin	Piperonyl butoxide	Simazine	Thiobencarb	Trifluralin
01/04/01	1305	nd	nd	19.5	nd	nd	nd
01/09/01	1206	nd	nd	14.7	10.6	11.1	17.7
01/11/01	1545	nd	nd	20.8	0.0	8.1	20.9
01/13/01	1135	nd	nd	33.8	16.2	12.1	15.9
01/16/01	1400	nd	nd	25.2	17.5	nd	26.3
01/18/01	1420	nd	nd	19.8	19.2	nd	23.3
01/23/01	1345	nd	nd	19.9	24.3	13.3	nd
01/30/01	0925	nd	nd	34.8	43.0	13.3	15.5
02/06/01	1200	nd	nd	19.4	69.7	nd	18.2
02/11/01	1500	nd	20.1	17.6	105	nd	20.8
02/12/01	1000	nd	nd	6.3	61.3	7.5	9.7
02/13/01	1050	51.2	nd	27.0	64.4	20.4	36.0
02/14/01	0940	nd	nd	9.4	26.4	nd	12.1
02/15/01	1115	nd	nd	9.7	62.9	nd	12.3
02/16/01	1015	nd	nd	7.1	63.7	nd	7.4
02/17/01	1045	nd	nd	7.2	69.6	nd	7.6
02/20/01	1020	nd	nd	nd	98.0	19.2	10.9
02/27/01	1030	nd	14.6	5.6	113	nd	8.4
03/06/01	1110	nd	19.7	4.7	187	nd	9.5
03/13/01	1050	nd	17.6	15.7	68.9	nd	6.2

Table 9. Pesticide concentrations detected in water samples collected at Boyd's Pump during 2002

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected at this site during 2002: Alachlor, Atrazine, Azinphos-Methyl, Butylate, Carbaryl, Carbofuran, Chlorpyrifos, Cyanazine, Cycloate, Dacthal, Diethyl-ethyl, EPTC, Ethalfuralin, Fonofos, Malathion, Methidathion, Methyl parathion, Metolachlor, Napropamide, Oxyfluorfen, Pebulate, Pendimethalin, Phosmet, Piperonyl butoxide, Sulfotep, Thiobencarb; nd, nondetection; (), concentration detected below the method detection limit]

Date (mm/dd/yy)	Time	Diazinon	Hexazinone	Molinate	Simazine	Trifluralin
01/02/02	0800	nd	nd	28.2	28.7	nd
01/09/02	0800	nd	nd	29.4	26.3	nd
01/16/02	0930	19.7	nd	25.8	nd	nd
01/23/02	0815	31.2	nd	18.0	nd	nd
01/30/02	0800	19.5	nd	19.6	nd	nd
02/06/02	0800	7.2	nd	8.7	nd	(2.3)
02/13/02	0730	19.4	12.2	22.3	nd	nd
02/20/02	0800	10.3	nd	11.3	nd	nd
02/21/02	0730	6.7	nd	8.4	nd	nd
02/22/02	0830	8.0	nd	12.4	nd	nd
02/23/02	0800	6.5	nd	15.3	nd	nd
02/24/02	1200	9.9	16.3	17.3	nd	nd
02/25/02	1230	6.8	10.0	14.2	nd	nd
02/27/02	0915	5.1	10.1	10.4	nd	nd
03/06/02	0845	7.0	7.4	nd	nd	nd
03/07/02	1015	7.2	nd	13.9	23.5	nd
03/08/02	0700	5.0	9.2	12.3	22.3	nd
03/09/02	0815	nd	nd	nd	nd	nd
03/10/02	1000	6.8	12.6	nd	nd	nd
03/11/02	0900	7.2	13.0	6.1	nd	nd
03/13/02	0900	nd	12.7	7.9	22.9	nd
03/20/02	0915	nd	nd	nd	nd	nd

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Table 10. Pesticide concentrations detected in water samples collected at Knights Landing during 2002

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected at this site during 2002: Alachlor, Atrazine, Azinphos-Methyl, Butylate, Carbaryl, Carbofuran, Chlorpyrifos, Cyanazine, Cycloate, Dacthal, Diethatyl-ethyl, EPTC, Ethalfuralin, Fonofos, Malathion, Methidathion, Methyl parathion, Napropamide, Oxyfluorfen, Pebulate, Pendimethalin, Phosmet, Piperonyl butoxide, Sulfotep; nd, nondetection; (), concentrations detected below the method detection limit]

Date (mm/dd/yy)	Time	Diazinon	Hexazinone	Metolachlor	Molinate	Simazine	Thiobencarb	Trifluralin
01/02/02	0930	nd	28.1	9.5	nd	21.7	nd	7.7
01/09/02	0830	nd	nd	nd	nd	nd	nd	nd
01/16/02	1100	nd	nd	nd	nd	nd	nd	nd
01/23/02	0900	11.4	18.7	nd	10.1	nd	nd	nd
01/30/02	0945	31.6	17.0	nd	6.8	nd	7.4	nd
02/06/02	0845	6.9	20.9	nd	5.5	nd	nd	nd
02/13/02	0900	6.7	15.4	nd	6.0	nd	nd	(2.1)
02/20/02	0900	8.5	25.6	nd	nd	nd	nd	9.2
02/21/02	0830	5.2	17.1	nd	(2.5)	nd	nd	nd
02/22/02	0930	8.2	15.7	nd	nd	nd	nd	nd
02/23/02	0830	12.0	16.0	nd	nd	nd	nd	nd
02/24/02	1100	6.3	11.1	nd	nd	nd	nd	nd
02/25/02	1145	4.4	7.3	nd	nd	nd	nd	nd
02/27/02	0930	nd	11.2	nd	nd	nd	nd	nd
03/06/02	0945	nd	13.3	nd	nd	nd	nd	nd
03/07/02	1045	5.7	11.2	nd	nd	nd	nd	3.0
03/08/02	0800	nd	7.6	nd	nd	nd	nd	nd
03/09/02	0900	nd	8.7	nd	nd	nd	nd	nd
03/10/02	1045	11.1	12.8	nd	nd	nd	nd	nd
03/11/02	0945	nd	13.3	nd	nd	nd	nd	nd
03/13/02	0930	nd	11.1	nd	nd	nd	nd	nd
03/20/02	1015	nd	9.1	nd	nd	nd	nd	nd

Table 11. Pesticide concentrations detected in water samples collected at Ulatis Creek during 2002

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected at this site during 2002: Alachlor, Azinphos-Methyl, Butylate, Carbaryl, Cyanazine, Cycloate, Diethatyl-ethyl, Ethalfluralin, Fonofos, Malathion, Methidathion, Methyl parathion, Molinate, Pebulate, Phosmet, Sulfotep, Thiobencarb; nd, nondetection; (), concentrations detected below the method detection limit]

Date (mm/dd/yy)	Time	Atrazine	Carbofuran	Chlorpyrifos	Dacthal	Diazinon	EPTC	Hexazinone	Metolachlor
01/02/02	1245	nd	nd	30.5	6.7	27.9	nd	914	60.3
01/09/02	1300	30.4	nd	29.8	nd	16.6	nd	162	33.0
01/16/02	1330	32.2	nd	16.8	nd	nd	nd	84.2	15.7
01/23/02	1048	37.5	nd	12.1	nd	21.6	nd	37.7	13.2
01/30/02	1145	33.5	nd	10.9	nd	24.7	nd	358	85.5
02/06/02	0730	29.1	nd	9.4	nd	nd	nd	30.6	15.4
02/13/02	1030	43.0	nd	nd	nd	nd	18.8	244	22.4
02/20/02	1045	23.5	nd	nd	nd	149	nd	nd	96.1
02/21/02	1045	18.4	nd	10.5	nd	63.5	nd	nd	47.6
02/22/02	1145	20.5	nd	8.0	nd	15.2	nd	25.8	43.4
02/23/02	0915	20.3	nd	nd	nd	12.8	nd	14.7	32.8
02/24/02	1315	26.8	nd	nd	nd	9.9	nd	16.6	22.9
02/25/02	0945	23.3	nd	nd	nd	nd	nd	9.3	14.3
02/27/02	1305	25.8	nd	nd	nd	4.3	nd	16.9	12.0
03/06/02	1115	25.6	nd	nd	nd	nd	15.9	11.6	6.1
03/07/02	1230	nd	nd	nd	nd	nd	nd	nd	nd
03/08/02	1000	19.4	nd	9.7	nd	57.2	nd	15.8	94.3
03/09/02	1100	26.5	nd	6.9	nd	29.1	nd	8.7	14.6
03/10/02	1200	18.1	nd	10.0	nd	26.4	nd	19.1	21.4
03/11/02	1245	15.3	6.8	nd	nd	29.7	nd	16.1	35.8
03/13/02	1330	25.1	nd	nd	nd	10.6	nd	15.5	17.9
03/20/02	1145	25.4	12.0	181	nd	19.0	nd	35.4	nd

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Table 11. Pesticide concentrations detected in water samples collected at Ulatis Creek during 2002—Continued

Date (mm/dd/yy)	Time	Napropamide	Oxyfluorfen	Pendimethalin	Piperonyl butoxide	Simazine	Trifluralin
01/02/02	1245	45.0	35.3	74.9	nd	nd	10.5
01/09/02	1300	59.4	25.4	48.9	nd	nd	7.8
01/16/02	1330	nd	16.1	19.2	nd	nd	nd
01/23/02	1048	nd	nd	20.4	10.8	nd	nd
01/30/02	1145	nd	nd	59.9	nd	11.3	(2.7)
02/06/02	0730	nd	nd	15.5	nd	nd	(2.1)
02/13/02	1030	nd	nd	nd	nd	nd	nd
02/20/02	1045	nd	nd	46.0	nd	nd	9.4
02/21/02	1045	nd	nd	21.2	nd	nd	7.9
02/22/02	1145	nd	nd	13.9	nd	nd	8.1
02/23/02	0915	nd	nd	9.2	nd	nd	nd
02/24/02	1315	nd	nd	8.8	nd	nd	nd
02/25/02	0945	nd	nd	nd	nd	nd	nd
02/27/02	1305	nd	nd	nd	nd	nd	nd
03/06/02	1115	nd	nd	nd	nd	nd	7.1
03/07/02	1230	nd	nd	nd	nd	nd	nd
03/08/02	1000	nd	nd	26.2	nd	18.1	5.4
03/09/02	1100	nd	nd	13.0	nd	nd	3.9
03/10/02	1200	nd	nd	20.5	nd	nd	4.2
03/11/02	1245	nd	nd	20.2	nd	nd	3.6
03/13/02	1330	nd	nd	10.3	nd	nd	nd
03/20/02	1145	nd	nd	nd	nd	nd	nd

Table 12. Pesticide concentrations detected in water samples collected at Tuolumne during 2002

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected during 2002: Alachlor, Azinphos-Methyl, Butylate, Carbofuran, Cyanazine, Cycloate, Dacthal, Diethatyl-ethyl, Ethalfuralin, Fonofos, Methyl parathion, Metolachlor, Pebulate, Phosmet, Sulfotep. (), concentrations detected below the method detection limit; nd, nondetection]

Date (mm/dd/yy)	Time	Atrazine	Carbaryl	Chlorpyrifos	Diazinon	EPTC	Hexazinone	Malathion	Methodathion
01/02/02	1208	13.7	nd	nd	17.4	nd	nd	nd	69.3
01/09/02	0754	nd	nd	nd	19.4	nd	nd	nd	nd
01/16/02	0812	nd	nd	nd	19.7	nd	nd	nd	nd
01/23/02	0735	nd	30.8	nd	25.4	nd	nd	nd	nd
01/30/02	0800	6.2	15.7	nd	55.1	nd	nd	nd	nd
02/06/02	0745	4.2	nd	nd	6.8	nd	9.9	nd	nd
02/13/02	0800	nd	nd	nd	4.8	nd	nd	nd	nd
02/20/02	0815	nd	nd	nd	19.9	nd	17.2	nd	nd
02/21/02	1215	(3.7)	nd	nd	5.6	nd	nd	nd	nd
02/22/02	1045	nd	nd	nd	nd	nd	12.9	nd	nd
02/23/02	0900	5.5	nd	nd	7.3	nd	13.1	nd	nd
02/24/02	0915	6.4	nd	nd	nd	nd	12.6	nd	nd
02/25/02	0945	6.4	nd	nd	nd	nd	12.8	nd	nd
02/27/02	1030	5.6	nd	nd	nd	nd	8.7	nd	nd
03/06/02	0930	7.1	nd	nd	nd	nd	7.9	nd	nd
03/08/02	1000	nd	nd	nd	7.0	38.9	7.9	nd	nd
03/09/02	0830	4.2	nd	nd	(3.4)	51.0	5.5	nd	nd
03/10/02	0915	5.3	nd	nd	nd	36.2	11.0	nd	nd
03/11/02	1000	nd	nd	14.5	13.1	16.2	14.3	317	nd
03/13/02	1130	nd	nd	nd	nd	nd	13.0	nd	nd
03/20/02	1100	nd	nd	nd	nd	nd	8.7	nd	nd
03/27/02	0830	nd	nd	nd	nd	nd	9.8	nd	nd
04/03/02	1115	nd	nd	nd	nd	nd	nd	nd	nd
04/10/02	0930	nd	nd	nd	nd	nd	nd	nd	nd
05/01/02	0930	nd	nd	nd	nd	nd	10.0	nd	nd
05/08/02	0915	nd	nd	nd	nd	nd	9.2	nd	nd
05/15/02	1030	nd	nd	nd	nd	nd	nd	nd	nd
05/22/02	1100	nd	nd	9.7	nd	nd	nd	nd	nd
05/29/02	1015	nd	nd	7.6	nd	nd	nd	nd	nd

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Table 12. Pesticide concentrations detected in water samples collected at Tuolumne during 2002—Continued

Date (mm/dd/yy)	Time	Molinate	Napropamide	Oxyfluorfen	Pendimethalin	Piperonyl butoxide	Simazine	Thiobencarb	Trifluralin
01/02/02	1208	nd	83.2	nd	29.8	nd	136	nd	nd
01/09/02	0754	nd	nd	nd	nd	nd	30.0	nd	7.8
01/16/02	0812	nd	nd	nd	14.1	nd	nd	nd	nd
01/23/02	0735	nd	nd	nd	nd	nd	nd	nd	nd
01/30/02	0800	nd	nd	nd	22.2	10.0	16.6	nd	(2.3)
02/06/02	0745	nd	nd	nd	9.1	nd	nd	nd	(2.7)
02/13/02	0800	nd	nd	nd	nd	nd	nd	nd	nd
02/20/02	0815	nd	nd	nd	nd	nd	22.2	nd	nd
02/21/02	1215	nd	nd	nd	7.4	nd	15.5	nd	6.7
02/22/02	1045	nd	nd	25.7	8.3	nd	18.4	nd	nd
02/23/02	0900	nd	nd	nd	8.0	nd	14.1	nd	nd
02/24/02	0915	nd	nd	nd	6.9	nd	14.2	nd	nd
02/25/02	0945	nd	nd	nd	nd	nd	nd	nd	nd
02/27/02	1030	nd	nd	nd	nd	nd	16.5	nd	nd
03/06/02	0930	nd	nd	nd	nd	nd	nd	nd	nd
03/08/02	1000	nd	nd	nd	10.4	nd	21.7	nd	nd
03/09/02	0830	nd	nd	nd	nd	nd	17.6	nd	nd
03/10/02	0915	nd	nd	nd	nd	nd	nd	nd	nd
03/11/02	1000	nd	nd	nd	24.2	nd	nd	nd	nd
03/13/02	1130	nd	nd	nd	9.6	nd	21.6	nd	nd
03/20/02	1100	nd	nd	nd	nd	nd	nd	nd	nd
03/27/02	0830	nd	nd	nd	8.3	nd	41.9	nd	nd
04/03/02	1115	nd	nd	nd	8.7	nd	nd	nd	nd
04/10/02	0930	nd	nd	nd	nd	nd	91.0	nd	nd
05/01/02	0930	nd	nd	nd	nd	nd	99.2	nd	nd
05/08/02	0915	nd	nd	nd	nd	nd	nd	nd	nd
05/15/02	1030	nd	nd	nd	nd	nd	nd	nd	nd
05/22/02	1100	nd	nd	nd	nd	nd	nd	nd	4.2
05/29/02	1015	15.1	nd	nd	nd	nd	nd	13.0	nd

Table 13. Pesticide concentrations detected in water samples collected at Vernalis during 2002

[Values are reported as nanograms per liter; water samples were analyzed for the following pesticides that were not detected at this site during 2002: Alachlor, Azinphos-Methyl, Butylate, Cyanazine, Cycloate, Dacthal, Diethyl-ethyl, Ethalfluralin, Fonofos, Methidathion, Methyl parathion, Molinate, Napropamide, Pebulate, Phosmet, Sulfotep, Thiobencarb. (), concentrations detected below the method detection limit; nd, nondetection]

Date (mm/dd/yy)	Time	Atrazine	Carbaryl	Carbofuran	Chlorpyrifos	Diazinon	EPTC	Hexazinone
01/02/02	1011	nd	nd	nd	nd	32.3	nd	38.3
01/09/02	0710	nd	nd	nd	nd	19.7	nd	39.6
01/16/02	0720	nd	nd	nd	nd	13.3	nd	16.2
01/23/02	0655	7.7	nd	nd	nd	28.4	7.5	17.1
01/30/02	0700	nd	46.7	nd	nd	25.3	6.2	16.0
02/06/02	0715	nd	nd	nd	nd	6.3	nd	17.2
02/13/02	0700	4.2	nd	nd	nd	6.4	nd	31.0
02/20/02	0700	nd	nd	nd	nd	12.8	nd	21.9
02/21/02	1130	nd	nd	nd	nd	3.8	nd	23.6
02/22/02	0930	nd	nd	27.0	nd	nd	nd	55.0
02/23/02	0815	4.8	13.4	7.6	nd	7.9	nd	32.2
02/24/02	0800	8.2	nd	16.6	nd	9.9	nd	60.0
02/25/02	0915	7.0	nd	21.9	nd	5.0	nd	48.0
02/27/02	0945	6.2	nd	11.9	nd	23.4	nd	95.0
03/06/02	0730	nd	nd	nd	nd	nd	nd	11.2
03/07/02	1145	5.3	nd	nd	nd	nd	13.6	7.0
03/08/02	0815	nd	nd	(2.9)	nd	nd	5.3	190
03/09/02	0800	nd	nd	9.7	11.0	10.0	5.7	156
03/10/02	0815	nd	nd	12.7	14.8	nd	16.7	139
03/11/02	0930	nd	nd	11.4	22.7	nd	12.5	154
03/13/02	1045	nd	nd	15.1	17.2	7.9	nd	117
03/20/02	0945	nd	nd	37.6	9.8	nd	nd	58.5

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Table 13. Pesticide concentrations detected in water samples collected at Vernalis during 2002—Continued

Date (mm/dd/yy)	Time	Malathion	Metolachlor	Oxyfluorfen	Pendimethalin	Piperonyl butoxide	Simazine	Trifluralin
01/02/02	1011	nd	nd	nd	31.4	nd	424	8.1
01/09/02	0710	nd	15.4	nd	19.4	nd	108	nd
01/16/02	0720	nd	8.0	nd	nd	nd	26.7	nd
01/23/02	0655	nd	11.0	nd	nd	nd	26.6	nd
01/30/02	0700	nd	nd	nd	15.0	nd	59.5	nd
02/06/02	0715	nd	7.5	nd	14.6	nd	11.8	(1.9)
02/13/02	0700	nd	12.5	nd	13.0	nd	28.7	(2.6)
02/20/02	0700	nd	20.4	nd	nd	nd	nd	9.3
02/21/02	1130	nd	13.1	nd	5.6	nd	19.1	9.1
02/22/02	0930	nd	15.4	nd	nd	7.4	16.9	9.5
02/23/02	0815	nd	15.1	10.3	6.6	8.8	16.0	9.8
02/24/02	0800	nd	15.3	11.6	6.9	9.0	22.9	9.9
02/25/02	0915	nd	13.3	nd	nd	nd	19.5	7.9
02/27/02	0945	nd	12.9	nd	nd	nd	28.1	8.5
03/06/02	0730	nd	6.7	nd	nd	nd	nd	5.9
03/07/02	1145	nd	nd	nd	nd	nd	nd	nd
03/08/02	0815	nd	6.1	nd	17.7	5.8	26.6	5.3
03/09/02	0800	nd	7.2	nd	19.8	nd	25.8	4.8
03/10/02	0815	53.2	6.7	nd	21.3	5.8	21.7	5.1
03/11/02	0930	21.6	6.9	nd	52.9	nd	31.6	5.9
03/13/02	1045	nd	10.3	nd	16.0	nd	42.5	8.4
03/20/02	0945	nd	8.2	nd	11.3	nd	54.7	12.0

Table 14. Dissolved organic carbon concentrations detected in water samples collected in 2001

[mg/L, milligrams per liter]

Sampling site	Date (mm/dd/yy)	Time	Concentration (mg/L)
Verona	01/11/01	0815	3.21
Verona	01/13/01	1450	2.55
Verona	01/16/01	0800	1.63
Verona	01/23/01	0750	1.16
Verona	01/30/01	0900	1.51
Verona	02/06/01	0815	1.46
Verona	02/11/01	1815	1.52
Verona	02/13/01	0745	3.76
Verona	02/15/01	0800	3.12
Verona	02/17/01	0915	2.04
Verona	02/27/01	0845	3.40
Verona	03/13/01	0830	2.36
Verona	03/27/01	0830	1.44
Greens Landing	01/11/01	0940	2.15
Greens Landing	01/13/01	1340	2.43
Greens Landing	01/16/01	1000	3.59
Greens Landing	01/23/01	0930	1.89
Greens Landing	01/30/01	1045	3.70
Greens Landing	02/06/01	1600	2.67
Greens Landing	02/11/01	1135	2.13
Greens Landing	02/13/01	0930	2.10
Greens Landing	02/15/01	1315	3.67
Greens Landing	02/17/01	1220	3.19
Greens Landing	02/27/01	1200	3.04
Greens Landing	03/13/01	1300	2.73
Greens Landing	03/27/01	1230	1.58
Ulati Creek	01/11/01	1145	6.09
Ulati Creek	01/13/01	0800	3.88
Ulati Creek	01/16/01	1150	7.23
Ulati Creek	01/23/01	1130	5.90
Ulati Creek	01/30/01	1215	6.16
Ulati Creek	02/06/01	1100	6.21
Ulati Creek	02/11/01	1645	7.33
Ulati Creek	02/12/01	1015	7.05
Ulati Creek	02/13/01	1445	7.88
Ulati Creek	02/15/01	1015	6.58
Ulati Creek	02/20/01	0945	7.13
Ulati Creek	02/27/01	1045	5.16
Ulati Creek	03/06/01	1000	6.51
Ulati Creek	03/13/01	1045	3.13

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Table 14. Dissolved organic carbon concentrations detected in water samples collected in 2001—Continued

Sampling site	Date (mm/dd/yy)	Time	Concentration (mg/L)
Vernalis	01/11/01	1405	1.41
Vernalis	01/13/01	1005	4.38
Vernalis	01/16/01	1545	3.71
Vernalis	01/23/01	1515	3.57
Vernalis	02/06/01	1005	3.25
Vernalis	02/11/01	1315	3.03
Vernalis	02/13/01	1230	3.07
Vernalis	02/15/01	0945	4.87
Vernalis	02/17/01	0920	3.72
Vernalis	02/27/01	0900	3.69
Vernalis	03/13/01	0915	4.99
Vernalis	03/27/01	0945	3.74
Middle River	01/11/01	1545	3.29
Middle River	01/13/01	1135	9.27
Middle River	01/16/01	1400	3.98
Middle River	01/23/01	1345	4.31
Middle River	01/30/01	0925	4.61
Middle River	02/06/01	1200	4.89
Middle River	02/11/01	1500	4.58
Middle River	02/13/01	1050	4.71
Middle River	02/15/01	1115	4.88
Middle River	02/17/01	1045	4.59
Middle River	02/27/01	1030	4.85
Middle River	03/13/01	1050	5.37

Table 15. Dissolved organic carbon concentrations detected in water samples collected in 2002

[mg/L, milligrams per liter]

Sampling site	Date (mm/dd/yy)	Time	Concentration (mg/L)
Ulatis Creek	01/16/02	1330	2.63
Ulatis Creek	01/30/02	1145	3.30
Ulatis Creek	02/13/02	1030	3.16
Ulatis Creek	02/20/02	1045	4.52
Ulatis Creek	02/22/02	1145	3.76
Ulatis Creek	02/23/02	0915	3.92
Ulatis Creek	02/24/02	1315	3.67
Ulatis Creek	02/25/02	0945	3.73
Ulatis Creek	03/07/02	1230	4.13
Ulatis Creek	03/08/02	1000	3.91
Ulatis Creek	03/09/02	1100	3.83
Ulatis Creek	03/10/02	1200	3.62
Ulatis Creek	03/11/02	1245	4.14
Ulatis Creek	03/20/02	1145	3.69

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Table 16. Method detection limits for pesticides analyzed in water samples in 2001 and 2002

[ng/L, nanograms per liter]

Pesticide	2001/2002 Method detection limit (ng/L)
Alachlor ¹	2.1
Atrazine	4.2
Azinphos-methyl ¹	11.1
Butylate	1.8
Carbaryl	4.2
Carbofuran	3.3
Chlorpyrifos	4.2
Cyanazine ¹	3.0
Cycloate	1.5
Dacthal	1.2
Diazinon	3.6
Diethatyl-ethyl	3.6
EPTC	4.5
Ethalfuralin ¹	2.4
Fonofos ¹	2.4
Hexazinone	5.7
Malathion	2.1
Methidathion	5.4
Methyl parathion ¹	4.2
Metolachlor	3.3
Molinate	2.7
Napropamide	7.2
Oxyfluorfen	4.2
Pebulate ¹	.6
Pendimethalin	2.4
Phosmet ¹	4.2
Piperonyl butoxide	3.3
Simazine	6.9
Sulfotep ¹	1.2
Thiobencarb	3.9
Trifluralin	3.0

¹Pesticide not detected during study