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CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

Concentrations of Pesticides in Sacramento Metropolitan Area Rainwater and Creeks during the 2001, 2002 and 2003 Orchard Dormant Spray Seasons

June 2004

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State of California

California Environmental Protection Agency

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FOREWARD

Sample analysis for this three-year monitoring project was conducted by the Agricultural and Priority Pesticides Laboratory (APPL) in Fresno, California, in 2001, and the California Department of Food and Agriculture (CDFA) laboratory in Sacramento, California in 2002 and 2003. The sampling plan was developed by, and sample collection was performed by, Central Valley Regional Water Quality Control Board staff with assistance from DeltaKeeper on rain sample collection in Stockton, California.

DISCLAIMER

Mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use.

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1 BACKGROUND

Seven Sacramento County waterways are listed as impaired by diazinon and/or chlorpyrifos, pursuant to Section 303(d) of the Clean Water Act. The seven waterways are: Arcade Creek; Chicken Ranch Slough; Elder Creek; Elk Grove Creek; Morrison Creek; Natomas East Main Drain; and, Strong Ranch Slough. Concentrations of diazinon and chlorpyrifos were detected in these waterways above applicable California Department of Fish and Game (CDFG) freshwater aquatic life criteria. The California Regional Water Quality Control Board, Central Valley Region (Regional Board) is responsible for developing Total Maximum Daily Loads (TMDLs) for these listed urban water bodies. The Regional Board must identify the sources of pollutants to these impaired water bodies and determine the maximum loads of diazinon and chlorpyrifos that will not harm freshwater aquatic life. A key component of the TMDL process is identification and quantification of pollutant sources. The sources and the spatial and temporal distribution of diazinon and chlorpyrifos in three of the impaired waterways are further characterized in this monitoring study to support TMDL efforts.

Possible sources of pesticides in stormwater runoff are direct washing from plants, soil, and impervious surfaces to which they were applied and also from aerial deposition, primarily via rain and fog. Within urban areas of these watersheds, diazinon and chlorpyrifos levels found in urban creeks originate from structural, landscape maintenance, and municipal applications, as well as from local and regional agricultural uses, particularly during the orchard dormant spray season. Previous studies have shown that chlorpyrifos and diazinon are present in the Sacramento-area atmosphere throughout the year, and seasonal patterns of chlorpyrifos and diazinon levels in the atmosphere indicate that during the months of January and February, orchard dormant spraying is the dominant source (Majewski and Baston, 2002). Thus, atmospheric deposition of pesticides in the Sacramento metropolitan area may originate from nearby urban usage or from agricultural applications occurring many miles away.

Majewski and Baston (2002) suggest that agriculture is the predominant source of diazinon in the atmosphere during the winter dormant spray season and that urban usage is the predominant source during the summer in the Central Valley. Previous urban creek sampling results indicate that aerial deposition from orchard dormant spraying could be a significant source of OP pesticides in Central Valley urban creeks (Bailey *et al.*, 2000). Rain and fog are considered potentially important pesticide transport mechanisms in the atmosphere, particularly since the winter rainy season in the Central Valley coincides with the orchard dormant spray season in the valley (Majewski and Baston, 2002; Bailey *et al.*, 2000). During rainfall events, some portion of the pesticides in rainfall can subsequently runoff into Sacramento area waterways.

In the 1994 - 1995 Bailey (2000) study, short-term temporal changes in diazinon concentrations in three streams (Arcade and Elder creeks in Sacramento County and Mosher Slough in San Joaquin County) were evaluated to obtain a better idea of how orchard dormant sprays might contribute to pesticide concentrations in urban streams. The study findings showed that, although not all of the high diazinon concentrations occurred during the Central Valley dormant spray season, the dormant spray season was associated with high diazinon concentrations in all three streams (Bailey *et al.*, 2000).

A 1996 - 1997 United States Geological Survey (USGS) study of atmospheric transport of pesticides in the Sacramento County metropolitan area collected composite bulk air samples weekly, along with wind speed and wind direction measurements, at one urban and two agricultural locations in Sacramento County (Majewski and Baston, 2002). A variety of pesticides were detected throughout the study period. Diazinon and chlorpyrifos (and three other pesticides) were detected most frequently and at the highest concentrations. Chlorpyrifos and diazinon were frequently detected at all monitoring sites, particularly when the prevailing wind was from the south.

Rain samples collected during the 2001 Sacramento Stormwater Management Program study contained diazinon and chlorpyrifos at concentrations ranging from 20 to 80 percent of the diazinon and chlorpyrifos concentrations measured in nearby Sacramento urban creeks (Russick, 2001).

The USEPA and technical registrants of diazinon and chlorpyrifos insecticides agreed to cancel most non-agricultural uses (USEPA 2000 and USEPA 2001a). The manufacture and sale of chlorpyrifos products for use by residents in the urban environment were stopped as of December 2001 and professional chlorpyrifos use in the urban environment is being scaled back. The sale of diazinon products for use in the urban environment will be non-existent by December 31, 2004 (when final registration cancellations go into effect that involve diazinon use for landscape maintenance and any other outdoor residential or outdoor non-agricultural areas). However, individual homeowners that have purchased chlorpyrifos or diazinon products prior to the stop-sale dates can continue to use their supplies and, therefore, continue to be a potential source for chlorpyrifos and diazinon in Sacramento County urban creeks.

In the agricultural environment, many chlorpyrifos and diazinon uses are being further restricted (USEPA 2001b and USEPA 2002). The USEPA, however, is not phasing out or restricting chlorpyrifos use at nurseries but is restricting the diazinon use at nurseries, from a use rate of 2 pounds per acre to 1 pound per acre (Meyers, 2002 and Parsons, 2002). Due to the changes in USEPA-allowed diazinon and chlorpyrifos uses, insecticides containing pyrethroids are replacing diazinon and chlorpyrifos insecticides historically used in both urban and agricultural environments.

2 INTRODUCTION

The purpose of the Regional Board's three-year rain and creek monitoring study is to measure and document trends of diazinon and chlorpyrifos concentrations in Sacramento County rainfall and impaired urban creeks during the Central Valley orchard dormant spray season. Storm events were sampled during the orchard dormant spray season months of January and February 2001 and 2002, and January through April 2003, to determine pesticide concentrations in rain and creeks during and after the orchard dormant spray season.

From 2001 to 2003, the Regional Board conducted rain and creek monitoring in the Sacramento urban area during and after the orchard dormant spray season to track the concentrations of diazinon and chlorpyrifos in impaired Sacramento urban creeks and in greater Sacramento rain.

In 2001 and 2003, Regional Board staff monitored the segment of Elder Creek that runs adjacent to a 250-acre commercial nursery to better characterize nursery contributions of pesticides to Elder Creek, a tributary of Morrison Creek. Morrison Creek, which is identified in the Bay Protection Plan as a Toxic Hot Spot, was also monitored from the predominately open land area upstream of Hedge Road (near Sunrise Boulevard) to the predominately urban area downstream at Franklin Boulevard.

Future monitoring of impaired Sacramento area waterways will be conducted by the Sacramento Stormwater Program Permittees to track the effects that USEPA-mandated diazinon and chlorpyrifos phase-outs and restrictions will have on surface water quality in select urban creek.

3 OBJECTIVES

This study focused on:

- Monitoring and assessing diazinon, chlorpyrifos and other pesticide concentrations in rainfall and in select impaired Sacramento County waterways (Arcade, Elder, Elk Grove, and Morrison creeks) during and following the Central Valley orchard dormant spray season;
- Tracking diazinon and chlorpyrifos concentration changes in these creeks, as a result of the on-going nationwide USEPA phase-outs and restrictions of diazinon and chlorpyrifos use in urban and agricultural environments; and
- Analyzing diazinon and chlorpyrifos concentrations in the Elder Creek watershed, where several commercial nurseries are located.

4 STUDY AREA

The study area spanned the greater Sacramento area, from Lincoln in the north to Stockton in the south (Figure 1). The study area included creek and rainfall sampling locations described below.

4.1 Creek Sampling Locations

Four creeks - Arcade, Elder, Elk Grove, and Morrison - were sampled for this study. Descriptions of the creeks, their watersheds, and the sampling locations at on each creek are provided below. Latitude and longitudes for each creek sampling site are listed in Table 1.

Arcade Creek

Arcade Creek, which spans approximately 40 square miles with elevations ranging from 20 to 270 feet above sea level, is the most extensively studied watershed in Sacramento County. Nearly the entire Arcade Creek watershed (98 percent) lies within urbanized parts of Sacramento County, from the northeastern corner of the City of Citrus Heights at its eastern edge to its western boundary at the Natomas East Main Drainage Canal. From the headwaters of Arcade Creek to

upstream of one large golf course, Arcade Creek is not channelized and contains riparian woodland along its banks. Downstream of the golf course, Arcade Creek has both natural segments, with varying amounts of vegetation, and concrete-lined channel segments. with few trees along its banks (Russick, 2001). Typical dry weather flows in Arcade Creek are less than 1 cubic foot per second (cfs), but, during rainfall events, storm runoff into Arcade Creek can create flows of over 2,200 cfs, as measured at the USGS gage station located at Watt Avenue.

Arcade Creek traverses low and high-density residential developments, commercial developments, three large golf courses and three cemeteries, and is adjacent to two major branches of Highway 80. A major mall (Sunrise Mall) is also located in the Arcade Creek watershed. Arcade Creek discharges into the Natomas East Main Drainage Canal, which discharges into the Sacramento River. The Arcade Creek surface water-sampling site (C1) is located at Watt Avenue, near the USGS 'Arcade Creek near Del Paso Heights' flow gage (see Figure 1).

Elder Creek

Elder Creek, a tributary of Morrison Creek, originates south of Mather Field and Kiefer Boulevard (north of Highway 16) and west of Eagles Nest Road, and flows southwesterly toward the city of Florin, joining Morrison Creek northwest of the Franklin Boulevard and Mack Road intersection (DeLorme, 1998). The Elder Creek watershed covers approximately 22 square miles with its eastern portion predominately rural and its western portion predominately urban. Principal land uses in the Elder Creek watershed include residential, industrial, commercial, grazing, and agricultural. A 250-acre commercial nursery (Village Nursery) is located adjacent to Elder Creek, at Bradshaw Road and Elder Creek Road and three other known commercial nurseries are also located within the Elder Creek watershed. Elder Creek was monitored by Regional Board staff at two locations in 2003 - upstream and downstream of Village Nursery (monitoring sites C2 and C3). In 2001, Regional Board staff monitored Elder Creek at three sites, Elder Creek Road (Site C3), Elk Grove-Florin Road (Site C7), and Franklin Boulevard (Site C8) (see Figure 1).

Elk Grove Creek

The Elk Grove Creek watershed covers approximately six square miles. Elk Grove Creek begins east of the Grant Line Road and Elk Grove Boulevard intersection and flows northwesterly through the city of Elk Grove to join Laguna Creek. From the headwaters of the Elk Grove Creek watershed, land use changes from predominantly rural (grazing, agricultural, and residential) to predominantly urban (residential and commercial in the city of Elk Grove), changing back to rural before Elk Grove Creek joins Laguna Creek (DeLorme, 1998). In 2001, Elk Grove Creek was monitored by the Regional Board at two sites - at Waterman Road (Site C9) and at Emerald Vista Drive (Site C10) (see Figure 1).

Morrison Creek

The Morrison Creek watershed covers approximately 150 square miles. Elder Creek, Laguna Creek, and Elk Grove Creek are tributaries of Morrison Creek. Land use in the Morrison Creek watershed includes a mix of rural and urban uses including grazing, agriculture, low- to high-density residential, industrial, and commercial buildings. The portion of the watershed generally east of Hedge Road and Waterman Road is predominately rural. The portion of the watershed generally west of these roads is predominately urban.

Morrison Creek flows from near the intersection of White Rock Road and Grant Line Road to Stone Lake west of Interstate 5 (DeLorme, 1998). The two monitoring sites that were monitored in 2003 are Morrison Creek near Sunrise Boulevard (Site C4) and Morrison Creek at Franklin Boulevard (Site C5). In 2001, Morrison Creek was monitored by Regional Board staff at three sites - at Sunrise Boulevard (Site C4), at Hedge Road (Site C6), and at Franklin Boulevard (Site C5) (See Figure 1). Samples were also collected from Florin Creek (Site C11) in 2001 but are not a focus of this report, since Florin Creek is not a 303(d)-listed waterbody.

The focus of the sampling described in this report was on collecting and analyzing rain samples. The number of creeks samples varied by year, depending on funding levels available for sample collection and analysis. In 2001, funding allowed for analyzing some creek samples collected from rural and urban sites along the same creek. Funding constraints in later years did not allow for samples to be collected from all of the previous sites.

4.2 Rainwater Sampling Locations

Rainwater samples were collected at four locations spanning the greater Sacramento metropolitan area along a north-south axis: Lincoln Airport to the north of all the impaired urban water bodies; Arcade Creek at Greenback Lane, located mid-transect; and Herald Fire Department and Stockton located to the south of all the impaired water urban bodies. With the exception of the Stockton site, the rain monitoring sites generally transect the Sacramento urban impaired water bodies at approximately the same elevation. The settings of the rainwater sample collection sites are described below, by county.

Sacramento County (two):	Herald (R1) – Fire Department located in rural, agricultural setting; Arcade Creek at Greenback Lane (R2)-highly urbanized
Placer County:	Lincoln Airport (R3) – Airport land use; commercial, residential, industrial land use on outskirts
San Joaquin County:	Stockton (R4) - This site serves to bridge the gap between the 2003 USGS atmospheric study sites in the San Joaquin Valley and the USGS atmospheric study sites located in the Sacramento Valley.

Figure 1 depicts the Regional Board's selected rain and creek sampling locations.

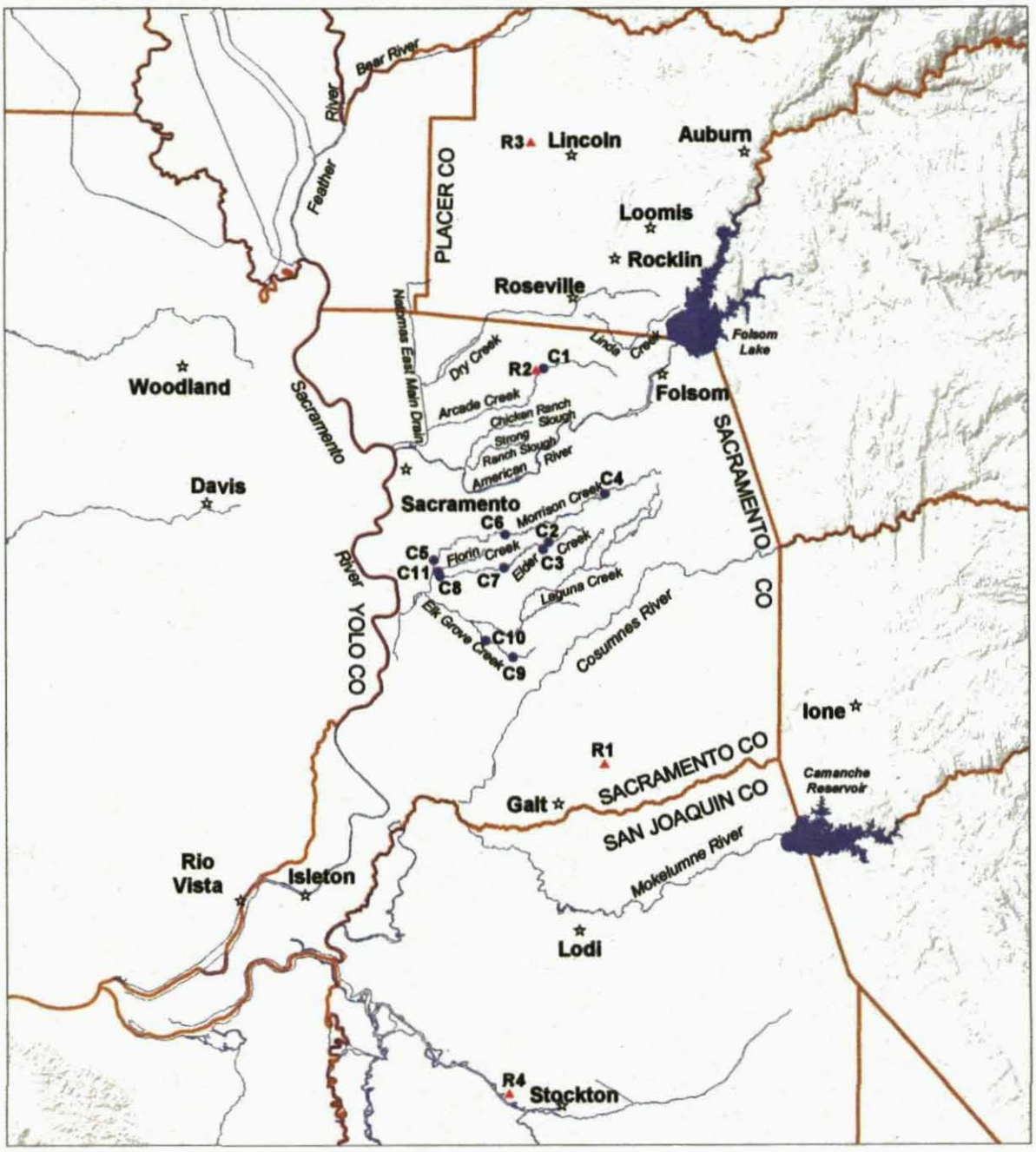

Figure 1. Sacramento Urban Rain and Creek Sampling Sites

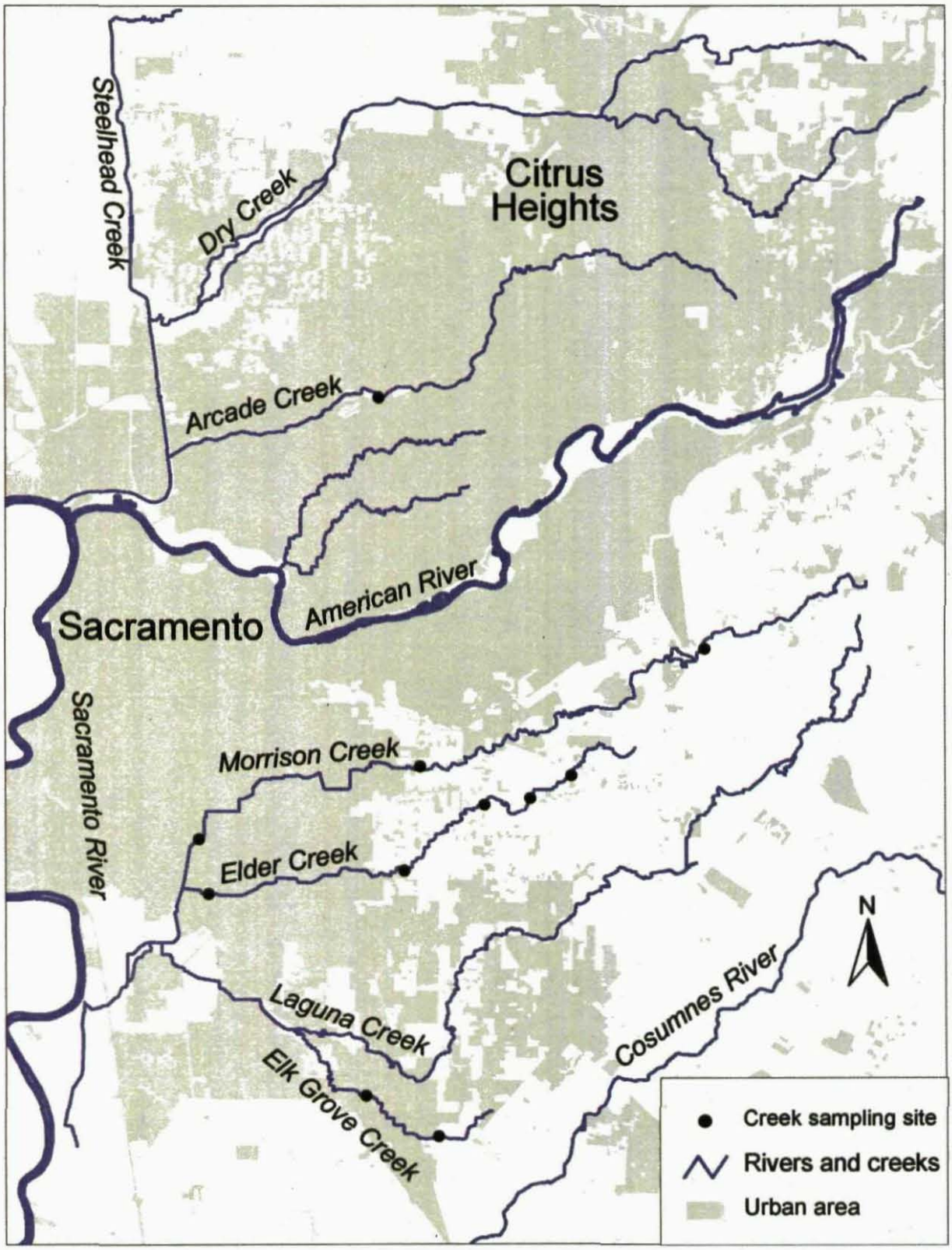

Figure 2. Creek Sampling Sites

5 RAIN AND CREEK SAMPLE COLLECTION AND LABORATORY ANALYTICAL METHODS

Rainfall and creek sample collection methods, laboratory analytical methods, and quality assurance/quality control samples are discussed below.

5.1 Rain Sample Collection Method

The rain sampling protocol is based on Regional Board sampling techniques employed during Sacramento metropolitan area rain monitoring in 2001 through 2003. Rainfall samples were collected using rainfall sampling devices that consisted of a 19-inch diameter stainless steel bowl with a hole punched in the bottom and secured with stainless steel wire to the top of a 7-gallon plastic bucket. A 3/8-inch diameter piece of stainless steel tubing set into the hole in the bowl guided the water into a 3-gallon glass carboy set inside the bucket underneath the bowl.

All surfaces that could come into contact with the rainwater sample, including the glass carboys, were cleaned in the Regional Board laboratory prior to sampling, as follows:

1. scrub with warm water and Alconox or Liquinox detergent
2. 3 rinses with warm tap water
3. rinse with de-ionized water

After washing and rinsing, the rainfall sampling devices were wrapped in clean plastic bags until set-up in the field. In the field, each rainfall sampler was set-up in an open area and allowed to accumulate rain at least until the following day. Rain collectors were cleaned in the field, using the method described above, and deployed one day prior to each forecasted rain sampling event. Equipment blank samples were collected after the rain collectors were cleaned.

An attempt was made to deploy the rain sample collectors as close as possible to the beginning of anticipated storm events. However, for some sampling events, the targeted accumulated amount of rainfall (about 0.25 inches) did not occur within 24 hours and the samplers were left deployed until there had been sufficient rainfall. Table 2 lists rainfall measurements for two Sacramento area rain gage stations, for storm events that occurred during this study period.

Rainfall samples were poured into 1-liter (L) glass amber bottles. (In 2001, smaller diameter stainless steel bowls that captured less rainfall were used; therefore, Regional Board staff collected rain samples when storm events produced 0.30 inches or more of rain). The sample bottles were labeled, placed in a cooler with ice, and delivered to the laboratory under chain-of-custody protocol. The samples (rain and creek) were shipped Federal Express to the APPL Lab in Fresno, California during the 2001 monitoring season. During the 2002 and 2003 monitoring seasons, Regional Board staff transported rain and creek samples to the CDFA Lab, in Sacramento, California for analysis. Rain sample collection dates for 2001 – 2003 and analytes for each sample are shown in Table 3.

5.2 Creek Sample Collection Method

The creek sampling protocol is based on the USGS National Field manual (USGS, 2000). The Teflon container was rinsed with creek water before filling with creek sample water. A vertically-integrated sample was collected. The sample was transferred to the 1-L amber bottles. Regional Board staff used a PVC pole sampler (which accommodated either one or two 1-L glass amber bottles) to fill the sample bottles directly from the creeks. Samples were collected beneath the water surface as near as possible to the center of the stream when water levels were low or when access was only possible from the bank. A 3-L Teflon container was used to collect samples when using a pole sampler was not possible. Otherwise, three to four grab samples were collected as one integrated grab sample. The sample bottles were labeled, placed in a cooler with ice, and delivered to the laboratory under chain-of-custody protocol. In 2001, samples were refrigerated for no more than three days prior to shipment to the APPL lab. In 2002 and 2003, all rain and creek samples were immediately placed on ice and transported to the CDFA lab at the end of each sampling day.

Creek samples collected in 2001 were analyzed for OP pesticides, other pesticides, and total suspended solids (TSS). Samples collected for TSS analysis were poured in the field from the sample bottle into 250-milliliter (mL) plastic bottles. In 2002 and 2003, creek and rain samples were analyzed for OP pesticides and other pesticides including pyrethroids. Creek sample collection dates for 2001 – 2003 and analytes for each sample are shown in Table 3.

5.3 Laboratory Analytical Methods

For the 2001 sampling period, laboratory analysis was performed by the APPL in Fresno, California using USEPA Method 8141A, after extraction by USEPA Method 3510C. APPL's laboratory quality control protocols for low-level pesticide analysis were followed. Total Suspended Solids analysis was performed by APPL laboratory using USEPA Method 160.2.

Samples collected during the 2002 and 2003 orchard dormant spray seasons were prepared at the CDFA Lab in Sacramento, California using Method 8141A. Samples were analyzed using a Gas Chromatography/Mass Spectrometer Detector with selected ion method (GC/MSD-SIM mode) (CDFA, 2003). CDFA's laboratory quality control protocols for low-level pesticide analysis were followed.

5.4 Quality Assurance/Quality Control Samples

During each monitoring season, additional samples were collected for quality assurance/quality control (QA/QC) purposes. The frequency that QA/QC samples were collected was based on the total number of primary samples collected during each monitoring period. Four types of quality assurance samples were collected to confirm the integrity of analytical results reported in this three-year monitoring study. The QA/QC samples included sample duplicates, equipment blanks, matrix spikes, and matrix spike duplicates. Sample duplicates provide a measure of analytical precision; equipment blanks are used to evaluate possible contamination during sample collection; and matrix spikes and matrix spike duplicates are used to evaluate recovery of constituents by the analytical techniques. The procedures used for collecting the QA/QC samples are based on the San Joaquin River TMDL Quality Assurance Project Plan (Azimi *et al.*, 2002).

During this 2001-2003 study, approximately 15-25 percent of the samples collected were either equipment blanks, sample duplicates, or matrix spikes and matrix spike duplicates. Equipment blank samples were collected immediately after the rain collectors were cleaned. Equipment blanks were produced in the field by pouring de-ionized water over all contact surfaces of the rain sampler apparatus, then pouring the blank sample into a clean 1-liter amber glass bottle. When collecting rain samples, duplicates were produced by swirling the sampling carboy to mix the sample and filling two identical 1-L amber glass bottles. Matrix spike samples and matrix spike duplicate samples were also collected in the same manner as rain samples. Samples were spiked by the analytical labs.

In 2001, creek samples were collected with a 12-foot fiberglass sampling pole that accommodated one1-L amber glass sample bottle secured to the end of the pole. The sample bottle was rinsed once with creek water before filling. When using the PVC creek sample collector in 2002 and 2003, two 1-L samples were collected and appropriately labeled as either a primary, duplicate, matrix spike, or matrix spike duplicate sample.

6 ANALYTICAL RESULTS FOR ENVIRONMENTAL SAMPLES

Rain and creek sample analysis results are discussed in this section and data quality results are discussed in Section 7. Tables 4 and 5 list APPL and CDFA Lab Practical Quantitation Limits (PQLs) for pesticides of concern and laboratory acceptance criteria for quality control samples analyzed by the CDFA and APPL labs. Tables 6-13 include diazinon and chlorpyrifos concentrations measured in Sacramento urban rainwater and creek water samples during the three-year monitoring period, as well as results for other detected pesticides. Table 14 shows the sampling and extraction dates for creek and rain samples collected as part of this study. All of the samples were extracted within their holding times.

6.1 Sacramento Metropolitan Area Rainwater Sample Results

2001

During the 2001 orchard dormant spray season, 11 rain samples were collected from three rain monitoring sites (Lincoln Airport, Arcade Creek at Greenback Lane, and Herald; see Figure 1). Rainwater samples were analyzed for diazinon, chlorpyrifos, other pesticides (but not for pyrethroids)[1]. Thirty-six percent of the rain samples exceeded the CDFG acute aquatic life water quality criterion for diazinon (0.080 micrograms per liter, µg/L), and approximately 18 percent exceeded the CDFG acute aquatic life water quality criterion for chlorpyrifos (0.020 µg/L). (Note: The chlorpyrifos detection limit was 0.050 µg/L.) Other pesticides, with the exception of pendimethalin, were not detected in these rain samples. Pendimethalin was detected below the practical quantitation limit of 0.010 µg/L.

[1] Other pesticides analyzed by APPL lab: azinphos methyl, sulprofos (Bolstar®), coumaphos, tribufos (Def), demeton, dichlorvos, dimethoate, disulfoton, EPN, EPTC, ethion, ethoprop, fensulfothion, fenthion, malathion, merphos, mevinphos, naled, ethyl-parathion, methyl-parathion, phorate, pendimethalin (Prowl), ronnel, stirophos, sulfotepp, tokuthion, and trichloronate. Tributylphosphate and triphenylphosphate were the surrogates.

2002

In 2002, a total of 21 rain samples were collected during the orchard dormant spray season and were analyzed by the CDFA lab for diazinon, chlorpyrifos, other OP pesticides and pyrethroids[2]. Approximately 14 percent of the rain samples exceeded the CDFG acute water quality criterion for diazinon (0.080 µg/L) and 14 percent exceeded the CDFG acute water quality criterion (0.020 µg/L) for chlorpyrifos. The rain monitoring results also indicated that diazinon concentrations and chlorpyrifos concentrations were higher at the southern site (Herald) than at the Arcade Creek or Lincoln sites. Samples collected from Lincoln airport in mid-February contained the highest diazinon concentrations.

Rain sample analysis results also showed that diazinon was detected in all rain samples collected during the 2002 monitoring period. The lowest diazinon concentrations occurred in late January, at the beginning of the 2002 study period, at Arcade Creek (the urban residential/commercial site) and at Lincoln Airport (the rural residential/commercial site). Meanwhile, diazinon concentrations at Herald (the rural residential/agricultural site) were up to seven times higher in comparison. By early February, diazinon concentrations reached their peak at all rain monitoring sites. Diazinon levels continued to decrease during subsequent storm events from mid-February to mid-March 2002.

Chlorpyrifos concentrations in rain samples collected from the Lincoln Airport rain monitoring site were low to non-detectable until mid-March when chlorpyrifos was measured at 0.017 µg/L. The highest chlorpyrifos concentrations were detected in Herald rain samples during this 2002 monitoring period. Pyrethroids were not detected in any rain samples collected from the three rain monitoring sites.

2003

In 2003, a total of 35 rain samples were collected during the orchard dormant spray season and were analyzed by the CDFA lab for diazinon, chlorpyrifos, and other pesticides[2]. Rainwater samples were collected at sites in the Sacramento metropolitan area and in Stockton during ten storm events from mid-January to late April (see Figure 1). Storms were more difficult to track during the 2003 orchard dormant spray season than during the 2001 and 2002 dormant spray seasons. Some storm systems that approached California split as they tracked across the Central Valley. As a result, less rain fell at the southern rain monitoring sites (R1 and R4) than at the northern rain monitoring sites (R2 and R3). During some storm events, rain samples could not be collected at the southern rain monitoring sites. The time-span between storm events was greater during the 2003 rainy season as well.

Diazinon and chlorpyrifos concentrations in rain samples collected from the two northern rain monitoring sites (R2 and R3) during mid-January were low to non-detectable. Rain samples were not collected from the two southern rain monitoring sites (R1 and R4) due to insufficient rainfall at those sites. During late January, diazinon concentrations in samples collected at both northern sites increased by an order of magnitude. During the next (mid-February) storm event, rain

[2] Pyrethroids and other pesticides analyzed by CDFA lab: azinphos methyl, bifenthrin, carbaryl, cyanazine, cyfluthrins, l-cyhalothrin, cypermethrin, dacthal (DCPA), disulfoton, eptam (EPTC), esfenvalerate, methidathion, metolachlor, propargite, and the herbicides cyanazine, and simazine. Chlorpyrifos methyl was the surrogate.

samples were collected at all four rain monitoring sites. The Lincoln Airport (Site R3) rain sample contained the greatest concentration of diazinon (0.53 µg/L).

By the time of the next storm (March 15, 2003), diazinon concentrations decreased in the samples collected at the northern rain monitoring sites (R2 and R3) while chlorpyrifos concentrations increased, particularly at the Lincoln Airport site. Also, samples collected from the southern rain monitoring sites (R1 and R4) contained increased levels of diazinon and chlorpyrifos. After March 15, 2003 diazinon and chlorpyrifos concentrations in samples collected at all four rain monitoring sites generally decreased.

Overall, from late January 2003 to mid-February 2003, diazinon concentrations in rain were highest at Lincoln Airport (R3), the northernmost rain monitoring site (during one sample day concentrations were very high, other sample days concentrations were similar). Then concentrations for Site R3 decreased to comparable concentrations for Sites R1 and R2, then to non-detectable at the end of the four-month monitoring period. (By comparison, throughout the 2002 monitoring period, diazinon and chlorpyrifos concentrations in rain samples collected from the Herald rain monitoring site (R1) were generally higher than at the Lincoln Airport and Arcade Creek at Greenback Lane rain monitoring sites (R3 and R2).

Of the 35 rain samples collected during the 2003 monitoring period, approximately 11 percent exceeded the CDFG acute aquatic life water quality criterion for diazinon (0.080 µg/L) and 17 percent exceeded the acute aquatic life water quality criterion for chlorpyrifos (0.020 µg/L).

Pyrethroids were not detected in any rain samples collected during the 2003 monitoring period. Other constituents (dacthal-DCPA, methidathion, and some herbicides) were detected, but at concentrations below lab quantitation limits. Carbaryl, a carbamate insecticide, was detected at all rain monitoring sites in April 2003.

Tables 6-9 present the diazinon and chlorpyrifos analytical results for rain samples collected in 2001-2003. These tables include analytical results for other detected pesticides.

6.2 Sacramento Metropolitan Area Creek Sample Results

2001

In 2001, Regional Board staff collected 19 creek samples from nine creek monitoring sites. Samples were analyzed for diazinon, chlorpyrifos, and other pesticides (but not for pyrethroids)[3]. Approximately 37 percent of the creek samples collected during the 2001 monitoring period exceeded the CDFG acute diazinon water quality criterion, while none of the samples exceeded the CDFG chronic or acute chlorpyrifos water quality criteria (note: The APPL lab's PQL was 0.05 µg/L). With the exception of malathion and pendimethalin, no other pesticides were detected in

[3] Other pesticides analyzed by APPL lab: azinphos methyl, sulprofos (Bolstar®), coumaphos, tribufos (Def), demeton, dichlorvos, dimethoate, disulfoton, EPN, EPTC, ethion, ethoprop, fensulfothion, fenthion, malathion, merphos, mevinphos, naled, ethyl-parathion, methyl-parathion, phorate, pendimethalin (Prowl), ronnel, stirophos, sulfotepp, tokuthion, and trichloronate. Tributylphosphate and triphenylphosphate were the surrogates.

creek samples collected during the 2001 study period. Total suspended solids were also measured and exceeded the 10 milligrams per liter (mg/L) quantitation limit 86 percent of the time.

2002

Creek samples in the Sacramento metropolitan area were not collected during the 2002 orchard dormant spray season.

2003

During ten storm events during the orchard dormant spray season, a total of 50 creek samples were collected between January 23, 2003 and April 24, 2003. The samples were analyzed by the CDFA lab for diazinon, chlorpyrifos, and other pesticides including pyrethroids[4]. Approximately 24 percent of the samples exceeded the CDFG acute aquatic life water quality criterion for diazinon (0.080 µg/L) and 24 percent also exceeded the acute aquatic life water quality criterion (0.020 µg/L) for chlorpyrifos.

Diazinon concentrations in Arcade Creek at Watt Avenue (Site C1) were generally an order of magnitude higher in comparison to the other four creek monitoring sites (C2, C3, C4, and C5). Ninety percent of the time diazinon concentrations at the Arcade Creek site were greater than the CDFG aquatic life water quality criterion for diazinon (0.080 µg/L) criteria and chlorpyrifos was detected 40 percent of the time at levels above the CDFG aquatic life water quality criterion for chlorpyrifos (0.020 µg/L).

Diazinon concentrations were low to non-detectable at the upstream and downstream Elder Creek monitoring sites (C2 and C3). However, chlorpyrifos concentrations at the Elder Creek downstream monitoring site (C3, downstream of a 250-acre commercial nursery) were the highest overall, with 70 percent of the chlorpyrifos detections above the CDFG aquatic life water quality criterion for chlorpyrifos (0.020 µg/L). From mid-March to mid-April, chlorpyrifos concentrations in samples collected from the downstream Elder Creek monitoring site were consistently high (ranging from 0.035 µg/L to 0.320 µg/L) while samples collected from the upstream Elder Creek monitoring site had non-detectable chlorpyrifos concentrations 80 percent of the time.

Diazinon concentrations at the downstream urban Morrison Creek site (C5) were above the CDFG acute aquatic life water quality criterion for diazinon (0.080 µg/L) 50 percent of the time. Chlorpyrifos was detected 30 percent of the time at monitoring site C5, but was never detected at the upstream, rural Morrison Creek monitoring site (Site C4).

Bifenthrin was detected throughout the 2003 monitoring period at low levels (around 0.010 µg/L) at the Arcade Creek at Watt Avenue monitoring site only. Metolachlor and carbaryl were also repeatedly detected throughout this monitoring period in samples collected from the Arcade, Elder and Morrison Creek monitoring sites.

Samples to measure total suspended solids were not collected during the 2003 monitoring period.

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[4] Pyrethroids and other pesticides analyzed by CDFA lab: azinphos methyl, bifenthrin, carbaryl, cyanazine, cyfluthrins, l-cyhalothrin, cypermethrin, dacthal (DCPA), disulfoton, eptam (EPTC), esfenvalerate, methidathion, metolachlor, propargite, and the herbicides cyanazine and simazine. Chlorpyrifos methyl was the surrogate.

The laboratory detection limits were much different between 2001 and 2003; therefore, it is difficult to draw any solid conclusions to account for higher concentrations detected in creek samples.

Tables 10-13 present the diazinon and chlorpyrifos analytical results for creek samples collected in 2001-2003. Analytical results for other pesticides are presented if there were any detectable amounts of a particular pesticide.

7 ANALYTICAL RESULTS FOR DATA QUALITY SAMPLES

Quality assurance elements, including the quality control sample results, are reviewed below.

7.1 Calibration

CDFA calibrations for instrument performance analysis were conducted in the following manner: five concentrations of sixteen standard compounds were prepared in a reagent grade water matrix. A linear regression was used including the origin for each pesticide. The standards mixtures were analyzed, linear calibrations were conducted, and R^2 values were calculated for each compound (the R^2 value is the regression correlation coefficient). However, some compounds did not meet the required R^2 of 0.99 for the linear regression. In some instances with very low detection limits, a quadratic regression was used to meet the required R^2 value of greater than or equal to 0.99. Therefore, CDFA used a quadratic equation for the non-linear responding compounds[5].

Each analysis started with a five-point calibration standard. A calibration standard was analyzed after every 10 samples to verify the calibration curve. Throughout a given sample set, a single level calibration standard was intermittently assayed. When calibration failed, the instrument was recalibrated and all samples assayed since the last successful calibration were re-assayed using the newly qualified calibration curves.

When pesticide concentrations were greater than the highest calibration level, the sample was diluted and reanalyzed.

7.2 Matrix Spike and Matrix Spike Duplicate Samples

For the 2001 monitoring period, matrix spikes were not performed due to insufficient sample volume.

For the 2002 monitoring period, four matrix spike samples and two matrix spike duplicate samples were prepared and analyzed. The matrix spike samples and matrix spike duplicate samples were spiked with diazinon, chlorpyrifos, and bifenthrin. Both matrix spike duplicates and five matrix spike samples met the laboratory acceptance criterion range of 70-130 percent. One matrix spike sample (collected on March 10, 2002) did not meet the lab acceptance criterion range of 70-130 percent for chlorpyrifos, diazinon, and bifenthrin.

[5] The quadratic calibration is not linear but rather a curved line over the calibration range. The R^2 value for a quadratic curve shows how well the five points of the calibration meet the calculated points on the curve.

For the 2003 monitoring period, ten matrix spike samples and one matrix spike duplicate sample were prepared and analyzed. The matrix spike samples and matrix spike duplicate samples were spiked with diazinon, chlorpyrifos, and bifenthrin. Four matrix spike samples met the CDFA laboratory acceptance criterion range of 70-130 percent (see Table 15) for chlorpyrifos, diazinon, or bifenthrin. Seven matrix spike samples and the single matrix spike duplicate sample did not meet the laboratory acceptance criterion range of 70-130 percent for at least one of the spiked compounds. Re-injection of the necessary compound(s) was performed on four of the seven matrix spike samples and the single matrix spike duplicate sample and the samples, again, did not meet the CDFA lab acceptance criterion. All samples that were outside the acceptance criterion range were below 70%, therefore, the sample analyses likely underestimate the actual sample concentrations.

Results for samples run in the same batch as a matrix spike or lab spike that were outside the lab acceptance criterion range are shaded in Tables 5-13. Only the compound(s) found to be outside the lab acceptance range are shaded. Table 15 includes the matrix spike results.

Matrix spikes are real environmental samples that are spiked with target compounds. Therefore, matrix interferences from environmental samples may cause poor recovery of the matrix spike compounds. Poor matrix spike recovery may also be due to poor sample preparation. However, during this study, additional sample material was not available to re-extract and re-analyze.

The concentrations of the spike compounds added were 5 to 10 times lower than their lower laboratory reporting limits. The concentration of the spike compounds cannot be compared to sample concentrations because sample concentrations are variable.

7.3 Surrogates

Of 42 samples spiked with tributylphosphate during the 2001 monitoring period, 37 spiked samples met the laboratory acceptance criterion range of 67-139 percent and 5 spiked samples did not meet this criterion. Re-extraction and re-analysis is generally performed on samples for which surrogate recoveries were outside the laboratory acceptance criteria ranges. However, due to insufficient sample volumes, the APPL laboratory was unable to re-extract and re-analyze the samples. Of 42 samples spiked with triphenylphosphate, all 42 samples met the laboratory acceptance criterion range of 56-145 percent.

During the 2002 and 2003 Regional Board monitoring periods, chlorpyrifos methyl was the surrogate added to all environmental and QA/QC samples. In 2002, all twenty-one primary environmental samples met the 50-150 percent laboratory acceptance criterion range for chlorpyrifos methyl. In 2003, 84 primary environmental samples were collected. Chlorpyrifos methyl recovery in six samples (7 percent) fell outside the CDFA laboratory's acceptance criterion range. Four of the six samples were re-injected and they, again, did not meet the CDFA lab acceptance criterion range of 50-150 percent for chlorpyrifos methyl.

7.4 Duplicates

Duplicate samples were collected from rain and creek monitoring sites during the 2001 through 2003 monitoring period. Most constituents analyzed in the duplicate samples were generally not detectable or below laboratory quantitation limits. In 2001, tributylphosphate and triphenylphosphate (surrogate compounds) recoveries in duplicates met their respectiveAPPL lab acceptance criteria ranges of 67-139 percent and 56-145 percent, respectively. In 2002 and 2003, chlorpyrifos methyl (surrogate compound) recoveries in duplicates generally met the CDFA lab acceptance criteria range of 50-150 percent.

Tables 16 and 17 provide the analytical results and the relative percent differences (RPDs) for primary samples and their associated duplicates, when at least one pesticide was detected above quantitation limits.

The RPD between the primary and duplicate samples collected on February 17, 2002 is 42 percent, which exceeds the USEPA generic Quality Assurance RPD of below 20 percent (Richmond, 2000). The volume for the duplicate sample was only 444 mL (not the standard 1 liter sample) and this may have affected the RPD. The RPD of 25 percent calculated for the March 10, 2002 primary and duplicate samples also did not meet the USEPA generic Quality Assurance RPD of below 20 percent.

7.5 Equipment Blanks

In general, equipment blanks were collected after the rain collectors were cleaned.

Three equipment blanks were collected during the 2001 monitoring period. Analytical results indicated that analytes were not detected above the PQLs. The percent recoveries of tributylphosphate and triphenylphosphate were also within the APPL laboratory acceptance criteria ranges of 67-139 percent and 56-145 percent, respectively.

For the 2002 monitoring period, four equipment blanks were collected. Analytical results indicate that no pesticides were detected in three of the four equipment blank samples. Simazine, an herbicide, was detected in one equipment blank sample (from the Lincoln Airport rain sampler on February 8, 2002). Of the four equipment blanks collected during this monitoring project, chlorpyrifos methyl surrogate recoveries for all four equipment blanks fell within the CDFA laboratory acceptance criteria range of 50-150 percent.

During the 2003 monitoring period, 14 equipment blanks were collected. Analytical results indicate that no pesticides were detected in any of the 14 equipment blank samples. Of the 14 equipment blanks collected during this monitoring project, chlorpyrifos methyl surrogate recoveries for all equipment blanks fell within the laboratory acceptance criteria range of 50-150 percent.

7.6 Method Blanks and Lab Control Spikes

During the 2001 monitoring period, three method blanks were analyzed and results indicated that analytes were not detected above the PQLs for all three blanks. The percent recoveries of tributylphosphate and triphenylphosphate were within the laboratory acceptance criteria ranges for all three blanks.

During the 2002 monitoring period, five laboratory method blanks and five laboratory control spikes were prepared and analyzed by the CDFA lab. None of the five laboratory method blanks contained detectable levels of the 17 pesticide compounds. Four of the five lab control spike samples fell within the laboratory's acceptance criteria of 70-130 percent for bifenthrin, chlorpyrifos and diazinon (see Tables 18 and 19). The lab control spike sample that was analyzed on March 25, 2002 was slightly below the laboratory's quality control acceptance criteria for all associated spike compounds (bifenthrin, chlorpyrifos, and diazinon). However, the chlorpyrifos methyl surrogate recovery for all primary samples (collected on March 10, 2002) associated with this lab control spike sample were within the laboratory's acceptance criteria of 50-150 percent.

During the 2003 monitoring period, 20 laboratory method blanks and 20 laboratory control spikes were prepared and analyzed by the CDFA lab. None of the 20 laboratory method blanks contained detectable levels of the 17 pesticide compounds. Eleven of twenty lab control spike samples fell within the laboratory's acceptance criteria of 70-130 percent for the spike compounds bifenthrin, diazinon, and chlorpyrifos. The nine lab control spike samples that did not meet the CDFA lab's acceptance criteria for one or more of the associated spike compounds (bifenthrin, diazinon and chlorpyrifos) were re-injected with the compounds. Re-injection results showed little improvement in meeting the CDFA lab's recovery ranges. However, the chlorpyrifos methyl surrogate recoveries in eight of the nine lab control spike samples were within the laboratory's acceptance criteria of 50-150 percent for chlorpyrifos methyl.

The laboratory has determined that the low recovery of LCSs may have been due to an inconsistent step in the extraction procedure. However, there was no additional sample available to re-extract and re-analyze. A corrective action was taken by Regional Board staff. The method was modified such that the CDFA lab is now using only 500 ml of sample for initial analysis and the remaining 500 ml is retained as a back up sample for re-analysis when the QA of the initial analysis is out of acceptance limits. The 2004 storm event monitoring data shows that the sample recovery for the majority of the quality control samples are within the acceptance limits and an improvement has been seen in the data.

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Table 1. Creek sampling locations

Creek	Sampling Location	Latitude	Longitude
Arcade Creek	Watt Avenue	38° 38' 30"	121° 22' 58"
Elder Creek	Excelsior Road	38° 31' 08"	121° 17' 52"
	Bradshaw Road	38° 30' 26"	121° 20' 06"
	Elder Creek Road	38° 30' 39"	121° 18' 52"
	Elk Grove-Florin Road	38° 29' 02"	121° 22' 19"
	Franklin Boulevard	38° 28' 34"	121° 27' 04"
Morrison Creek	Sunrise Boulevard	38° 33' 39"	121° 14' 40"
	Hedge Road	38° 31' 06"	121° 21' 46"
	Franklin Boulevard	38° 29' 29"	121° 27' 24"
Elk Grove Creek	Waterman Road	38° 23' 52"	121° 21' 11"
	Emerald Vista Drive	38° 24' 39"	121° 23' 03"
Florin Creek	Franklin Boulevard	38° 28' 50"	121° 27' 10

Table 2. Rainfall accumulations during the 2001-2003 rain and creek monitoring periods

Duration of Storm Events when Rainfall and/or Creek Samples were Collected	Accumulated Rainfall (inches) at Sacramento Metropolitan/International Airport (Station SMF/4239)	Accumulated Rainfall (inches) at Arcade Creek at Winding Way (Station AMC/1824)
2/9/01-2/12/01	1.73	1.86
2/19/01-2/25/01	2.32	2.60
1/26/02	0.43	0.63
1/28/02	0.08	0.08
2/7/02-2/8/02	0.28	0.35
2/16/02-2/17/02	0.16	0.40
2/19/02-2/20/02	0.11	0.25
3/5/02-3/7/02	0.83	1.46
3/9/02-3/10/02	0.47	0.47
1/12/03-1/14/03	0.28	0.19
1/21/03-1/23/03	0.51	0.51
2/12/03-2/13/03	0.47	0.58
2/15/03-2/17/03	0.59	0.63
2/19/03	0.12	0.12
3/13/03-3/16/03	2.24	1.81
3/19/03-3/21/03	0.24	0.24
3/22/03-3/23/03	0.28	0.19
4/4/03	0.19	0.28
4/12/03-4/14/03	0.83	1.65
4/24/03-4/25/03	0.39	0.55
4/27/03-4/29/03	0.71	1.35

Rainfall data for the Sacramento Metropolitan/International Airport and Arcade Creek at Winding Way rain gage stations was obtained from the California Data Exchange Center (CDEC) database for water years 2001, 2002, and 2003 (CDWR, 2001-2003).

Table 3. Sampling dates and analytical suites by sampling location (shading indicates no sample collected)

Sampling Site	Sample Type	Sampling Dates and Analytical Suites[1]																														
		2/10/2001	2/11/2001	2/19/2001	2/20/2001	2/25/2001	1/26/2002	1/28/2002	2/8/2002	2/17/2002	2/20/2002	3/6/2002	3/7/2002	3/10/2002	1/14/2003	1/23/2003	1/24/2003	2/13/2003	2/14/2003	2/16/2003	2/17/2003	2/19/2003	3/15/2003	3/20/2003	3/21/2003	3/23/2003	4/4/2003	4/13/2003	4/14/2003	4/24/2003	4/25/2003	4/28/2003
Arcade Creek at Watt Avenue	Creek															C		C		C		C	C	C		C	C	C		C		
Elder Creek at Franklin Boulevard	Creek			A,B	A,B																											
Elder Creek at Elk Grove-Florin Road	Creek			A,B	A,B																											
Elder Creek at Elder Creek Road	Creek			A,B	A,B																											
Elder Creek at Bradshaw Road	Creek															C		C		C		C	C	C		C	C	C		C		
Elder Creek at Excelsior Road	Creek															C		C		C		C	C	C		C	C	C		C		
Elk Grove Creek at Emerald Vista Way	Creek			A,B	A,B																											
Elk Grove Creek at Waterman Road	Creek			A,B	A,B																											
Florin Creek at Franklin Boulevard	Creek	A,B	A,B																													
Morrison Creek at Franklin Boulevard	Creek			A,B	A,B											C		C		C		C	C	C		C	C	C		C		
Morrison Creek at Hedge Road	Creek	A,B	A,B																													
Morrison Creek at Sunrise Boulevard	Creek	A,B	A,B													C		C		C		C	C	C		C	C	C		C		
Lincoln Airport (R3)	Rain	A	A			A	C	C	C	C	C	C	C	C	C		C		C		C		C		C		C		C		C	C
Arcade Creek at Greenback Lane (R2)	Rain	A	A		A	A	C		C	C	C	C	C	C	C		C		C		C		C		C		C		C		C	C
Herald Fire Department (R1)	Rain	A	A	A	A	A	C		C	C		C	C	C	C				C		C		C		C		C		C		C	C
Stockton (R4)	Rain																		C	C			C				C		C		C	C

Table 3 (continued). Sampling dates and analytical suites by sampling location

[1]Analytical suites: **A** = azinphos methyl, sulprofos (Bolstar®), coumaphos, tribufos (Def), demeton, dichlorvos, dimethoate, disulfoton, EPN, EPTC, ethion, ethoprop, fensulfothion, fenthion, malathion, merphos, mevinphos, naled, ethyl-parathion, methyl-parathion, pendimethalin (Prowl), phorate, ronnel, stirophos, sulfotepp, tokuthion, and trichloronate. Tributylphosphate and triphenylphosphate were the surrogates.

B = Total suspended solids

C = azinphos methyl, bifenthrin, carbaryl, cyanazine, cyfluthrins, l-cyhalothrin, cypermethrin, dacthal (DCPA), disulfoton, eptam (EPTC), esfenvalerate, methidathion, metolachlor, propargite, and the herbicides cyanazine, and simazine. Chlorpyrifos methyl was the surrogate.

Table 4. 2001 APPL Laboratory acceptance criteria limits and practical quantitation limits for select pesticides

COMPOUND	LABORATORY ACCEPTANCE CRITERIA RANGE (%)	PRACTICAL QUANTITATION LIMIT (PQL in µg/L)
Azinphos methyl	43-159	1.0
Bolstar	31-120	.10
Chlorpyrifos (Dursban)	53-115	.05
Coumaphos	40-127	.20
Def	53-119	.10
Demeton (Total)	21-80	.20
Diazinon	49-115	.05
Dichlorvos	13-145	.20
Dimethoate	33-227	.10
Disulfoton	5-119	.10
EPN	20-152	.10
EPTC	12-151	.10
Ethion	47-118	.10
Ethoprop	61-112	.10
Fensulfothion	37-172	.50
Fenthion	39-109	.10
Malathion	54-110	.10
Merphos	57-109	.10
Mevinphos	30-192	.70
Naled	16-285	.50
Parathion, ethyl	38-124	.10
Parathion, methyl	34-135	.10
Phorate	25-113	.10
Prowl (Pendimethalin)	30-129	.10
Ronnel	46-104	.10
Stirophos	31-162	.10
Sulfotep	50-106	.10
Tokuthion	48-117	.10
Trichloronate	36-115	.10
Trifluralin	31-107	.10
Tributylphosphate	67-139	Not Applicable
Triphenylphosphate	56-145	Not Applicable

Table 5. 2002 and 2003 CDFA Laboratory practical quantitation limits and acceptance criteria limits for select pesticides.

COMPOUND	PRACTICAL QUANTITATION LIMIT (PQL in µg/L)
Azinphos methyl	**0.050**
Bifenthrin	**0.050**
Carbaryl	**0.020**
Chlorpyrifos (Dursban)	**0.010**
Cyanazine	**0.050**
Cyflurthrins	**0.200**
I-Cyhalothrin	**0.100**
Cypermethrin	**0.200**
Dacthal (DCPA)	**0.050**
Diazinon	**0.020**
Disulfoton	**0.020**
Eptam (EPTC)	**0.050**
Esfenvalerate	**0.050**
Methidathion	**0.030**
Metolachlor	**0.020**
Propargite	**0.500**
Simazine	**0.200**

Chlorpyrifos methyl was used as a laboratory surrogate; the lab recovery range for this surrogate is 50 – 150%. Laboratory Acceptance ("Recovery") Criteria Limits for bifenthrin, chlorpyrifos, and diazinon were 70 – 130%.

Table 6. Pesticide analytical results for rainwater samples collected in Herald, California at the Herald Fire Department. Concentrations are in µg/L.

Sampling Date	Diazinon	Chlorpyrifos	Simazine	Cyanazine	Methidathion	Carbaryl	Dacthal (DCPA)	Pendimethalin	Metolachlor	% Recovery of Surrogate
02/10/2001	0.09	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	81 / 80
02/11/2001	0.13	e0.03	N/A	N/A	N/A	N/A	N/A	e0.05	N/A	87 / 84
02/19/2001	ND	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	73 / 70
02/20/2001	e0.03	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	74 / 73
02/25/2001	ND	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	
01/26/2002	0.078	e0.006	ND	ND	ND	ND	ND	N/A	ND	56
02/08/2002	0.523	0.017	0.465	ND	e0.028	0.031	ND	N/A	ND	96
02/17/2002	0.032	e0.005	e0.110	ND	ND	ND	e0.012	N/A	ND	68
03/06/2002[6]	0.053	0.029	0.416	e0.014	ND	ND	ND	N/A	ND	81
03/07/2002	0.028	0.014	e0.061	ND	ND	ND	ND	N/A	ND	99
03/10/2002	e0.015	0.069	e0.027	e0.015	ND	e0.015	ND	N/A	ND	85
02/14/2003	0.052	e0.006	e0.026	ND	ND	ND	ND	N/A	ND	84
02/17/2003	0.023	e0.009	e0.016	ND	ND	ND	e0.015	N/A	ND	88
03/15/2003	0.033	0.063	e0.076	ND	e0.024	ND	e0.022	N/A	ND	81
03/21/2003	ND	e0.006	ND	ND	ND	ND	ND	N/A	ND	82
04/04/2003	ND	ND	ND	ND	ND	ND	ND	N/A	ND	69
04/14/2003	0.034	e0.007	e0.007	ND	ND	0.430	e0.017	N/A	e0.008	72
04/25/2003	0.020	0.023	e0.006	ND	ND	0.190	ND	N/A	e0.011	74
04/28/2003	e0.007	ND	e0.006	ND	ND	0.032	ND	N/A	e0.009	75

N/A = not analyzed; ND = not detected; e = estimated (below quantitation limit). Shading indicates either lab spike or matrix spike samples did not meet the CDFA lab acceptance criterion range of 70 - 130 percent after reinjection. Surrogates in 2001 are tributylphosphate and triphenyl phosphate; surrogate in 2002 and 2003 is chlorpyrifos methyl.

[6] Sample collectors not cleaned prior to 03/06/2002 rain event. Results may reflect both dry and wet deposition.

Table 7. Pesticide analytical results for rainwater samples collected at the Arcade Creek at Greenback Lane site. Concentrations in µg/L.

Sampling Date	Diazinon	Chlorpyrifos	Simazine	Cyanazine	Methidathion	Carbaryl	Dacthal (DCPA)	Pendimethalin	Metolachlor	% Recovery of Surrogate
02/10/2001	0.12	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	94 / 88
02/11/2001	0.10	0.03e	N/A	N/A	N/A	N/A	N/A	ND	N/A	79 / 72
02/25/2001	ND	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	99 / 95
01/26/2002	e0.011	e0.004	e0.061	ND	e0.021	ND	ND	N/A	ND	103
02/08/2002	0.193	0.016	0.280	ND	ND	e0.015	ND	N/A	ND	92
02/17/2002	0.026	e0.007	e0.059	ND	ND	ND	e0.013	N/A	ND	73
02/20/2002	0.037	0.014	e0.185	ND	ND	ND	ND	N/A	ND	78
03/06/2002[7]	0.046	0.017	0.225	e0.018	ND	ND	ND	N/A	ND	110
03/07/2002	e0.016	e0.008	ND	ND	ND	e0.013	ND	N/A	ND	92
03/10/2002	e0.016	0.024	e0.016	e0.007	ND	ND	ND	N/A	ND	82
01/14/2003	0.027	ND	ND	e0.007	ND	ND	ND	N/A	ND	83
01/24/2003	0.120	0.018	e0.008	ND	e0.015	ND	ND	N/A	ND	83
02/14/2003	0.160	0.016	e0.008	ND	ND	ND	ND	N/A	ND	84
02/17/2003	0.026	0.011	e0.009	ND	ND	e0.011	e0.023	N/A	ND	80
03/15/2003	e0.020	0.016	e0.045	ND	ND	ND	e0.011	N/A	ND	83
03/21/2003	e0.008	e0.006	ND	ND	ND	ND	ND	N/A	ND	71
04/04/2003	ND	0.012	ND	ND	ND	ND	ND	N/A	ND	73
04/14/2003	e0.014	e0.009	e0.018	ND	ND	0.120	e0.010	N/A	ND	72
04/25/2003	e0.019	e0.006	ND	ND	ND	0.038	ND	N/A	ND	73
04/28/2003	e0.010	ND	ND	ND	ND	0.040	e0.007	N/A	ND	72

N/A = not analyzed; ND = not detected; e = estimated (below quantitation limit). Shading indicates either lab spike or matrix spike samples did not meet the CDFA lab acceptance criterion range of 70 - 130 percent for that compound after reinjection. Surrogates in 2001 are tributylphosphate and triphenyl phosphate; surrogate in 2002 and 2003 is chlorpyrifos methyl.

[7] Sample collectors not cleaned prior to 03/06/2002 rain event. Results may reflect both dry and wet deposition.

Table 8. Pesticide analytical results for rainwater samples collected in Lincoln, California at the Lincoln Airport. Concentrations in µg/L.

Sampling Date	Diazinon	Chlorpyrifos	Simazine	Cyanazine	Methidathion	Carbaryl	Dacthal (DCPA)	Pendimethalin	Metolachlor	% Recovery of Surrogate
02/10/2001	0.06	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	99 / 83
02/11/2001	0.07	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	104 / 95
02/25/2001	ND	ND	N/A	N/A	N/A	N/A	N/A	ND	N/A	
01/26/2002	e0.017	ND	e0.025	e0.008	e0.022	ND	ND	N/A	ND	128
01/28/2002	0.078	e0.006	ND	ND	ND	ND	ND	N/A	ND	56
02/08/2002	0.092	ND	0.112	ND	ND	ND	ND	N/A	ND	69
02/17/2002	0.036	ND	e0.070	ND	ND	ND	e0.018	N/A	ND	76
02/20/2002	0.021	ND	e0.056	ND	ND	ND	ND	N/A	ND	77
03/06/2002[8]	0.048	0.012	0.212	ND	ND	ND	ND	N/A	ND	122
03/07/2002	e0.010	ND	e0.015	ND	ND	ND	ND	N/A	ND	108
03/10/2002	e0.013	0.017	e0.013	ND	ND	ND	ND	N/A	ND	85
01/14/2003	e0.012	e0.007	ND	ND	ND	ND	ND	N/A	ND	89
01/24/2003	0.130	0.046	ND	ND	ND	ND	ND	N/A	ND	75
02/14/2003	0.530	0.030	e0.010	ND	ND	ND	ND	N/A	ND	88
02/17/2003	0.024	e0.008	e0.008	ND	ND	ND	e0.026	N/A	ND	85
03/15/2003	e0.017	0.022	e0.033	ND	ND	ND	e0.016	N/A	ND	88
03/21/2003	ND	0.024	ND	ND	ND	ND	ND	N/A	ND	82
04/04/2003	ND	ND	ND	ND	ND	ND	ND	N/A	ND	75
04/14/2003	ND	ND	e0.006	ND	ND	0.055	e0.007	N/A	ND	60
04/25/2003	e0.010	ND	ND	ND	ND	0.032	ND	N/A	ND	78
04/28/2003	ND	ND	ND	ND	ND	0.068	e0.008	ND	ND	71

N/A = not analyzed; ND = not detected; e = estimated (below quantitation limit). Shading indicates either lab spike or matrix spike samples did not meet the CDFA lab acceptance criterion range of 70-130 percent for that compound after reinjection. Surrogates in 2001 are tributylphosphate and triphenyl phosphate; surrogate in 2002 and 2003 is chlorpyrifos methyl.

[8] Sample collectors not cleaned prior to 03/06/2002 rain event. Results may reflect both dry and wet deposition.

Table 9. Pesticide analytical results for rainwater samples collected in Stockton, California at 3635 Rainer Avenue. Concentrations in µg/L.

Sampling Date	Diazinon	Chlorpyrifos	Simazine	Cyanazine	Methidathion	Carbaryl	Dacthal (DCPA)	Metolachlor	% Recovery of Surrogate
02/14/2003	0.074	0.011	e0.027	ND	ND	ND	<PQL	ND	90
02/16/2003	e0.015	e0.006	ND	ND	ND	ND	e0.019	ND	90
03/15/2003	0.066	0.110	e0.027	ND	ND	ND	e0.015	ND	85
04/14/2003	e0.018	ND	e0.034	ND	ND	0.140	e0.010	e0.018	74
04/25/2003	0.037	ND	e0.006	ND	ND	0.110	ND	0.046	74
04/28/2003	0.026	ND	ND	ND	ND	e0.018	ND	e0.016	71

ND = not detected; e = estimated (below quantitation limit). Shading indicates either lab spike or matrix spike samples did not meet the CDFA lab acceptance criterion range of 70-130 percent for that compound after reinjection. Surrogates is chlorpyrifos methyl.

Table 10. Pesticide analytical results for samples collected in Arcade Creek at Watt Avenue in Sacramento County, California. Concentrations are in µg/L.

Sampling Date	Diazinon	Chlorpyrifos	Simazine	Carbaryl	Metolachlor	Methidathion	Bifenthrin	% Recovery of Surrogate
01/23/2003	0.220	0.024	e0.011	0.033	e0.012	e0.012	e0.014	91
02/13/2003	0.210	ND	ND	0.038	e0.019	ND	e0.010	89
02/16/2003	0.062	ND	e0.008	0.030	ND	ND	ND	33
02/19/2003	0.098	ND	e0.008	0.053	e0.007	ND	ND	76
03/15/2003	0.140	0.023	e0.016	0.110	ND	ND	e0.010	76
03/20/2003	0.110	ND	e0.011	0.090	0.065	ND	e0.010	92
03/23/2003	0.150	ND	ND	0.057	0.020	ND	ND	91
04/04/2003	0.190	ND	ND	0.140	e0.012	ND	ND	63
04/13/2003	0.150	0.020	e0.022	0.360	ND	ND	e0.007	74
04/24/2003	0.100	0.029	e0.012	0.300	ND	ND	e0.010	50

N/A = not analyzed; ND = not detected; e = estimated (below quantitation limit). Shading indicates samples not meeting the CDFA lab acceptance criterion range of 70 - 130 percent after reinjection for diazinon, chlorpyrifos or bifenthrin, or the acceptance range of 50-150 percent for the surrogate (chlorpyrifos methyl).

Table 11. Pesticide analytical results for samples collected from Elder Creek, Sacramento County, California. Concentrations are in µg/L.

Site Name	Sampling Date	Diazinon	Chlorpyrifos	Simazine	Carbaryl	Metolachlor	% Recovery of Surrogate
Excelsior Road	01/23/2003	e0.013	ND	ND	ND	ND	67
	02/13/2003	e0.012	0.017	e0.013	ND	0.110	54
	02/16/2003	e0.011	ND	ND	ND	ND	67
	02/19/2003	ND	ND	ND	ND	ND	66
	03/15/2003	ND	ND	e0.024	ND	ND	74
	03/20/2003	ND	ND	e0.015	ND	ND	89
	03/23/2003	ND	ND	e0.014	ND	ND	89
	04/04/2003	ND	ND	e0.020	ND	ND	74
	04/13/2003	e0.012	ND	e0.016	0.060	e0.013	68
	04/24/2003	ND	0.170	e0.030	e0.019	0.140	50
Bradshaw Road	01/23/2003	0.030	0.037	e0.018	ND	0.220	44
	02/13/2003	e0.009	ND	ND	ND	ND	36
	02/16/2003	e0.018	0.033	e0.029	ND	0.300	45
	02/19/2003	e0.010	0.016	e0.013	ND	0.053	67
	03/15/2003	ND	0.064	e0.038	ND	0.270	52
	03/20/2003	ND	0.060	e0.033	ND	0.180	75
	03/23/2003	ND	0.035	e0.022	ND	0.150	68
	04/04/2003	ND	0.078	e0.018	e0.010	0.190	64
	04/13/2003	e0.013	0.320	e0.033	0.069	0.270	68
	04/24/2003	ND	ND	e0.008	ND	ND	53
Elder Creek Road	02/19/2001	ND	ND	N/A	N/A	N/A	61 / 57
	02/20/2001	ND	ND	N/A	N/A	N/A	68 / 63
Elk Grove-Florin Rd	02/19/2001	ND	ND	N/A	N/A	N/A	69 / 61
Franklin Blvd	02/19/2001	0.17	ND	N/A	N/A	N/A	76 / 81
	02/20/2001	e0.03	ND	N/A	N/A	N/A	70 / 63

N/A = not analyzed; ND = not detected; e = estimated (below quantitation limit). Shading indicates samples not meeting the CDFA lab acceptance criterion range of 70 - 130 percent after reinjection for diazinon, chlorpyrifos or bifenthrin, or the acceptance range of 50-150 percent for the surrogate, chlorpyrifos methyl. Surrogates in 2001 are tributylphosphate and triphenyl phosphate; surrogate in 2002 and 2003 is chlorpyrifos methyl.

Table 12. Pesticide analytical results for samples collected from Morrison Creek, Sacramento County, California. Concentrations are in µg/L.

Site Name	Sampling Date	Diazinon	Chlorpyrifos	Malathion	Simazine	Carbaryl	Metolachlor	Methidathion	Bifenthrin	% Recovery of Surrogate
Sunrise Boulevard	02/10/2001	ND	ND	ND	N/A	N/A	N/A	N/A	N/A	76 / 73
	02/11/2001	ND	ND	ND	N/A	N/A	N/A	N/A	N/A	77 / 73
	02/19/2001	ND	ND	ND	N/A	N/A	N/A	N/A	N/A	65 / 64
	02/20/2001	ND	ND	ND	N/A	N/A	N/A	N/A	N/A	72 / 71
	01/23/2003	ND	ND	N/A	e0.016	ND	ND	ND	ND	66
	02/13/2003	e0.014	ND	N/A	e0.008	ND	ND	ND	ND	84
	02/16/2003	e0.012	ND	N/A	e0.006	ND	ND	ND	ND	66
	02/19/2003	ND	ND	N/A	ND	ND	ND	ND	ND	69
	03/15/2003	e0.014	ND	N/A	e0.018	ND	ND	ND	ND	63
	03/20/2003	ND	ND	N/A	e0.012	ND	ND	ND	ND	80
	03/23/2003	ND	ND	N/A	e0.010	ND	ND	ND	ND	77
	04/04/2003	ND	ND	N/A	e0.012	ND	ND	ND	ND	70
	04/13/2003	e0.013	ND	N/A	e0.019	0.075	ND	ND	ND	69
	04/24/2003	ND	ND	N/A	e0.008	ND	ND	ND	ND	49
Hedge Avenue	02/10/2001	0.06	ND	ND	N/A	N/A	N/A	N/A	N/A	103/ 81
	02/11/2001	0.10	ND	e0.07	N/A	N/A	N/A	N/A	N/A	390/ 88
	02/19/2001	e0.03	ND	ND	N/A	N/A	N/A	N/A	N/A	74 / 67

N/A = not analyzed; ND = not detected; e = estimated (below quantitation limit). Shading indicates samples not meeting the CDFA lab acceptance criterion range of 70 - 130 percent after reinjection for diazinon, chlorpyrifos or bifenthrin, or the acceptance range of 50-150 percent for the surrogate, chlorpyrifos methyl. Surrogates in 2001 are tributylphosphate and triphenyl phosphate; surrogate in 2002 and 2003 is chlorpyrifos methyl.

Table 12 (continued). Pesticide analytical results for samples collected from Morrison Creek, Sacramento County, California. Concentrations are in µg/L.

Site Name	Sampling Date	Diazinon	Chlorpyrifos	Malathion	Simazine	Carbaryl	Metolachlor	Methidathion	Bifenthrin	% Recovery of Surrogate
Franklin Blvd.	02/19/2001	0.09	ND	ND	N/A	N/A	N/A	N/A	N/A	76 / 90
	01/23/2003	0.150	0.016	N/A	e0.011	0.063	0.027	e0.010	ND	71
	02/13/2003	0.160	ND	N/A	ND	0.037	0.072	ND	ND	86
	02/16/2003	0.052	ND	N/A	e0.011	0.028	0.021	ND	ND	51
	02/19/2003	0.043	ND	N/A	ND	0.058	e0.010	ND	ND	76
	03/15/2003	0.160	ND	N/A	e0.027	0.054	e0.020	ND	ND	90
	03/20/2003	0.033	ND	N/A	ND	0.065	e0.014	ND	ND	67
	03/23/2003	0.140	0.110	N/A	ND	0.040	0.022	ND	ND	73
	04/4/2003	0.07	ND	N/A	0.200	0.140	0.031	ND	ND	82
	04/13/2003	0.080	0.014	N/A	e0.035	0.120	e0.009	ND	ND	72
	04/24/2003	0.038	ND	N/A	e0.058	0.130	e0.016	ND	ND	35

N/A = not analyzed; ND = not detected; e = estimated – below quantitation limit; Shading indicates samples not meeting the CDFA lab acceptance criterion range of 70-130 percent after reinjection for diazinon, chlorpyrifos or bifenthrin, or the acceptance range of 50-150 percent for the surrogate, chlorpyrifos methyl. Surrogates in 2001 are tributylphosphate and triphenyl phosphate; surrogate in 2002 and 2003 is chlorpyrifos methyl.

Table 13. Pesticide analytical results for samples collected from Elk Grove and Florin Creeks, Sacramento County, California. Concentrations are in µg/L.

Site Name	Sampling Date	Diazinon	Chlorpyrifos	Malathion	Pendimethalin	
Elk Grove Creek at Waterman Road	02/19/2001	ND	ND	ND	ND	77 / 77
	02/20/2001	ND	ND	ND	ND	63 / 63
Elk Grove Creek at Emerald Vista Drive	02/19/2001	0.38	ND	ND	e0.08	78 / 79
	02/20/2001	0.20	ND	ND	ND	69 / 65
Florin Creek at Franklin Boulevard	02/10/2001	0.33	ND	e0.09	0.13	87 / 86
	02/11/2001	0.16	ND	e0.08	0.11	91 / 90

ND = not detected; e = estimated (below quantitation limit). Surrogates in 2001 are tributylphosphate and triphenyl phosphate.

Table 14. Rain and creek sampling and sample extraction dates

Monitoring Site Name	Sampling Date	Extraction Date
Lincoln Airport (rain)	2/10/2001	2/16/2001
	2/11/2001	2/16/2001
	2/25/2001	3/1/2001
	1/26/2002	1/29/2002
	1/28/2002	1/29/2002
	2/8/2002	2/11/2002
	2/17/2002	2/21/2002
	2/20/2002	2/22/2002
	3/6/2002	3/8/2002
	3/7/2002	3/8/2002
	3/10/2002	3/13/2002
	1/14/2003	1/16/2003
	1/24/2003	1/27/2003
	2/14/2003	2/18/2003
	2/17/2003	2/24/2003
	3/15/2003	3/18/2003
	3/21/2003	3/24/2003
	4/4/2003	4/8/2003
	4/14/2003	4/16/2003
	4/25/2003	4/30/2003
	4/28/2003	4/30/2003
Arcade Creek at Greenback Lane (rain)	2/10/2001	2/16/2001
	2/11/2001	2/16/2001
	2/25/2001	3/1/2001
	1/26/2002	1/29/2002
	2/8/2002	2/11/2002
	2/17/2002	2/21/2002
	2/20/2002	2/22/2002
	3/6/2002	3/8/2002
	3/7/2002	3/8/2002
	3/10/2002	3/13/2002
	1/14/2003	1/16/2003
	1/24/2003	1/27/2003
	2/14/2003	2/18/2003
	2/17/2003	2/24/2003
	3/15/2003	3/18/2003
	3/21/2003	3/24/2003
	4/4/2003	4/8/2003
	4/14/2003	4/16/2003
	4/25/2003	4/30/2003
	4/28/2003	4/30/2003

Table 14 (continued). Rain and creek sampling and sample extraction dates

Monitoring Site Name	Sampling Date	Extraction Date
Herald Fire Department (rain)	2/10/2001	2/16/2001
	2/11/2001	2/16/2001
	2/19/2001	2/22/2001
	2/20/2001	2/22/2001
	2/25/2001	3/1/2001
	1/26/2002	1/29/2002
	2/8/2002	2/11/2002
	2/17/2002	2/21/2002
	3/6/2002	3/8/2002
	3/7/2002	3/8/2002
	3/10/2002	3/13/2002
	1/14/2003	1/16/2003
	2/14/2003	2/18/2003
	2/17/2003	2/24/2003
	3/15/2003	3/18/2003
	3/21/2003	3/24/2003
	4/4/2003	4/8/2003
	4/14/2003	4/16/2003
	4/25/2003	4/30/2003
	4/28/2003	4/30/2003
Stockton (rain)	2/14/2003	2/18/2003
	2/16/2003	2/24/2003
	3/15/2003	3/18/2003
	4/14/2003	4/16/2003
	4/25/2003	4/30/2003
	4/28/2003	4/30/2003
Arcade Creek at Watt Avenue	1/23/2003	1/24/2003
	2/13/2003	2/18/2003
	2/16/2003	2/20/2003
	2/19/2003	2/25/2003
	3/15/2003	3/18/2003
	3/20/2003	3/20/2003
	3/23/2003	3/25/2003
	4/4/2003	4/8/2003
	4/13/2003	4/16/2003
	4/24/2003	4/25/2003

Table 14 (continued). Rain and creek sampling and sample extraction dates

Monitoring Site Name	Sampling Date	Extraction Date
Elder Creek near Excelsior Road	1/23/2003	1/24/2003
	2/13/2003	2/18/2003
	2/16/2003	2/20/2003
	2/19/2003	2/25/2003
	3/15/2003	3/18/2003
	3/20/2003	3/20/2003
	3/23/2003	3/25/2003
	4/4/2003	4/8/2003
	4/13/2003	4/16/2003
	4/24/2003	4/25/2003
Elder Creek at Elder Creek Road	2/19/2001	2/22/2001
	2/20/2001	2/22/2001
Elder Creek at Bradshaw Road	1/23/2003	1/24/2003
	2/13/2003	2/18/2003
	2/16/2003	2/20/2003
	2/19/2003	2/25/2003
	3/15/2003	3/18/2003
	3/20/2003	3/20/2003
	3/23/2003	3/25/2003
	4/4/2003	4/8/2003
	4/13/2003	4/16/2003
	4/24/2003	4/25/2003
Morrison Creek near Sunrise Boulevard	2/10/2001	2/16/2001
	2/11/2001	2/16/2001
	2/19/2001	2/22/2001
	2/20/2001	2/22/2001
	1/23/2003	1/24/2003
	2/13/2003	2/18/2003
	2/16/2003	2/20/2003
	2/19/2003	2/25/2003
	3/15/2003	3/18/2003
	3/20/2003	3/20/2003
	3/23/2003	3/25/2003
	4/4/2003	4/8/2003
	4/13/2003	4/16/2003
	4/24/2003	4/25/2003

Table 14 (continued). Rain and creek sampling and sample extraction dates

Monitoring Site Name	Sampling Date	Extraction Date
Morrison Creek at Hedge Road	2/10/2001	2/16/2001
	2/11/2001	2/16/2001
	2/19/2001	2/22/2001
Elder Creek at Elk Grove-Florin Road	2/19/2001	2/22/2001
Elder Creek at Franklin Boulevard	2/19/2001	2/22/2001
	2/20/2001	2/22/2001
Elk Grove Creek at Waterman Road	2/19/2001	2/22/2001
	2/20/2001	2/22/2001
Elk Grove Creek at Emerald Vista Drive	2/19/2001	2/22/2001
	2/20/2001	2/22/2001
Florin Creek at Franklin Boulevard	2/10/2001	2/16/2001
	2/11/2001	2/16/2001

Table 15. Percent recovery of matrix spike samples

Site	Sampling Date	Diazinon	Chlorpyrifos	Bifenthrin	Chlorpyrifos Methyl (Surrogate)
Rain Samples					
Arcade Creek Greenback Lane	04/4/2003*	72	75	56	75
	04/14/2003	103	75	86	75
Herald	02/17/2002	102	97	80	81
	03/06/2002	92	103	90	91
	03/06/2002	74	86	75	76
	03/07/2002	85	101	88	90
	03/10/2002	68	52	67	72
	04/28/2003	68	73	90	71
Lincoln Airport	01/26/2002	N/S	112	108	104
	01/26/2002	N/S	96	104	88
	02/20/2002	72	77	73	63
	01/14/2003	71	87	85	81
	01/24/2003	71	74	71	74
Stockton	04/28/2003	69	78	91	75
Creek Samples					
Arcade Creek at Watt Ave.	01/23/2003	48	107	32	79
	01/23/2003*	71	102	40	82
Elder Creek Excelsior Ave.	03/15/2003	80	93	51	84
Morrison Creek Franklin Blvd.	04/04/2003	35	96	21	61
	04/4/2003*	35	NR	26	60
	04/24/2003	74	94	43	59
	04/24/2003*	NR	NR	38	60
	04/24/2003	81	98	36	61
	04/24/2003*	NR	NR	34	60
Morrison Creek Sunrise	02/19/2003	78	71	94	69

* Sample was re-injected due to poor recovery of one of the constituents. NR = not reported (initial analyte recovery acceptable). N/S = not spiked.

Table 16. Pesticide analytical results for primary and duplicate rain samples. Concentrations are in µg/L.

Site Name	Sampling Date	Sample type	Diazinon (D)	Chlorpyrifos (C)	Simazine (S)	Dacthal (DCPA) (Da)	Metolachlor (M)	Carbaryl (Ca)	Relative % Difference
Herald	02/10/2001	P	0.13	ND	N/A	N/A	N/A	N/A	D-7
	02/10/2001	D	0.14	ND	N/A	N/A	N/A	N/A	
	2/17/2002*	P	0.032	ND	ND	ND	ND	ND	D-42
	2/17/2002*	D	0.049	ND	ND	ND	ND	ND	
	03/15/2003	P	0.033	0.063	e0.076	e0.022	e0.024	ND	D-9; C-3;
	03/15/2003	D	0.036	0.065	e0.080	e0.023	e0.029	ND	S-5; Da-4;M-19
	04/13/2003	P	0.033	ND	ND	ND	ND	0.054	D-9
	04/13/2003	D	0.036	ND	ND	ND	ND	0.056	Ca-4
Arcade Creek/ Greenback Lane	03/06/2002	P	0.046	0.017	0.225	ND	ND	e0.018	D-10; C-11
	03/06/2002	D	0.051	0.019	0.222	e0.008	ND	e0.019	S-1; Ca-5
	03/10/2002	P	e0.016	0.024	e0.016	ND	ND	ND	D-12; C-25
	03/10/2002	D	e0.018	0.031	e0.018	ND	ND	ND	S-12
	04/25/2003	P	ND	0.029	ND	ND	ND	0.038	C-10
	04/25/2003	D	ND	0.032	ND	ND	ND	0.034	Ca-11
Lincoln Airport	02/14/2003	P	0.530	0.030	e0.010	ND	ND	ND	D-6; C-11
	02/14/2003	D	0.500	0.027	e0.010	ND	ND	ND	S-0
Stockton	02/14/2003	P	0.074	0.011	0.027	ND	ND	ND	D-1; C-1
	02/14/2003	D	0.073	0.011	0.029	ND	ND	ND	S-7
	02/16/2003	P	e0.015	e0.006	ND	e0.019	ND	ND	D-0;C-0
	02/16/2003	D	e0.015	e0.006	ND	e0.017	ND	ND	Da-11
	04/14/2003	P	e0.018	ND	e0.034	e0.010	ND	0.140	D-0; S-3;Da-10;
	04/14/2003	D	e0.018	ND	e0.035	e0.011	ND	0.140	Ca-0[9]

If more than one analyte was detected, the relative percent difference for each analyte detected is shown. N/A = Not analyzed.
*Due to insufficient rainfall during this event, only a 444 mL duplicate rainwater sample was collected on February 17, 2002. Therefore, the laboratory detection limit was increased by two times for this duplicate sample

[9] Metolachlor was detected below the limit of quantitation in both the primary sample (e0.018 µg/L) and the duplicate sample.

Table 17. Pesticide analytical results for primary and duplicate creek samples. Concentrations are in µg/L.

Site Name	Sampling Date	Sample type	Diazinon	Chlorpyrifos	Simazine	Dacthal (DCPA)	Metolachlor	Carbaryl	Relative % Difference
Arcade Creek/Watt Ave.	03/23/2003	P	0.150	ND	ND	ND	0.020	0.057	D-6; M-0; Ca-9
	03/23/2003	D	0.160	ND	ND	ND	0.020	0.052	
	04/24/2003	P	0.100	0.029	e0.012	ND	ND	0.300	D-0; C-10; S-8;
	04/24/2003	D	0.100	0.032	e0.013	ND	ND	0.350	Ca-15
Elder Creek/Bradshaw Ave.	02/16/2003	P	e0.018	0.035	e0.029	ND	0.300	ND	D-6; C-18;
	02/16/2003	D	e0.017	0.042	e0.033	ND	0.310	ND	S-13; M-3
Elder Creek/Franklin Ave.	02/19/2001	P	0.17	ND	N/A	N/A	N/A	N/A	RPD cannot be
	02/19/2001	D	ND	ND	N/A	N/A	N/A	N/A	calculated.
Morrison Creek/Sunrise Blvd.	04/13/2003	P	e0.013	ND	e0.019	ND	ND	0.075	D-21; S-5
	04/13/2003	D	e0.016	ND	e0.018	ND	ND	0.070	Ca-7
Morrison Creek/Franklin Ave.	01/23/2003	P	0.150	ND	ND	ND	ND	ND	D-7
	01/23/2003	D	0.140	ND	ND	ND	ND	ND	
	03/15/2003	P	0.160	ND	e0.027	ND	e0.020	0.054	D-6; S-4; M-0;
	03/15/2003	D	0.150	ND	e0.026	ND	0.020	0.056	Ca-4

If more than one analyte was detected, the relative percent difference for each analyte detected is shown.
ND = Not detected; N/A = Not analyzed.

Table 18. Percent recovery of lab spike samples analyzed with rain samples.

Sampling Date	Diazinon	Chlorpyrifos	Bifenthrin	Chlorpyrifos methyl (surrogate)	Tributyl-phosphate (surrogate)	Triphenyl-phosphate (surrogate)
02/10/2001	66	68	N/A	N/A	84	80
02/20/2001	64	65	N/A	N/A	67	65
02/25/2001	84	88	N/A	N/A	112	104
02/08/2002	93	91	85	80	N/A	N/A
02/17/2002	79	79	78	73	N/A	N/A
02/20/2002	70	77	75	76	N/A	N/A
03/06/2002	93	98	101	90	N/A	N/A
03/07/2002	93	98	101	90	N/A	N/A
03/10/2002	62	66	64	69	N/A	N/A
01/14/2003	77	82	82	88	N/A	N/A
01/24/2003	66	68	75	70	N/A	N/A
01/24/2003*	67	76	82	74	N/A	N/A
02/14/2003	71	70	83	78	N/A	N/A
02/14/2003 [S]	68	65	82	74	N/A	N/A
02/14/2003 *[S]	65	68	NR	NR	N/A	N/A
02/16/2003 [S]	69	72	68	77	N/A	N/A
02/16/2003*[S]	70	73	78	77	N/A	N/A
02/17/2003	69	72	68	77	N/A	N/A
02/17/2003*	70	73	78	77	N/A	N/A
03/15/2003	80	77	85	76	N/A	N/A
03/21/2003	75	82	97	90	N/A	N/A
04/04/2003	75	78	82	82	N/A	N/A
04/14/2003	93	65	86	70	N/A	N/A
04/14/2003*	NR	60	NR	68	N/A	N/A
04/25/2003 [S]	73	67	82	69	N/A	N/A
04/25/2003*[S]	NR	67	NR	86	N/A	N/A
04/25/2003	73	67	82	69	N/A	N/A
04/25/2003	NR	67	NR	86	N/A	N/A
04/28/2003	73	67	82	69	N/A	N/A
04/28/2003*	NR	67	NR	86	N/A	N/A

*Re-analyzed due to low recovery in initial analysis. NR = not reported (initial analyte recovery acceptable). N/A = Not analyzed. [S]Lab spike samples analyzed with Stockton samples. Shading indicates samples not meeting the CDFA lab acceptance criterion range of 70-130 percent for diazinon, chlorpyrifos or bifenthrin or the acceptance range of 50-150 percent for the surrogate (chlorpyrifos methyl).

Table 19. Percent recovery of lab spike samples analyzed with creek samples.

Sampling Date	Diazinon	Chlorpyrifos	Bifenthrin	Chlorpyrifos methyl (surrogate)
01/23/2003	84	81	80	92
02/13/2003	68	65	82	74
02/16/2003	74	78	59	80
02/16/2003*	NR	NR	81	78
02/19/2003	75	66	88	80
02/19/2003*	95	92	93	80
03/15/2003	80	77	85	76
03/20/2003	64	61	90	72
3/20/2003*	66	62	86	73
03/23/2003	69	65	69	72
03/23/2003*	68	63	85	70
04/04/2003	75	78	82	82
04/13/2003	93	65	86	70
04/13/2003*	NR	60	NR	68
04/24/2003	47	46	71	48
04/24/2003*	49	51	NR	50

*Re-analyzed due to low recovery in initial analysis. NR = not reported (initial analyte recovery acceptable). Shading indicates samples not meeting the CDFA lab acceptance criterion range of 70-130 percent for diazinon, chlorpyrifos or bifenthrin or the acceptance range of 50-150 percent for the surrogate, chlorpyrifos methyl.