APPENDIX A

Diazinon and Chlorpyrifos TMDL

Upper Newport Bay and San Diego Creek

California Regional Water Quality Control Board

Santa Ana Region

February 21, 2003

Diazinon and Chlorpyrifos TMDL: Upper Newport Bay and San Diego Creek

Table Of Contents

Diazinon and Chlorpyrifos TMDL: Upper Newport Bay and San Diego Creek
List of Tables

Diazinon and Chlorpyrifos TMDL: Upper Newport Bay and San Diego Creek
List of Figures

1.0 INTRODUCTION

On June 14, 2002, the United States Environmental Protection Agency (USEPA) established Total Maximum Daily Loads (TMDLs) for 14 toxic pollutants, including chlorpyrifos and diazinon in San Diego Creek and Upper Newport Bay (USEPA 2002). The USEPA TMDL for chlorpyrifos and diazinon was based on a draft TMDL prepared by staff of the Santa Ana Regional Water Quality Control Board (SARWQCB). To address impairment specified in the 1998 Section 303(d) list, the TMDL addressed diazinon and chlorpyrifos in both reaches of San Diego Creek and chlorpyrifos in Upper Newport Bay. TMDLs are required despite recent re-registration agreements to phase out certain uses of these two organophosphate pesticides by 2006 (USEPA 2001, 2000a).

This document summarizes the information presented in the USEPA TMDL document (USEPA 2002) and presents additional information related to the problem statement (Section 2) and development of the numeric targets (Section 3). The source analysis is discussed in Section 4. Loading capacity, allocations, seasonal variation, and the margin of safety are discussed in Sections 5,6,7, and 8, respectively. Finally, Section 9 of this document presents the implementation plan for the TMDL. The remainder of this introduction provides background information on the Newport Bay Watershed.

1.1 Watershed Background

The Newport Bay watershed is located in Orange County, Southern California. The watershed covers an area of 154 square miles (98,500 acres). Cities located partly or fully within the watershed include Orange, Tustin, Santa Ana, Irvine, Lake Forest, Laguna Hills, Costa Mesa, and Newport Beach (Figure 1-1). The watershed consists largely of the Tustin Plain, bounded to the east by the Santiago hills and by the San Joaquin hills to the west (Figure 1-2).

<u>Land Use</u>

Table 1-1 provides the latest available land use data for the San Diego Creek drainage and the Newport Bay watershed as a whole.

Table 1-1. Land Use in the Newport Bay Watershed

Land Use	San Diego Creek		Newport Bay Watershed	
	Acres	Percent	Acres	Percent
Vacant	21,910	28.5 %	23,462	23.9 %
Residential	11,668	15.2 %	19,420	19.7 %
Education/Religion/Recreation	15,811	20.6 %	17,393	17.7 %
Roads	10,295	13.4 %	15,774	16.0 %
Commercial	6,381	8.3 %	9,641	9.8 %
Industrial	3,965	5.2 %	5,263	5.4 %
Agriculture	5,092	6.6 %	5,147	5.2 %
Transportation	1,177	1.5 %	1,326	1.3 %
No code	440	0.6 %	936	0.9 %
Total	76,739	100%	98,362	99.9 %

Source: Orange County Public Facilities and Resources Department, provided March 2002

The watershed contains large areas of open space, mainly in the foothills and upper areas of the watershed where development has not yet occurred. Agriculture, while once more widespread, is now largely confined to areas north of Interstate 5 (Figure 1-1), and accounts for slightly more than five percent of the watershed area. The middle and lower portions of the watershed are more urbanized.

Newport Bay consists of a highly developed lower bay south of the Pacific Coast Highway Bridge (Highway 1), and a less developed upper bay that contains a 752-acre ecological reserve. The ecological reserve provides important coastal wetland habitat for six endangered bird species and two endangered plant species.

Climate

The climate of the watershed is characterized by short, mild winters, and dry summers. Average rainfall is about 13 inches per year, with 90 percent of the rainfall occurring between November and April.

Hydrology

San Diego Creek is the major drainage channel in the Newport Bay watershed and contributes about 95% of the freshwater flow volume into Upper Newport Bay. San Diego Creek is divided into two reaches. Reach 1 is designated as the length from Upper Newport Bay to Jeffrey road (a point approximately two miles downstream of Marshburn channel), while Reach 2 is the remaining section to the headwaters of the creek. The drainage area of San Diego Creek (including its largest tributary, Peters Canyon Channel) accounts for about 77% of the watershed.

Daily flow records for San Diego Creek at the Campus Drive monitoring station reveal a wide range of flow rates. In dry weather, baseflow typically ranges from 8 to 15 cubic feet per second (cfs). During wet weather, daily storm flows in San Diego Creek can range up to about 9,200 cfs, although most storm flows fluctuate between 20 and 815 cfs (Orange County Public Facilities and Resources Department [OCPFRD] data).

The second largest drainage in the watershed is that of the Santa Ana Delhi channel, which accounts for 11% of the watershed area, and provides about 5% of the freshwater flow to Upper Newport Bay. Average dry weather flows in the Santa Ana Delhi channel are typically between 1 and 2 cfs, with storm flows ranging up to 1,370 cfs.

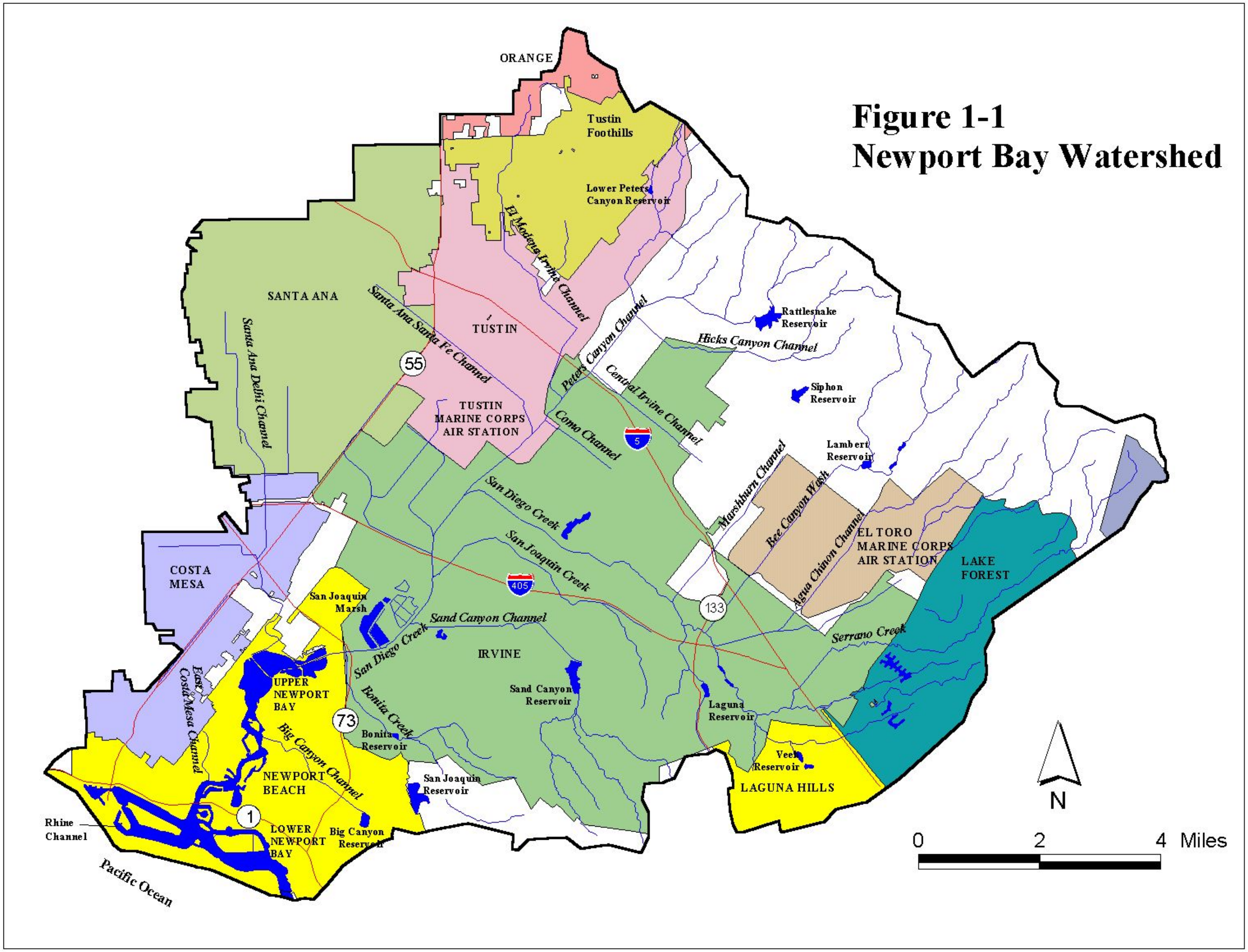


Figure 1-1
Newport Bay Watershed
ORANGE
Tustin Foothills
Lower Peters Canyon Reservoir
El Modena Irvine Channel
SANTA ANA
Santa Ana Delhi Channel
Santa Ana Santa Fe Channel
TUSTIN
55
Peters Canyon Channel
Rattlesnake Reservoir
Hicks Canyon Channel
Central Irvine Channel
Siphon Reservoir
TUSTIN MARINE CORPS AIR STATION
Como Channel
5
Lambert Reservoir
Marshburn Channel
Bee Canyon Wash
Agua Chinon Channel
EL TORO MARINE CORPS AIR STATION
LAKE FOREST
San Diego Creek
San Joaquin Creek
COSTA MESA
405
133
San Joaquin Marsh
Sand Canyon Channel
Serrano Creek
San Diego Creek
IRVINE
UPPER NEWPORT BAY
East Costa Mesa Channel
Bonita Creek
Sand Canyon Reservoir
Laguna Reservoir
73
Big Canyon Channel
Bonita Reservoir
Veeh Reservoir
NEWPORT BEACH
San Joaquin Reservoir
LAGUNA HILLS
N
1
Rhine Channel
LOWER NEWPORT BAY
Big Canyon Reservoir
0 2 4 Miles
Pacific Ocean

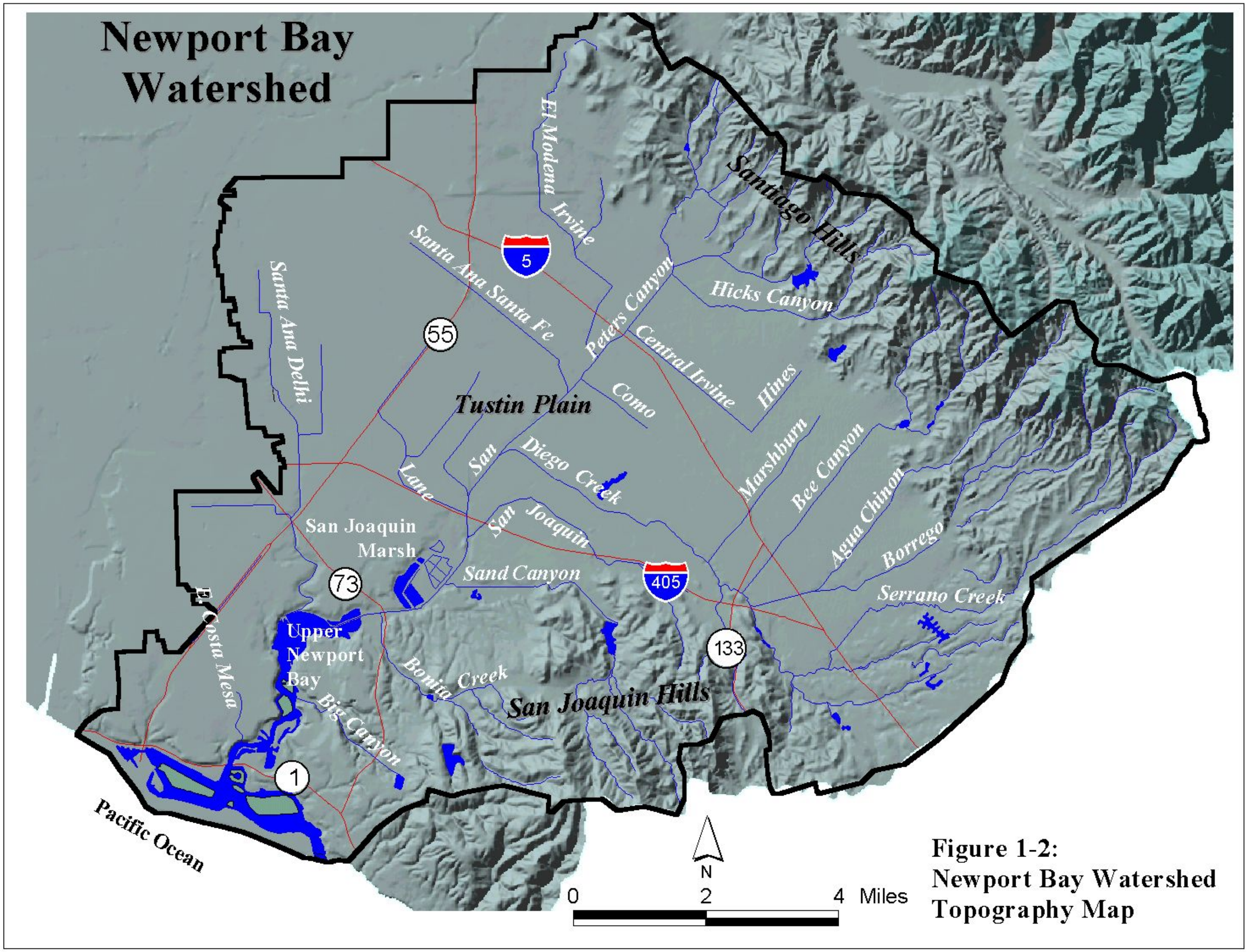


Figure 1-2:
Newport Bay Watershed
Topography Map

2.0 PROBLEM STATEMENT

An investigation of stormwater runoff in tributaries to Newport Bay in 1992 and 1993 demonstrated the existence of aquatic life toxicity (Bailey et al 1993). A toxicity identification evaluation (TIE) performed on several of the samples collected during the study, indicated that one or more pesticides were responsible for the observed toxicity, and that diazinon was likely one of these pesticides.

Separate sampling programs, the Toxic Substances Monitoring Program (TSMP), and the State Mussel Watch (SMW), demonstrated that chlorpyrifos and diazinon were present in fish and mussel tissue. The TSMP and SMW were conducted in upper and lower Newport Bay as well as in the drainage channels in the Newport Bay watershed, with diazinon and chlorpyrifos data available from 1983 onwards.

As a result of these investigations, upper and lower Newport Bay and Reach 1 of San Diego Creek were included on California's 1998 Clean Water Act Section 303d list for pesticides. Reach 2 of San Diego Creek was listed for unknown toxicity.

Supplemental studies to determine the sources of the toxicity observed during the 1992-93 investigation were carried out from 1996 to 2000 (Lee and Taylor 1999, 2001). These studies further documented the occurrence of aquatic life toxicity in the Newport Bay watershed, and concluded that diazinon and chlorpyrifos were causing a large portion of the observed toxicity in San Diego Creek. An investigation of Upper Newport Bay indicated the presence of toxicity attributable to chlorpyrifos in stormwater runoff entering the upper bay from San Diego Creek (Lee and Taylor 1999, 2001). No samples were collected from lower Newport Bay.

Based on these findings, TMDL development for diazinon and chlorpyrifos in San Diego Creek, and chlorpyrifos in upper Newport Bay was initiated (Santa Ana Regional Water Quality Control Board [SARWQCB] 2001). Diazinon and chlorpyrifos are widely used organophosphate pesticides, and are among the pesticides detected most frequently in urban waterways. Further details on diazinon and chlorpyrifos usage in the Newport Bay watershed can be found in Section 4.

The remainder of this problem statement summarizes previous investigations in the Newport Bay watershed and describes the impairment of water quality standards caused by pesticide-derived aquatic life toxicity.

Previous Investigations/Available Data

This TMDL is based primarily on analysis of data collected in the Newport Bay watershed during the period 1996-2000. The available data were generated by state and local agencies as part of various investigative or monitoring programs. These programs are briefly described below.

1. Toxic Substances Monitoring Program (TSMP) and State Mussel Watch (SMW): The TSMP and SMW are statewide screening programs designed to identify areas where toxic substances

are bioaccumulating in fish and mussel tissue. The TSMP includes four locations in the Newport Bay watershed, one location in Upper Newport Bay, and one location in Lower Newport Bay. Sample analysis for diazinon and chlorpyrifos began in 1983, and has continued at irregular intervals through 2000 (State Water Resources Control Board [SWRCB] 2001, TSMP Database 1983-2000). The SMW program includes sample collection for diazinon and chlorpyrifos analysis from 19 locations, mostly within Upper and Lower Newport Bay. Although some of the locations were sampled only once or twice since 1982, annual samples have been collected at several locations for over ten years (SWRCB 2000, SMW Database, 1980-1996).

2. Aquatic Life Toxicity Investigations; 319(h) and 205(j) studies: These studies were funded under the USEPA Clean Water Act Section 205(j) and 319(h) grant programs. The first study (under the 205(j) program) was carried out from 1996-1999. Eighty-five samples were collected from seven stormwater runoff events and four dry-weather sampling events. The second study (under the 319(h) program) was carried out during 1999 and 2000. Three stormwater runoff events and two dry weather events were monitored, and a total of 31 samples were analyzed for diazinon and chlorpyrifos. Acute toxicity tests were performed on 63 of the samples collected under the 205(j) and 319(h) studies. Further details on these studies can be found in the respective reports (Lee and Taylor 1999, 2001).

3. Orange County Public Facilities and Resources Department (OCPFRD): Orange County has been implementing a water quality monitoring program since 1991 as part of the areawide municipal stormwater permit issued to Orange County and its co-permittees. Although no diazinon and chlorpyrifos analyses are currently required under this permit, the OCPFRD has collected semi-annual sediment data for diazinon analysis.

3. California Department of Pesticide Regulation (CDPR) Pesticide Use Reports: Beginning in January 1990, California required growers to report all pesticides used on all crops. All pesticides applied on golf courses, parks, cemeteries, rangeland, pasture, and along roadside and railroad rights-of-way were also subject to the expanded reporting requirements. Pesticide dealers also faced expanded reporting and record keeping requirements. Structural fumigators, professional gardeners and other nonagricultural Pest Control Operators continued to report all pesticide use. Home-use pesticides are exempt from the regulations.

4. CDPR Red Imported Fire Ant (RIFA) Monitoring: The RIFA is an aggressive, exotic insect that was first discovered in Southern California in October 1998. In response, the California Department of Food and Agriculture (CDFA) designed a RIFA eradication/control plan to deal with the infestations (CDFA 1999). Part of the plan required treatment of targeted areas with a suite of pesticides that included diazinon and chlorpyrifos.

To monitor the environmental impact of the RIFA plan, a surface water sampling program was initiated in Orange County, conducted by the CDPR. Over 100 samples were collected and analyzed for pesticides during the period March 1999 to January 2001. These included 22 rounds of monthly sampling and one rainfall runoff sampling event. Acute toxicity tests were performed on 60 samples. Data from the sampling events are summarized in monthly monitoring memos (CDPR 1999-2000).

5. CDPR Sales and Use Survey: The CDPR and the University of California conducted a residential pesticide survey to better document the residential use occurring in the Newport Bay watershed. A project report was published in 2001 (Wilen 2001).

Water Quality Standards

Water quality standards include beneficial uses, water quality objectives (numeric and narrative) and an antidegradation policy.

Beneficial Uses: Beneficial Uses for San Diego Creek are designated in the Basin Plan (SARWQCB, 1995). San Diego Creek Reach 1 has the following designated beneficial uses:

- Water contact recreation (REC1)
- Non-contact water recreation (REC2)
- Wildlife habitat (WILD)
- Warm freshwater habitat (WARM)

The Basin Plan identifies the same uses for Reach 2, but, in this case, the uses are designated as intermittent. In addition, Reach 2 has the intermittent groundwater recharge (GWR) beneficial use designation (SARWQCB, 1995).

Designated beneficial uses for Upper Newport Bay include REC1, REC2, and WILD, as well as the following:

- Preservation of Biological Habitats of Special Significance (BIOL)
- Commercial and Sport Fishing (COMM)
- Estuarine Habitat (EST)
- Marine Habitat (MAR)
- Rare, Threatened, or Endangered Species (RARE)
- Spawning, Reproduction, and Development (SPWN)
- Shellfish Harvesting (SHEL)

Numeric Water Quality Objectives: The Regional Board has not adopted numeric water quality objectives for diazinon and chlorpyrifos. The USEPA has promulgated numeric water quality criteria for California for priority toxic pollutants, but diazinon and chlorpyrifos are not included in this list.

Narrative Water Quality Objectives: The Basin Plan specifies two narrative water quality objectives for toxic substances. These are:

(1) Toxic substance shall not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health, and
(2) The concentration of toxic substances in the water column, sediment or biota shall not adversely affect beneficial uses.

Antidegradation Policy: As diazinon and chlorpyrifos are man-made chemicals that do not naturally occur in the environment, it can be argued that their presence in surface water constitutes a lowering of the water quality of that surface water. Pursuant to federal and state antidegradation policies, this is permissible only if beneficial uses are protected, and it can be demonstrated that the lowering of water quality is consistent with the maximum benefit to the people of the state of California.

IMPAIRMENT ASSESSMENT

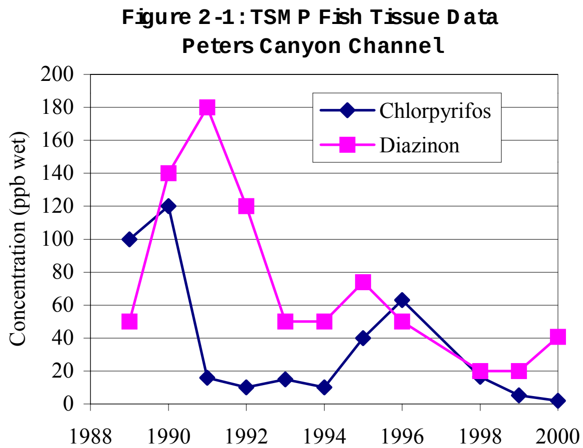
Bioaccumulation/Food Consumption Guidelines

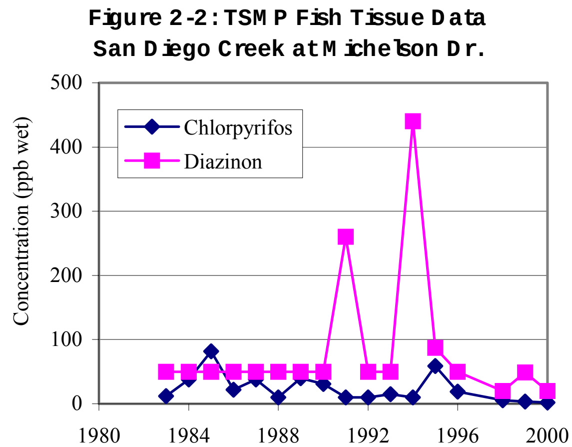
The USEPA has established recommended screening values for diazinon and chlorpyrifos in fish tissue. The screening values are intended to identify chemical concentrations that may be of human health concern for frequent consumers of sport fish. The USEPA tissue screening values are 900 ppb and 30,000 ppb for diazinon and chlorpyrifos respectively (wet weight). The California Office of Environmental Health Hazard Assessment (OEHHA) published a study (the California Lakes Study) in 1999 that calculated screening values for diazinon and chlorpyrifos (OEHHA 1999). These screening values were calculated using EPA guidance, with the only difference being a fish consumption rate three times higher than used by USEPA. As a result, the OEHHA screening values were 300 ppb and 10,000 ppb (one-third the USEPA values).

The TSMP and SMW programs have collected fish and mussel tissue samples from the Newport Bay watershed. Samples have been collected from both Upper and Lower Newport Bay, and from San Diego Creek and its tributaries.

TSMP data: Chlorpyrifos tissue concentrations have consistently remained orders-of-magnitude below the OEHHA screening value (10,000 ppb) for fish consumption. Diazinon concentrations have exceeded the OEHHA screening value of 300 ppb only once (440 μg/kg) during the program's history. Figures 2-1 and 2-2 show the TSMP results for the two stations where the longest record of data is available (Peters Canyon Channel and San Diego Creek at Michelson), and where the highest diazinon concentration was observed.

SMW data: Diazinon and chlorpyrifos concentrations in mussel tissue have never exceeded the OEHHA guidelines. The observed concentrations were only detected intermittently and there is no trend apparent in the data. Detection frequencies were 40% and less than 10% for chlorpyrifos and diazinon, respectively.





(OEHHA Screening Values: Diazinon = 300 ppb; Chlorpyrifos = 10,000 ppb)

Although diazinon and chlorpyrifos are detected intermittently in the TSMP and SMW programs, the concentrations observed in the Newport Bay watershed do not provide evidence of bioaccumulation to levels of concern.

Aquatic Life Toxicity

San Diego Creek and Upper Newport Bay were listed as impaired due in part to pesticide-derived toxicity. Although a mixture of pesticides was associated with the toxicity, the primary sources of toxicity were identified as diazinon and chlorpyrifos. The impairment was documented through acute toxicity tests conducted on 123 water samples from 1996 to 2001. The toxicity tests were performed as part of the 205(j) and 319(h) programs, and as part of the DPR-RIFA water quality investigation. In addition, nurseries in the Newport Bay watershed that have waste discharge permits began conducting bimonthly chronic toxicity tests in 2000.

Figures 2-3 and 2-4 summarize all the toxicity test results using *Ceriodaphnia dubia*, (the most sensitive of the test species). Eighty-one toxicity tests were conducted on baseflow samples collected in the Newport Bay watershed. Toxicity to *Ceriodaphnia* was not present in 20% of these tests, while 80% of the tests resulted in at least partial (<100%) mortality to *Ceriodaphnia* (**Figure 2-3**).

Figure 2-3: Ceriodaphnia Toxicity Tests in the Newport Bay Watershed
Baseflow; 1996-2001

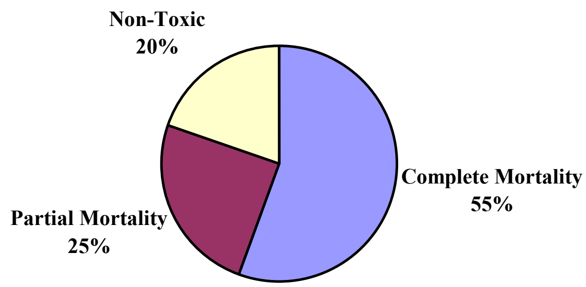
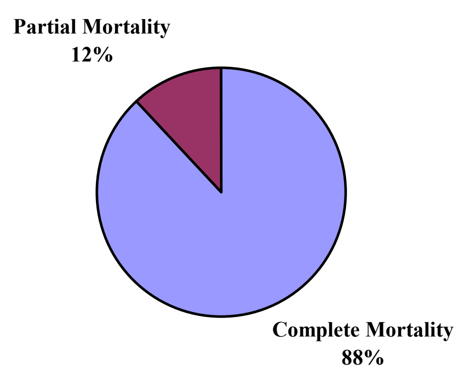


Figure 2-4 summarizes the stormwater toxicity data. Forty-two toxicity tests using *Ceriodaphnia* were conducted on stormwater samples collected from various locations in the Newport Bay watershed. All samples were toxic to *Ceriodaphnia*, with 88% of the samples causing complete (100%) mortality within a few days.

Figure 2-4: Ceriodaphnia Toxicity Tests in the Newport Bay Watershed
Stormflow; 1996-2001



Aquatic Life Toxicity Investigations (319(h) and 205(j) Programs)

A total of 63 undiluted samples were collected for acute toxicity testing during the 205(j) and 319(h) investigations. Several additional samples required dilution prior to testing due to salinity levels that were high enough to cause mortality to one of the test organisms *(Ceriodaphnia dubia)*. With serial dilutions and TIE procedures, over 300 toxicity tests were conducted on the water samples.

Acute toxicity attributable to diazinon and chlorpyrifos occurred in San Diego Creek during virtually all monitored storm events. Dry weather toxicity was generally confined to the upper reaches of the watershed and diluted or otherwise ameliorated upstream of monitoring locations in San Diego Creek. (Lee and Taylor, 1999, 2001) In the 319(h) study, 100% *Ceriodaphnia* mortality was observed in virtually all storm samples, usually within 2 days. Stormwater runoff samples, with the salinity adjusted to that of seawater, were also acutely toxic to the saltwater test species *Mysidopsis bahia*. The toxicity to *Mysidopsis* is attributable to the chlorpyrifos concentration in the samples.

Most of the toxicity tests performed under the 319(h) program were conducted using serial dilutions to measure the acute toxic units present. TIEs were also performed in many cases to identify the specific constituents responsible for the observed toxicity.

Table 2-1 shows toxicity test data on samples collected in the Newport Bay watershed during the 319(h) investigation. The data are sorted by the expected toxicity based on the water column concentrations, and reference LC50s for diazinon and chlorpyrifos. The LC50 is the concentration of a toxic constituent that results in 50% mortality to the test organism. For Table 2-1, the reference LC50s are those published by the CDFG (CDFG 2000a: diazinon = 440 ng/L and chlorpyrifos = 60 ng/L). Measured toxicity that exceeds the expected toxicity suggests the presence of additional compounds at toxic concentrations. Based on TIE work performed on these samples, the additional toxicity is mainly attributable to carbaryl, and potentially to some pyrethroid pesticides. Several samples still had significant toxicity that was due to unknown causes.

Samples with the highest measured toxicity in February 2000, have been linked to an isolated toxic event caused by runoff from agricultural fields that were treated with carbaryl. Carbaryl was applied to deal with an infestation of cutworms in strawberry fields. A pellet-like bait formulation was selected to minimize offsite migration, however, the baits were carried into the drainage channels during the storms in February. (John Kabashima, personal communication 2002).

A report summarizing the TIE work done on the February 21, 2000 sample set is included as Appendix C of the 319h report (Lee and Taylor, 2001).

Table 2-1: Results of 319(h) *Ceriodaphnia* Acute Toxicity Tests (sorted by expected diazinon and chlorpyrifos toxicity)

		GC Results (ng/L)		Mortality		Acute Toxicity (TUa)	
Station	Date	Chlorpyrifos	Diazinon	(%)	(days)	Measured	Expected
San Joaquin Creek – Univ Dr.	12-Feb-00	770	<50	100	1	32	12.8
San Joaquin Creek – Univ Dr.	21-Feb-00	470	<50	100	1	6	7.8
San Diego Creek - Harvard Av.	12-Feb-00	310	280	100	1	8	5.8
Hines Channel - Irvine Blvd.	29-Sep-99	310	220	100	1	16	5.7
San Diego Creek - Campus Dr.	12-Feb-00	260	460	100	1	8	5.4
Central Irvine Channel - Monroe	12-Feb-00	150	810	100	1	8	4.3
Hines Channel - Irvine Blvd.	12-Feb-00	120	760	100	1	8	3.7
Peters Canyon Channel - Walnut	12-Feb-00	150	520	100	1	16	3.7
San Diego Creek - Harvard Av.	21-Feb-00	190	200	100	1	3	3.6
San Diego Creek - Campus Dr.	25-Jan-00	160	320	100	1	8	3.4
San Diego Creek - Campus Dr.	21-Feb-00	170	220	100	1	5	3.3
Hines Channel - Irvine Blvd.	21-Feb-00	50	810	100	1	5	2.7
Peters Canyon - Barranca	12-Feb-00	100	420	100	1	8	2.6
Peters Canyon - Barranca	21-Feb-00	80	330	100	1	3	2.1
Peters Canyon - Barranca	29-Sep-99	<50	820	100	1	2	1.9
Central Irvine Channel - Monroe	21-Feb-00	70	280	100	1	5.5	1.8
East Costa Mesa - Highland Dr.	12-Feb-00	<50	370	100	2	n/a	1.7
East Costa Mesa - Highland Dr.	21-Feb-00	<50	560	100	1	2.5	1.3
El Modena-Irvine upstream of PCC	21-Feb-00	<50	330	100	6	0	0.8
East Costa Mesa - Highland Dr.	31-May-00	<50	210	100	5	1	0.5
Santa Ana Delhi - Mesa Dr.	21-Feb-00	<50	200	100	7	0	0.5
El Modena-Irvine upstream of PCC	31-May-00	<50	180	0	0	0	0.4
Peters Canyon – Barranca	31-May-00	<50	170	0	0	0	0.4
San Diego Creek - Campus Dr.	31-May-00	<50	160	0	0	0	0.4
Santa Ana Delhi - Mesa Dr.	12-Feb-00	<50	120	100	3	1	0.3
Santa Ana Delhi - Mesa Dr.	31-May-00	<50	110	0	0	0	0.3
Sand Canyon Ave - NE corner Irv. Blvd.	12-Feb-00	<50	110	22	7	0	0.3
Central Irvine Channel - Monroe	31-May-00	<50	90	n/a	n/a	n/a	0.2
Sand Canyon Ave - NE corner Irv. Blvd.	21-Feb-00	<50	70	30	7	0	0.2
Hines Channel - Irvine Blvd.	31-May-00	<50	47	44	7	n/a	0.1
San Diego Creek - Harvard Av.	31-May-00	<50	<50	0	0	0	0.0

n/a = not available; TUa = acute toxic units; GC= Gas Chromatography
(Adapted from Lee and Taylor,2001)

DPR-RIFA: Acute Toxicity Tests

The DPR has completed 22 sampling rounds in the Newport Bay watershed. Sixty acute toxicity tests have been performed using *Ceriodaphnia dubia*. The DPR-RIFA tests were not accompanied by serial dilutions or TIEs, and identification of the toxic constituents was based on expected toxicity derived from reference LC50 data.

The DPR has not completed detailed data analysis for the RIFA monitoring project, however, preliminary analysis indicates that chlorpyrifos and diazinon are responsible for most of the observed toxicity in San Diego Creek. At the nursery discharge monitoring locations, bifenthrin appears to account for a significant portion of the toxicity in addition to diazinon, and chlorpyrifos. However, bifenthrin is relatively immobile compared to diazinon and chlorpyrifos, and has been detected in only one of 22 DPR monthly sampling events downstream in San Diego Creek (CDPR, 1999-2001).

Nurseries: Chronic Toxicity Tests

The nurseries in the Newport Bay watershed began performing chronic toxicity tests on their effluent in 2000. As of January 2001, Hines Nurseries had completed seven chronic toxicity tests, and El Modeno Gardens had completed two chronic toxicity tests. Bordiers Nursery had not yet conducted chronic toxicity tests.

Test results were generally 2 chronic toxic units (TUc) for reproduction and 1-2 TUc for survival. DPR data show that the mix of pesticides causing toxicity in nursery discharge typically includes diazinon, chlorpyrifos, and bifenthrin (CDPR, 1999-2001).

SUMMARY

Toxicity tests have been performed on 123 water samples collected from the Newport Bay watershed. These tests have demonstrated the persistent occurrence of aquatic life toxicity in San Diego Creek and its tributaries, and in Upper Newport Bay, particularly during storm events. Based on water column chemistry data and TIEs, there is conclusive evidence that diazinon and chlorpyrifos are causing acute and chronic toxicity in San Diego Creek and Upper Newport Bay (chlorpyrifos). There is no compelling evidence of bioaccumulation of these substances to levels of concern.

The persistent occurrence of aquatic life toxicity in San Diego Creek and Upper Newport Bay is evidence of impairment, or at least threatened impairment of the established beneficial uses of these waterbodies. Adverse impacts to these beneficial uses are violations of the second narrative objective specified in the Basin Plan (SARWQCB, 1995).

3.0 NUMERIC TARGETS

At present, there are no established numeric water quality objectives for chlorpyrifos and diazinon. Two methods have been proposed for setting numeric targets in the Newport Bay watershed. These are:

(1) The CDFG (2000a) water quality criteria for diazinon and chlorpyrifos derived using USEPA guidelines (USEPA 1985). Note that these criteria have not been formally adopted, but are the best scientifically derived guidance available.

(2) A Probabilistic Ecological Risk Assessment (PERA) for diazinon implemented by Novartis (Hall and Anderson 2000). This method could also be applied for chlorpyrifos.

Table 3-1 shows potential diazinon and chlorpyrifos concentration targets, along with several reference concentrations for comparison.

Table 3-1 Potential Numeric Targets and Reference Values

Source	Concentration (ng/L)	
	Freshwater	Saltwater
DIAZINON		
CDFG chronic criterion	50	---
CDFG acute criterion	80	---
Probabilistic Ecological Risk Assessment (PERA) Arthropods 5th percentile	144	---
Ceriodaphnia chronic, acute NOECs	220, 350	---
Ceriodaphnia/Mysidopsis (LC50 or EC50)	440	4,500
Stormwater Mean	445	---
Maximum	960	---
CHLORPYRIFOS		
CDFG chronic criterion	14	9
CDFG acute criterion	20	20
Ceriodaphnia chronic NOEC	29	---
Ceriodaphnia/Mysidopsis (LC50 or EC50)	60	40
Stormwater Mean	87	43.3
Maximum	580	132

CDFG=California Department of Fish and Game. LC50=lethal concentration 50%. EC50=Effects concentration 50%. LC50 and EC50 from CDFG(2000a); NOEC=No Observed Effects Concentration

<u>USEPA Method as Applied by CDFG</u>: The USEPA method provides for development of an acute and a chronic concentration criterion. The acute criterion is referred to as the Criterion Maximum Concentration (CMC), and the chronic criterion is referred to as the Criterion Continuous Concentration. The use of two criteria is intended to be less restrictive than "a one-number criterion would have to be in order to provide the same degree of protection" (USEPA 1985).

The CMC is designed to "estimate the highest one-hour average concentration that should not result in unacceptable effects on aquatic organisms and their uses." The CCC is designed to "estimate the highest four-day average concentration that should not cause unacceptable toxicity during a long-term exposure" (USEPA, 1985).

The frequency of allowed exceedance for both the CCC and CMC is set as once in three years, an interval deemed sufficient to allow ecosystems to recover from the stress caused by the exceedance. The CCC and CMC are intended to provide protection to 95% of the species in the data set, and are derived by using acceptable toxicity tests from a representative set of species.

In accordance with USEPA (1985) guidance, the CDFG recommended criteria were derived using toxicity data from eight families of aquatic animals. Acute toxicity values (LC50s and EC50s) were assembled from tests that met standard acceptance protocols defined in USEPA guidelines (1985) and ASTM standards. For diazinon, a total of 40 acceptable tests from 15 genera were used, and for chlorpyrifos a total of 33 acceptable tests from 18 genera were used. Genus mean acute values (GMAVs) were calculated using the geometric means of the reported acute values (LC50s or EC50s), and the four lowest GMAVs were used to calculate the acute criteria. Chronic criteria were derived using acute-to-chronic ratios.

The USEPA methodology includes provisions to account for bioaccumulation, and for toxicity to plant species, if warranted. As discussed previously, bioaccumulation is not a concern for diazinon and chlorpyrifos. Toxicity to aquatic plants is also not a significant concern, based on toxicity test results in the Newport Bay watershed using the algae *Selenastrum capricornatum* (no toxicity present in any of the tests).

PERA Method: The PERA is a risk assessment, and is more comprehensive in scope than the USEPA method. The PERA approach characterizes risk to aquatic species by comparing distributions of environmental exposure data with distributions of species response data (toxicity data) from laboratory studies. The overlap of these distributions is a measure of potential risk to aquatic life.

The numeric target for the PERA is derived by pooling available toxicity tests to form a cumulative frequency distribution. The desired level of protection is then selected by choosing appropriate percentiles from the distribution (usually the 5^{th} or 10^{th} percentiles). In the Newport Bay watershed PERA, performed by Novartis (Hall and Anderson 2000), the 5^{th} and 10^{th} percentiles were determined separately for the entire toxicity data set (all species) and for arthropods (the most sensitive phylum to diazinon). The 5^{th} percentile for arthropods corresponds to protection of 95% of arthropod species, and is similar to the USEPA acute criterion, which is designed to be protective of 95% of the species included in the representative data set.

Differences between the USEPA method and the PERA as implemented by Novartis include differing statistical methods for grouping and averaging the data, and the additional requirement in the USEPA method for selection of a representative set of taxa.

However, the major difference between the USEPA method and the PERA is the inclusion of a safety margin in the USEPA method. Although both methodologies are based on statistically determining the 5th percentile of the toxicity test data, the USEPA method includes a final step to divide the 5th percentile value by a factor of two. The rationale for this safety margin is that the toxicity test data are based on LC50s. Using the LC50 without the safety margin implies a numeric target that allows 50% mortality (or greater) at the selected level of protection (5th percentile). But as stated by USEPA, "a concentration that would severely harm 50% of the 5th percentile cannot be considered to be protective of that percentile or that species" (USEPA, 1985). Noting this point, USEPA Region IX has stated that the PERA method as implemented by Novartis, is not considered protective under the Clean Water Act (USEPA 2000b).

For this TMDL, the selected numeric targets are the recommended acute and chronic criteria derived by the California Dept. of Fish and Game for chlorpyrifos and diazinon in freshwater and saltwater (CDFG 2000a). These numeric targets serve as the quantitative interpretation of the second narrative water-column quality objective as specified in the Basin Plan (1995). These numeric targets will be protective of aquatic life in San Diego Creek and Upper Newport Bay and sufficient to remove impairment caused by diazinon/chlorpyrifos toxicity. Target concentrations are shown in Table 3-2; saltwater chronic and acute targets for diazinon are not applicable since TMDLs are not required for this pollutant in any of the saltwater bodies covered by these TMDLs.

Table 3-2 Selected Numeric Targets

Pesticide	Criterion	Concentration (ng/L)	
		Freshwater	Saltwater
Diazinon	Chronic	50	N/a
	Acute	80	N/a
Chlorpyrifos	Chronic	14	9
	Acute	20	20

Calif. Fish & Game (2000a). Chronic means 4-consecutive day average

The CDFG applied the USEPA methodology by assembling a database of available toxicity tests and evaluating each test for inclusion in the set of tests used for calculating the acute and chronic recommended criteria. The numeric targets selected for this TMDL are the recommended acute and chronic criteria derived by the CDFG (CDFG 2000a). These concentrations are shown in Table 3-2. Setting numeric targets at the CDFG-derived criteria will ensure that aquatic organisms and their uses should not be affected unacceptably if the four-day average concentrations do not exceed the chronic numeric targets (Table 3-2), more than once every three years on the average, and if the one-hour average concentrations do not exceed the acute numeric targets (Table 3-2) more than once every three years on the average.

4.0 SOURCE ANALYSIS

This section of the TMDL presents a synopsis of the major sources of diazinon and chlorpyrifos to San Diego Creek and chlorpyrifos to Upper Newport Bay. This synopsis focuses on water column concentrations from several studies conducted in the watershed targeting aquatic life toxicity associated with pesticides (Lee and Taylor 1999, 2001; CDPR studies). These studies were not detailed enough to identify discrete sources, but it is generally recognized that these pesticides occur in non-point source runoff from both agriculture and urban use.

The analysis in this section is intended to evaluate diazinon and chlorpyrifos data collected in the watershed relative to the numeric targets, and provide general estimates of average diazinon and chlorpyrifos loading rates to San Diego Creek and Upper Newport Bay. This information is used primarily to evaluate the relative importance of different categories of sources in the watershed.

4.1 Physicochemical Properties and Environmental Fate

The environmental fate of chlorpyrifos and diazinon can be inferred from their physical properties. Table 4-1 presents properties for diazinon and chlorpyrifos along with several other pesticides that occasionally contribute to the aquatic life toxicity in San Diego Creek. In general, diazinon and chlorpyrifos are a more significant water quality threat because of the combined properties of higher toxicity, mobility, and persistence. Carbaryl, for example, is mobile but less toxic and less persistent than diazinon and chlorpyrifos.

Table 4-1. Pesticide properties

Pesticide	*Ceriodaphnia* LC50 (ng/L)	Solubility (mg/L)	Adsorption Coefficient (dim'less)	Henry's Law (atm-mol/m^3)	Vapor Pressure (mmHg)	Half-Lives (days)	
						Soil	Water
Bifenthrin	78	0.1	1,000,000	n/a	n/a	7-240	n/a
Carbaryl	3,380	40	300	$1.27x10^{-5}$	$4.1x10^{-5}$	7-28	10
Chlorpyrifos	60	2	6070	$4.16x10^{-6}$	$1.87x10^{-5}$	60-120	30-75
Diazinon	440	40	1000	$1.13x10^{-7}$	$8.47x10^{-5}$	14-28	180
DDT	4,700	<1	100,000	n/a	n/a	2-15 years	20-60
Malathion	1,140	130	2.75	$4.89x10^{-9}$	$1.25x10^{-6}$	1-25	< 7

Sources: EXTOXNET Pesticide Information Profiles; CDFG (2000a); Montgomery (1993)
n/a=not available; dim'less=dimensionless

Relative to most pesticides, diazinon is fairly soluble and mobile in aquatic systems. It is only weakly bound by sediment. In contrast, chlorpyrifos is much less soluble and has a much higher potential to adsorb to soil and sediment.

Diazinon
In general, diazinon is relatively persistent in aquatic environments with a half-life of about six-months under neutral pH conditions. The pH of the channel network in the Newport Bay watershed is generally between 7.5 and 8, a range that would maintain the stability of diazinon. In soil, the diazinon half-life is shorter owing to greater microbial degradation.

For diazinon, major routes for dissipation are hydrolysis, biodegradation, volatilization, and photolysis (USEPA 1999a). Diazinon degrades rapidly by hydrolysis under acidic conditions (half-life of 12 days at pH 5). Hydrolysis is slower under neutral and alkaline conditions (abiotic hydrolysis half-lives of 138 days at pH 7, and 77 days at pH 9). Degradation is fastest from bare soil, followed by vegetation, and aquatic environments. Biodegradation from impervious urban areas (walkways, pavement) would be slowest due to the relative absence of microbes. This indicates that diazinon may accumulate in residential areas until rainfall runoff carries it into the drainage channel network. In a residential runoff survey conducted in the Castro Valley Creek watershed, diazinon was found in all samples as long as seven weeks after application (Scanlin and Feng 1997).

Diazinon dissipation half-lives do not appear to be correlated with formulation type (granular, wettable powder, or emulsifiable concentrate). The reported diazinon formulations in Orange County for 1999 are listed in Table 4-2. The liquid formulations are likely to be the most mobile as they are already in soluble form. The granules would likely remain available until a storm event washed the remaining active ingredient into the storm drains.

Table 4-2. Diazinon Formulations Used in Orange County, 1999

Formulation	Use (lbs. ai)	Percent
Emulsifiable concentrate	14,776	60.4%
Granular/Flake	4,675	19.1
Wettable Powder	2,720	11.1
Flowable Concentration	1,969	8.1
Liquid Concentration	275	1.1
Dust/Powder	36.8	0.2
Pressurized Liquid/Sprays/Foggers	0.465	<0.5
Solution/Liquid (Ready to use)	0.184	<0.5
Total	24,452	100%

Source: CDPR Pesticide Use Report Database (CDPR 2000)
ai =active ingredient

Regardless of the formulation used, runoff is likely to occur only after significant rainfall or irrigation. Aside from runoff, a potentially significant discharge could occur through improper disposal of old or leftover material. The degree of knowledge concerning proper disposal varies considerably and it is unlikely that homeowners apply the exact amount needed in a manner that does not cause runoff.

Large-scale aerial spray applications may drift and result in significant offsite migration. These are generally applied to orchard crops in the Central Valley and, as Table 4-2 shows, they are not a significant application in Orange County.

There is evidence that the amount of diazinon in a watershed that reaches a receiving waterbody is generally less than one percent of that applied (Scanlin and Feng 1997). Thus, relatively limited instances of improper use (e.g. inappropriate disposal, excess outdoor application) could account for a large portion of the observed concentrations in the drainage channels.

Chlorpyrifos
Compared to diazinon, chlorpyrifos has a shorter half-life in water, but a longer half-life in soil. This is due in part to its higher adsorption coefficient, which results in chlorpyrifos partitioning out of the aquatic phase as it is bound by sediment and soil.

Table 4-3 shows the chlorpyrifos formulations used in Orange County in 1999. As with diazinon, concentrates, powders, and granular/flake formulations account for over 99% of the uses. These formulations require mixing/preparation prior to use.

Table 4-3. Chlorpyrifos Formulations used in Orange County, 1999

Formulation	Use (lbs. ai)	Percent
Emulsifiable concentrate	70,067	87.6%
Granular/Flake	6571	8.2
Wettable Powder	2281	2.9
Flowable Concentration	996	1.2
Liquid Concentration	38.1	<0.5
Dust/Powder	35.1	<0.5
Pressurized Liquid/Sprays/Foggers	1.58	<0.5
Solution/Liquid (Ready to use)	0.103	<0.5
Total	79,990	100%

Source: CDPR Pesticide Use Report Database (CDPR 2000)
ai =active ingredient

Of the top four formulations used in Orange County, only the granular/flake formulation would act to slowly release the active ingredient into the water, while the other formulations would enhance mobility. The lower release rate would result in lower concentrations over time.

Dissipation of chlorpyrifos from water takes place through sorption, volatilization, and photolysis. Chemical breakdown (hydrolysis) rates increase with increasing temperature and pH. Adsorbed chlorpyrifos is subject to degradation by UV light, chemical hydrolysis, and biodegradation.

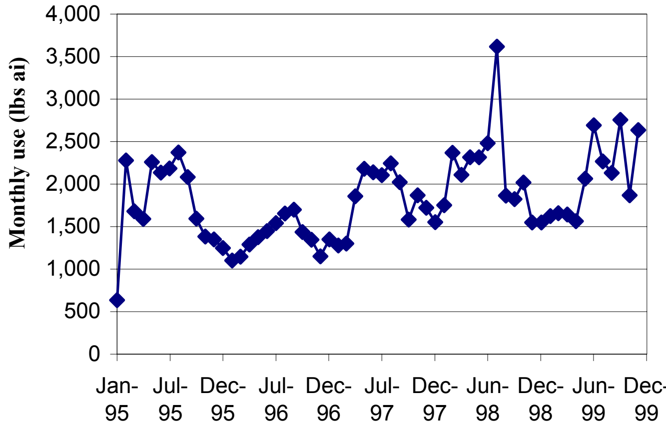
4.2 Pesticide Usage

The CDPR requires records of all pesticide applications except for residential use by homeowners. These records are compiled and reported on a county-by-county basis. The Newport Bay watershed occupies 20% of Orange County, and it is assumed here that 20% of the pesticide use reported for Orange County occurred within the Newport Bay watershed.

Diazinon
As shown in Figure 4-1, reported diazinon use in Orange County has remained fairly steady over the past five years. Seasonally correlated increases in diazinon use are apparent in the summer months in response to increased pest activity.

As noted above, residential use by homeowners is not reported in the CDPR database. Information on national pesticide usage by homeowners is available from the USEPA Pesticide Industry Sales and Usage Market Estimates report. On a national basis, 75% of the diazinon used in the US each year is for non-agricultural purposes, with 39% used by homeowners outdoors and 3% used by homeowners indoors (USEPA 1999b). Total homeowner use is therefore about 42% on a national basis.

Figure 4-1: Reported Diazinon Use Orange County: 1995-1999



In Orange County, the total agricultural use is likely less than the national average due to urbanization of the watershed. Thus, homeowner uses probably account for more than the 42% reported nationally. A more specific estimate of the unreported homeowner use can be obtained by assuming the national ratio of homeowner use to total non-agricultural use (42/75, or 56%) is applicable to Orange County. Since data on the total non-agricultural diazinon use in Orange County is reported to the CDPR on a yearly basis, the national ratio can be used to estimate the unreported homeowner use in Orange County. Estimating the unreported homeowner use at 56% of total non-agricultural use results in a figure of 29,119 lbs. active ingredient (ai) for 1999. This would amount to 54% of total use (including agricultural use) in Orange County; somewhat higher than the national figure of 42% reported by USEPA.

Tables 4-4 and 4-5 present the reported and estimated unreported diazinon use in Orange County. For 1999, the total diazinon use in the Newport Bay watershed would be one-fifth of the Orange County total, or approximately 10,714 lbs. ai, while the estimated residential use would be about 5,824 lbs. ai.

Table 4-5 indicates that urban uses accounted for over 97% of diazinon use, while agricultural uses (including nurseries) accounted for the remainder. Data from the Sales and Use Survey in the Newport Bay watershed (Wilen 2001) indicate that unreported residential diazinon use in 2000 was about 7,864 lbs. ai; about 32% larger than the estimate of 5,824 lbs. presented above using separate national data. This would suggest that total urban uses account for more than the 97% indicated in Table 4-5.

Table 4-4: Reported and Estimated Diazinon Use
Orange County: 1995-1999 (lbs. ai)

Use	1995	1996	1997	1998	1999
Structural	17,463	14,046	18,892	23,076	22,085
Nursery	1,037	839	803	1,212	1,144
Agriculture	2,004	746	1,363	865	429
Landscape	1,030	762	595	612	789
Other non-residential	9.8	46.2	1.6	1.7	5.3
Reported subtotal	21,543	16,439	21,655	25,766	24,452
Estimated Unreported Residential Use	23,548	18,905	24,804	30,150	29,119
Total	45,092	35,344	46,458	55,915	53,571

ai = active ingredient

Tables 4-4 and 4-5 show a decline in agriculture use from 1995 to 1999, both in absolute and percentage terms. The land use data also show a similar pattern, and the decline in agricultural diazinon usage may be a reflection of the continuing conversion of agricultural land to urban uses in Orange County and the Newport Bay watershed.

Table 4-5: Reported and Estimated Diazinon Use
Orange County: 1995-1999 (percent)

Use	1995	1996	1997	1998	1999
Structural	38.7%	39.7%	40.7%	41.3%	41.2%
Nursery	2.3%	2.4%	1.7%	2.2%	2.1%
Agriculture	4.4%	2.1%	2.9%	1.5%	0.8%
Landscape	2.3%	2.2%	1.3%	1.1%	1.5%
Other non-residential	0.0%	0.1%	0.0%	0.0%	0.0%
Estimated Residential	52%	53%	53%	54%	54%
Total	100%	100%	100%	100%	100%

USEPA Phaseout of Certain Diazinon Uses

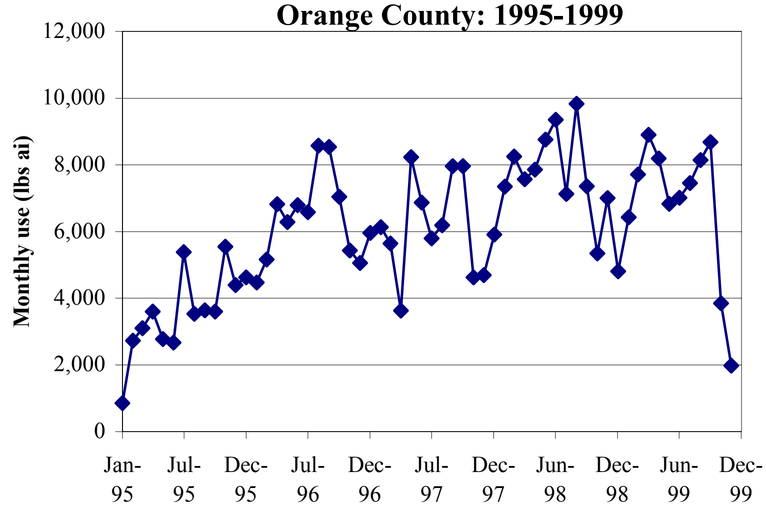
In January 2001, USEPA released a revised risk assessment and an agreement with registrants to phase out most diazinon uses (USEPA 2001). Under the agreement, all indoor uses will be terminated, and all outdoor non-agricultural uses will be phased out over the next few years. Indoor uses will be banned after December 31, 2002. The EPA expects that these actions will end about 75% of the current use of diazinon. In addition, on a national basis, about one-third of the agricultural crop uses will be removed. For the San Diego Creek/Newport Bay watershed, the percentage reduction in agricultural usage will be higher (ca. 55%) due to the particular crops that are grown in the watershed.

The usage data in Table 4-5 show that non-agricultural and non-nursery uses account for over 90% of the diazinon use in Orange County. It is thus likely that the EPA agreement will result in the cessation of most diazinon use in the Newport Bay watershed soon after the outdoor non-agricultural use registration expires on December 31, 2004. Use of diazinon in the RIFA program is considered a public health use and will not be affected by the USEPA re-registration.

Chlorpyrifos

Figure 4-2 shows the reported chlorpyrifos use in Orange County from 1995 to 1999. As with diazinon, higher use tends to occur in the dry season, and is likely correlated with increased pest activity during warmer weather. An increasing trend from 1995 to 1998 is apparent followed by a sharp drop in 1999. This drop may be due to the agreement between EPA and the manufacturers to begin phasing out certain uses of chlorpyrifos (see below).

Fig 4-2: Reported Chlorpyrifos Use Orange County: 1995-1999



Tables 4-6 and 4-7 show the reported and estimated unreported chlorpyrifos use in Orange County. While overall chlorpyrifos use declined in 1999, nursery use increased by 300 percent. The significant increase in chlorpyrifos use by nurseries is likely due to the requirements imposed by the CDFA under the Red Imported Fire Ant (RIFA) program. Runoff of the solution from the treatment area is not permitted (CDFA 1999).

Table 4-6: Reported and Estimated Chlorpyrifos Use Orange County: 1995-1999 (lbs. ai)

Use	1995	1996	1997	1998	1999
Structural	38,263	72,174	69,865	88,985	74,904
Nursery	652	772	971	994	2,913
Agriculture	1,414	952	1,450	645	1,132
Landscape	1,446	1,230	1,374	1,082	1,005
Other non-residential	7	268.5	1.6	1.6	35.3
Reported subtotal	41,782	75,396	73,662	91,707	79,990
Estimated Residential	21,663	40,185	38,859	49,128	41,424
Total	63,445	115,580	112,520	140,835	121,414

ai = active ingredient

Unreported (residential) chlorpyrifos use can be estimated by determining the national ratio of unreported home use to licensed (non-agricultural) use as reported in the USEPA Market Estimates Report (USEPA 1999b). Nationally, in 1995/96, the residential use was estimated at 2-4 million lbs. ai, while the licensed (non-agricultural) use was estimated at 4-7 million lbs. ai. Using the midpoints of these ranges, the ratio of residential use to licensed non-agricultural use is 0.545 on a national basis. Applying this ratio to the licensed non-agricultural use in Orange County reported to the CDPR for 1999 (75,944 lbs. ai) yields an estimate of 41,424 lbs. ai unreported residential use (Table 4-6). This indicates that the unreported residential use was roughly 34% of the total use in 1999 (Table 4-7). Total chlorpyrifos use in the Newport Bay watershed for 1999 would be approximately 24,300 lbs. ai (one-fifth of the Orange County total).

Data from the Sales and Use Survey (Wilen 2001) indicates that retail sales of chlorpyrifos in the Newport Bay watershed may have declined to as little as 546 lbs. ai on an annual basis in 2000. This compares to the estimated residential use of 8,285 lbs. ai (one-fifth of the Orange County total) presented in Table 4-6 for 1999. The decline in chlorpyrifos use appears to be a continuation of the trend shown in Figure 4-2 toward the end of 1999, and is likely related to the re-registration agreement for chlorpyrifos (see below).

Table 4-7: Reported and Estimated Chlorpyrifos Use Orange County: 1995-1999 (percent)

Use	1995	1996	1997	1998	1999
Structural	59.2%	61.9%	61.3%	62.7%	60.6%
Nursery	1.0%	0.7%	0.9%	0.7%	2.4%
Agriculture	2.2%	0.8%	1.3%	0.5%	0.9%
Landscape	2.2%	1.1%	1.2%	0.8%	0.8%
Other non-residential	0.0%	0.2%	0.0%	0.0%	0.0%
Reported subtotal	66%	65%	65%	65%	66%
Estimated Unreported Residential Use	34%	35%	35%	35%	34%
Total	100%	100%	100%	100%	100%

An analysis of chlorpyrifos sales data provided by Dow AgroSciences indicates that treatment for wood protection accounts for 70% of urban use (Giesy et al. 1998). Typical applications involve subsurface injection of chlorpyrifos at relatively high concentrations. Another 14% of urban use was categorized as home use (indoor pests, pet collars, lawns and gardens, building foundations, and other structural applications), while non-residential turf applications accounted for 7% of urban use.

USEPA Phaseout of Certain Chlorpyrifos Uses

In June 2000, the EPA published its revised risk assessment and agreement with registrants for chlorpyrifos (USEPA 2000a). The agreement imposes new restrictions on chlorpyrifos use in agriculture, cancels or phases out nearly all indoor and outdoor residential uses, and also cancels non-residential uses where children may be exposed. Application rates for non-residential areas where children will not be exposed (golf courses, road medians, industrial plant sites) will be reduced. Public health use for fire ant eradication and mosquito control will be restricted to professionals. Non-structural wood treatments will continue at current rates. Since the EPA estimates that about 50% of the chlorpyrifos use (both licensed and unreported) takes place at residential sites, the agreement is likely to result in at least a 50% decrease in chlorpyrifos use.

In Orange County, residential use (reported and unreported) likely accounts for over 90% of total chlorpyrifos use (most of the reported use is for structural protection applied in and around homes). Thus, it appears that over 90% of the current chlorpyrifos use in the Newport Bay watershed will be eliminated by the EPA agreement. Retail sales are scheduled to stop by December 31, 2001, and structural uses will be phased out by December 31, 2005. Use of chlorpyrifos in the RIFA program is considered a public health use and will not be affected by the USEPA re-registration.

As noted above, the CDPR data, and the Sales and Use Survey data (Wilen 2001) indicate that chlorpyrifos use has been declining sharply within the last two years. This is likely due to the warning from EPA that retailers should not purchase stock unless they were able to sell it by December 31, 2001. A survey conducted in northern California in late 2000 noted, "Chlorpyrifos products have become increasingly difficult to find" (TDC Environmental 2001). It should be noted that the available water-quality data for the Newport Bay watershed, is largely from 1996-2000, and not directly correlated to the latest usage data from 2000-2001.

4.3 Data Summary and Analysis

This section presents an analysis of the sources of diazinon and chlorpyrifos in the Newport Bay Watershed. Each chemical summary includes monitoring data and a discussion of diazinon and chlorpyrifos sources categorized by land use. Point sources and non-point sources are also discussed in a separate section.

Diazinon Data Summary

Table 4-8 summarizes the results of diazinon sampling in the Newport Bay watershed. The sampling programs are described in Section 2. The table shows the high diazinon detection frequency, particularly during stormflow. The observed diazinon concentrations are similar to those observed in urban watersheds elsewhere in California. The mean values for both baseflow and stormflow exceeded the chronic numeric target, while 86% of the diazinon concentrations observed in the watershed drainage channels exceeded the acute numeric target.

Table 4-8. Summary of Diazinon Sampling Results

Source	Count	No. of Detects	Detection Frequency	Min.	Max.	Mean	Median
Water Samples (ng/L)							
Drainage Channels (All Flows)	198	185	93%	<40	10,000	471	220
Baseflow	104	93	89%	<40	10,000	473	160
Stormflow	94	92	98%	<50	7990	451	357
Upper Newport Bay	26	26	100%	197	720	386	357
Rainfall	1	1	--	--	13	--	--
Sediment Samples (µg/kg)							
Drainage Channels	98	2	2%	<10	49	--	--
Newport Bay	64	2	3%	<0.4	60	--	--

Freshwater Numeric Targets: acute = 80 ng/L; chronic = 50 ng/L (CDFG 2000a)

For comparison, the median diazinon concentration in the Santa Ana River downstream of Prado dam was 100 ng/L (USGS 2000), and the detection frequency was 99% (72 of 73 samples). The

USGS also reported stormflow concentrations as significantly elevated relative to baseflow concentrations.

The low detection frequency for the sediment samples is in accordance with the moderately low diazinon adsorption coefficient, and its relatively high solubility. All the sediment detections were reported from samples collected in 1994, and diazinon has not been detected in subsequent semi-annual sediment sampling.

Table 4-9 presents the data summarized by waterbody group. Highest concentrations occur in the upstream tributary channels to San Diego Creek. The maximum concentrations collected in 1998 from Hines Channel (which drains to Peters Canyon Channel) were three baseflow samples with concentration ranging from 2,500 to 10,000 ng/L. The maximum concentration of six baseflow samples collected in Hines channel during 2000 was 323 ng/L, indicating either a decrease in usage or more effective runoff control.

Table 4-9: Diazinon Results by Waterbody Group

Waterbody	Count	Results (ng/L)				Exceedances	
		Min	Max	Mean	Median	Above acute	Above chronic
Tributaries to SDC Reach 2	24	40	7,990	817	256	96%	92%
Tributaries to SDC Reach 1	21	49	628	226	134	86%	67%
Tributaries to PCC	41	40	10,000	791	271	83%	78%
Peters Canyon Channel	15	170	820	390	367	100%	100%
SDC Reach 1	59	50	960	301	215	95%	92%
Tributaries to UNB	35	40	2,250	357	202	94%	91%

SDC=San Diego Creek; PCC=Peters Canyon Channel; UNB=Upper Newport Bay
Freshwater Numeric Targets: acute = 80 ng/L; chronic = 50 ng/L

The similarity in median concentrations indicates that there are no clearly dominant areas of the watershed with regard to diazinon loading to San Diego Creek and Upper Newport Bay. Concentrations in Peters Canyon Channel are somewhat elevated relative to the other segments of the drainage network. This was also a conclusion of the 319h study (Lee and Taylor 2001)

<u>San Diego Creek Reach 2</u>: There were no sampling stations within Reach 2 of San Diego Creek. However, 24 samples were collected from tributary channels (Bee Canyon and Marshburn Slough). These samples were collected several miles upstream of where these channels join San Diego Creek and were mainly targeted at monitoring nursery discharges. The median concentration for these samples was 256 ng/L, with maximum concentrations of 7,990 ng/L during stormflow and 2,320 ng/L during baseflow. Over 90% of the observed concentrations exceeded the acute and chronic numeric targets.

<u>San Diego Creek Reach 1</u>: The main tributary to San Diego Creek Reach 1, aside from Reach 2, is Peters Canyon Channel. Median diazinon concentrations in Peters Canyon Channel (367 ng/L) were higher than in San Diego Creek (208 ng/L). The median concentration for other tributaries to San Diego Creek was 143 ng/L. All 15 samples collected within Peters Canyon Channel exceeded both the acute and chronic numeric targets, while in the tributaries to Peters Canyon

Channel, the percentages exceeding the acute and chronic numeric targets were lower, 78% and 83% respectively. Over 90% of the observed concentrations within Reach 1 exceeded the acute and chronic numeric targets.

Upper Newport Bay: The median concentration for drainage channels discharging directly to Upper Newport Bay (East Costa Mesa/Westcliff Park, Santa Ana Delhi) was 202 ng/L. The CDFG has not recommended criteria for diazinon in saltwater, however, the LC-50 for the commonly used test species (*Mysidopsis bahia*) is 4,200 ng/L, and the observed diazinon concentrations were all below this level, with a maximum of 720 ng/L. The USEPA (2000a) has published draft recommended acute and chronic criteria for diazinon in saltwater (820 ng/L and 400 ng/L respectively). The maximum and average results from Upper Newport Bay were below the respective draft USEPA saltwater CMC and CCC.

Diazinon Sources Categorized by Land Use

Tables 4-10a and 4-10b present the diazinon results by sampling location for storm and baseflow conditions, respectively, along with the primary land use in the monitored sub-watershed. Because of the difficulty in isolating and sampling small drainages for very specific land uses (such as the categories shown in Table 1-1) only broad land use categories are shown in Table 4-10a. The results are sorted by sampling location, moving from the upper part of the watershed to upper Newport Bay (Figure 4-3). Several of the locations were sampled during only baseflow or only stormflow conditions.

Table 4-10a: Land Use and Diazinon Stormflow Concentrations
Newport Bay Watershed: 1996-2000

ID	Station	Land Use	Count	Stormflow Results (ng/L)			
				Min	Max	Avg.	Median
S1	El Modeno Nursery	Nursery	7	126	7,990	1,625	599
S2	Hines Nursery	Nursery	9	199	810	455	324
S3	Marshburn Ch	Nursery/Ag	9	70	291	150	129
S4	Central Irvine Ch	Ag/Residential	2	280	810	545	545
S5	El Modeno-Irvine Ch	Urban	1	330	330	330	330
S6	Peters Canyon Ch	Mixed	11	202	520	339	330
S7	SDC-Harvard	Mixed	2	200	280	240	240
S8	San Joaquin Ch	Ag/Open	2	<50	<50	<50	<50
S9	SDC-Campus	Mixed	25	96	960	445	375
S10	Bonita Creek	Urban	7	69	628	424	456
S11	Santa Ana Delhi Ch	Urban	10	64	375	171	174
S12	E. Costa Mesa Ch	Urban	9	174	1,079	642	598

See Figure 4-3 for station locations, Ch = Channel, SDC=San Diego Creek

At virtually all the locations, the median stormflow concentration is significantly higher than the median baseflow concentration. Since stormwater runoff constitutes about 80% of the volume of water discharged to Newport Bay on an annual basis, this would indicate that the overwhelming majority of the pesticide load would derive from stormflow rather than baseflow. The average concentration is actually higher for baseflow, but this is biased by a few very high detections from 1998 near nurseries. These results have not been observed in later sampling and the nurseries have subsequently instituted measures targeted at reducing pesticide runoff.

Table 4-10b Land Use and Diazinon Baseflow Concentrations Newport Bay Watershed: 1996-2000

ID	Station	Land Use	Count	Stormflow Results (ng/L)			
				Min	Max	Avg.	Median
S1	El Modeno Nursery	Nursery	13	<40	2,320	580	131
S2	Hines Nursery	Nursery	15	<40	10,000	1,433	136
S3	Marshburn Ch	Nursery/Ag	1	<40	<40	<40	<40
S4	Central Irvine Ch	Ag/Residential	8	90	1,940	645	595
S5	El Modeno-Irvine Ch	Urban	1	180	180	180	180
S6	Peters Canyon Ch	Mixed	4	170	820	533	570
S7	SDC-Harvard	Mixed	2	<50	<50	<50	<50
S9	SDC-Campus	Mixed	30	<50	570	202	152
S10	Bonita Creek	Urban	12	49	332	139	114
S11	Santa Ana Delhi Ch	Urban	6	<50	340	149	125
S12	E. Costa Mesa Ch	Urban	10	<40	2,250	410	213

See Figure 4-3 for station locations, Ch = Channel, SDC=San Diego Creek

Although the sampling network is not detailed enough to identify individual sources (aside from nurseries), two conclusions are apparent:

(1) Stormflow concentrations are virtually always higher than baseflow concentrations. This is particularly the case in the non-agricultural areas.
(2) Urban areas tend to yield the highest stormwater runoff concentrations while the nursery areas tend to yield the higher baseflow concentrations.

Studies reported in the literature indicate that residential hotspots (individual homes) can account for most of the diazinon runoff from a neighborhood. Samples collected from the near vicinity of these residential hotspots (prior to dilution in the storm drain), showed concentrations above 10,000 ng/L (Scanlin and Feng 1997). Such detailed sampling and analysis for pesticides has not been completed in residential areas of the Newport Bay watershed. The residential run-off reduction study is currently in progress but results were not available for these TMDLs.

Chlorpyrifos Data Summary

Table 4-11 summarizes the chlorpyrifos results. The detection frequency is lower than for diazinon. This is due, in part, to the lower solubility of chlorpyrifos, and its greater affinity for sediment (Table 4-1). The lower mobility of chlorpyrifos results in lower concentrations in the drainage channels, despite the fact that over twice as much chlorpyrifos is applied as compared to diazinon (lbs. ai) (Tables 4-4 and 4-6),

The average values for stormflow and baseflow exceed the chronic numeric targets. Within the drainage channels, 44% of the chlorpyrifos results exceeded the freshwater chronic target (14 ng/L), while 92% of the samples collected in Upper Newport Bay were over the saltwater chronic target (9 ng/L).

Table 4-11. Summary of Chlorpyrifos Sampling Results

Source	Count	No. of Detects	Det. Freq	Min.	Max.	Mean	Median
Water (ng/L)							
Drainage Channels (All flows)	198	89	45%	ND	770	139	<50
Baseflow	104	36	35%	ND	670	162	<40
Stormflow	94	53	56%	ND	770	123	50
Upper Newport Bay	24	24	100%	2	132	43.3	41.5
Rainfall	1	1	--	--	23	--	--
Sediment (μg/kg)							
Drainage Channels	2	2	100%	17	29	--	--

Freshwater Numeric Targets: acute = 20 ng/L; chronic = 14 ng/L (CDFG 2000a)
Saltwater Numeric Targets: acute = 20 ng/L; chronic = 9 ng/L (CDFG 2000a)

The sediment data for chlorpyrifos is reflective of the higher soil adsorption coefficient relative to diazinon. Although chlorpyrifos analyses were not presented in the OCPFRD data, chlorpyrifos was detected in both sediment samples collected by the CDFG (2000b).

Table 4-12 presents the chlorpyrifos data summarized by waterbody group. Detection frequencies were low, particularly in the upper reaches of the watershed. Detection frequencies were higher in Peters Canyon Channel and its tributaries, where a large proportion of the samples were from undiluted nursery discharges. Comparison to the acute and chronic numeric targets is difficult because they are set at levels below the analytical reporting limit used for most of the sampling/monitoring programs. In Table 4-12, all detections exceeded the acute and chronic targets.

Table 4-12. Chlorpyrifos Results by Waterbody Group

Waterbody	Count	Results (ng/L)			Detection Frequency*
		Max	Mean	Median	
Tributaries to SDC Reach 2	24	121	51	<40	33%
Tributaries to SDC Reach 1	21	770	95	<40	10%
Tributaries to P CC	41	670	108	50	54%
Peters Canyon Channel	15	420	83	57	60%
SDC Reach 1	59	580	102	57	59%
Tributaries to UNB	35	231	47	<40	37%
Upper Newport Bay	24	132	43.3	41.5	100%

SDC = San Diego Creek; PCC = Peters Canyon Channel; UNB=Upper Newport Bay
** The reporting limit for chlorpyrifos in freshwater was above the acute and chronic numeric targets, therefore all detected concentrations in freshwater exceeded the numeric targets.*

<u>San Diego Creek Reach 2</u>: There were no samples collected from within Reach 2, however, samples collected from tributary channels discharging into Reach 2 had a low detection frequency (33%) and a maximum concentration of 121 ng/L.

San Diego Creek Reach 1: Samples collected from locations in Reach 1 of San Diego Creek (at Campus, Coronado, and Harvard streets) had a relatively high detection frequency and the highest median concentration, along with Peters Canyon Channel. This may indicate that the greater part of the chlorpyrifos loading is derived from Peters Canyon Channel and its sampled tributaries (Hines, Central Irvine). However, the maximum chlorpyrifos concentrations occurred in two samples collected from San Joaquin Creek, which discharges directly into Reach 1 of San Diego Creek.

Upper Newport Bay: Chlorpyrifos was detected in all samples collected in Upper Newport Bay, where a lower detection limit was employed. Eighty percent of the results exceeded the acute numeric target, while 92% exceeded the chronic numeric target. The samples were collected over several days during a storm event in January 1999. The chlorpyrifos concentration that saltwater organisms are exposed to is largely dependent on the degree of mixing between saltwater and freshwater in the upper bay. In the case of the storm sampled in January 1999, a freshwater lens persisted for several days in the upper bay. Chlorpyrifos concentrations were inversely correlated with salinity. Overall, the observed concentrations were lower in Upper Newport Bay than in San Diego Creek.

Chlorpyrifos Sources Categorized by Land Use

Tables 4-13a and 4-13b present the chlorpyrifos results by sampling location during storm and baseflow conditions, respectively, along with the primary land use in the monitored sub-watershed. The results are sorted by sampling location, moving from the upper part of the watershed to upper Newport Bay (Figure 4-3). Several of the locations were sampled during only baseflow or only stormflow conditions.

Stations sampling runoff derived from mixed land use areas tended to have the highest chlorpyrifos concentrations under both baseflow and stormflow conditions. A major exception was the data from San Joaquin Creek. This creek was sampled during two separate storm events in February 2000. (Baseflow samples were not collected). The results were the two highest chlorpyrifos concentrations (770 ng/L and 470 ng/L) in the entire dataset. This sample was also associated with very high concentrations of carbaryl that were determined to originate from agricultural fields planted with strawberries that were treated with pesticides immediately prior to a rainfall event.

Chlorpyrifos was not detected in the two stormflow samples collected at the second non-nursery agricultural location (Sand Canyon Ave - NE corner Irvine Blvd). Therefore, it appears prudent to avoid assigning a median concentration to the entire watershed for non-nursery agriculture based on this limited data set.

It is difficult to draw strong conclusions from the data in Tables C-13a and C-13b due to the limited number of samples at most of the locations, and the large number of non-detect results. The chlorpyrifos results also do not correlate well with the diazinon results; the locations with the higher diazinon concentrations do not generally yield the higher chlorpyrifos concentrations. The sampling locations at Westcliff Park and the Central Irvine Channel at Monroe were the only locations among the top seven stormflow results for both chlorpyrifos and diazinon. The baseflow results had a somewhat better correlation, but overall the data suggest differing usage patterns for chlorpyrifos and diazinon.

Sample locations monitoring residential areas tended to have lower chlorpyrifos concentrations. Chlorpyrifos was not detected at three of the residential locations under either baseflow or stormflow conditions. The detection frequency, and maximum concentrations detected at another partly residential location (Santa Ana Delhi Channel) were low. The only residential site with relatively high chlorpyrifos concentrations was Westcliff Park (stormflow), but the baseflow concentrations were relatively low.

Although it appears that some of the nursery/agricultural locations yield higher chlorpyrifos concentrations than the residential areas, it should be noted that the nursery monitoring locations are selected to monitor undiluted nursery discharge, very close to where the chlorpyrifos is used. In contrast, runoff water quality data from individual homes or from distinct residential neighborhoods were not available. Rather, data were collected from drainage channels receiving mixed/diluted runoff from many residential neighborhoods. In addition, because of the relative immobility of chlorpyrifos, and its tendency to adsorb to sediment, higher chlorpyrifos concentrations are most likely to be encountered only near areas where it is applied, before it partitions out of the aqueous phase and settles out along with the sediment.

Table 4-13a: Land Use and Chlorpyrifos Stormflow Concentrations Newport Bay Watershed: 1996-2000

ID	Station	Land Use	Count	Stormflow Results (ng/L)		
				Detections	Median	Max
S1	El Modeno Nursery	Nursery	7	14 %	<40	60
S2	Hines Nursery	Nursery	9	56 %	<50	349
S3	Marshburn Ch	Nursery/Ag	9	78 %	62	121
S4	Central Irvine Ch	Ag/Urban	2	100 %	110	150
S5	El Modeno-Irvine Ch	Urban	1	0 %	<50	<50
S6	Peters Canyon Ch	Mixed	11	64 %	80	150
S7	SDC-Harvard	Mixed	2	100 %	250	310
S8	San Joaquin Ch	Ag/Open	2	100 %	620	770
S9	SDC-Campus	Mixed	25	72 %	57	260
S10	Bonita Creek	Urban	7	0 %	<40	<40
S11	Santa Ana Delhi Ch	Urban	10	30 %	<50	55
S12	E. Costa Mesa Ch	Urban	9	67 %	63	231

See Figure 4-3 for station locations, Ch = Channel, SDC=San Diego Creek

Table 4-13b: Land Use and Chlorpyrifos Baseflow Concentrations
Newport Bay Watershed: 1996-2000

ID	Station	Land Use	Count	Stormflow Results (ng/L)		
				Detections	Median	Max
S1	El Modeno Nursery	Nursery	13	15 %	<40	57
S2	Hines Nursery	Nursery	15	53 %	<50	670
S3	Marshburn Ch	Nursery/Ag	1	0 %	<40	<40
S4	Central Irvine Ch	Ag/Urban	8	75 %	63	315
S5	El Modeno-Irvine Ch	Urban	1	0 %	<50	<50
S6	Peters Canyon Ch	Mixed	4	50 %	53.5	420
S7	SDC-Harvard	Mixed	2	50 %	225	400
S8	San Joaquin Ch	Ag/Open	0	---	---	---
S9	SDC-Campus	Mixed	30	47 %	<50	580
S10	Bonita Creek	Urban	12	0 %	<40	<40
S11	Santa Ana Delhi Ch	Urban	6	33 %	<50	18
S12	E. Costa Mesa Ch	Urban	10	20 %	<40	129

See Figure 4-3 for station locations, Ch = Channel, SDC=San Diego Creek
Note: S11 max less than median due to lower reporting limit for some samples

Point Sources
The Regional Board issues Waste Discharge Requirements (WDRs) and NPDES permits for discharges of waste to land and surface waters, respectively. There are thirteen individual waste discharge requirement (WDR) or NPDES permit holders in the Upper Newport Bay watershed. In addition, three general NPDES permits and an areawide municipal stormwater permit apply within the San Diego Creek/Newport Bay watershed.

NPDES
NPDES - Stormwater Runoff:
Stormwater and urban nuisance flows in that portion of Orange County within the Santa Ana Regional Board's jurisdiction (including the San Diego Creek/Newport Bay watershed) are regulated under an areawide municipal stormwater permit issued to Orange County and its co-permittees. As presented above, these flows are significant sources of diazinon and chlorpyrifos inputs to surface waters within the San Diego Creek/Newport Bay watershed. As discussed in Section 2, the OCPFRD monitoring program does not include analysis for organophosphate pesticides. However, considerable data have been collected from stormwater runoff channels as part of the 205j, 319h, and CDPR investigations.

NPDES – Extracted Groundwater:
Many NPDES regulated discharges within the San Diego Creek/Newport Bay Watershed consist of extracted groundwater resulting from dewatering activities or groundwater cleanup projects. The Regional Board has issued some individual permits for these discharges, but most are regulated under general NPDES permits. These discharges are not expected to be sources of diazinon and chlorpyrifos loads to the watershed (groundwater is discussed further below), and the dischargers are not required to monitor for organophosphate pesticides.

NPDES - Boatyard General Permit
Six boatyard operations in Newport Beach are enrolled under a general NPDES permit. Diazinon/chlorpyrifos usage at boatyards is not expected to differ significantly from general urban uses. The permit prohibits discharge of water to Newport Bay with the exception of stormwater runoff after the first 1/10th inch of precipitation. In short, the boatyards are not regarded as a significant source of organophosphate pesticide runoff.

NPDES - Other
Diazinon has been found in effluent from sewage treatment plants (USEPA 1999a). This may be due to improper disposal of surplus pesticides into sewer drains, or to indoor diazinon usage in urban areas (TDC Environmental 2001). There are no sewage treatment plants in the Newport Bay Watershed that discharge effluent to the drainage channels or Newport Bay.

The Newport Bay Watershed residential use survey indicated a lack of knowledge among homeowners concerning proper disposal procedures (Wilen 2001). This is reflected in the diazinon and chlorpyrifos monitoring data for receiving waters affected by storm and urban nuisance flows.

Waste Discharge Requirements:
Nursery Waste Discharge Requirements (WDR):
There are three commercial nurseries in the Newport Bay watershed that are regulated under WDRs. (While the nurseries discharge to surface waters, they and other agricultural operations are exempt from permitting under the NPDES program.) WDRs are being prepared for an additional two nurseries. Together, these nurseries account for less than two percent of the area in the Newport Bay Watershed. As part of the nutrient TMDL for Newport Bay (1999), nurseries greater than five acres and discharging to tributaries that enter Newport Bay were required to institute a regular monitoring program. The monitoring program includes bi-monthly monitoring for toxicity; however, diazinon and chlorpyrifos are not currently analyzed. Several of the sampling locations for the 205j, 319h and DPR-RIFA studies were chosen to monitor discharges from nurseries to the drainage channel network. The highest diazinon results occurred in sampling stations near the Hines and El Modeno nurseries.

Other WDRs:
Several other facilities (including one landfill) have WDRs but none are required to monitor for organophosphate pesticides, and they are not considered to be significant sources of diazinon and chlorpyrifos runoff.

Groundwater

Although there are no currently available groundwater data for diazinon and chlorpyrifos in the Newport Bay watershed, groundwater does not appear to be contributing diazinon and chlorpyrifos loads to the drainage system. Diazinon and chlorpyrifos concentrations are lower downstream of areas where groundwater seeps into the drainage channels. This indicates that the groundwater serves to dilute the concentrations.

In general, diazinon and chlorpyrifos tend to dissipate from the ground surface or in the upper soil layers before percolating to groundwater. Diazinon and chlorpyrifos have not been detected in groundwater sampling conducted by the USGS in the lower Santa Ana River Basin.

Sediment Remobilization

As discussed in the fate and transport section, diazinon has a relatively low potential to adsorb to sediment, while chlorpyrifos has a greater adsorption coefficient (Table 4-1). Chlorpyrifos could accumulate in sediment and be gradually released into the water through desorption. This would require stability of the adsorbed chlorpyrifos, but adsorbed chlorpyrifos is still subject to chemical hydrolysis and biodegradation.

The available sediment data demonstrate that diazinon is not being bound to sediment to a significant degree. As shown in Table 4-8, the detection frequency for diazinon in sediment samples is less than two percent.

Two sediment samples were collected by the CDFG in July/August 2000. Chlorpyrifos was detected in sediment from Hines channel (29 ng/g) and in sediment collected nine miles downstream from the nurseries in San Diego Creek (17 ng/g) (CDFG 2000b). Diazinon was not detected at either location (reporting limit of 10 ng/g dry weight)

As part of the semi-annual sampling program, the OCPFRD collected 96 sediment samples from the Newport Bay watershed and 54 sediment samples from the Bay itself from 1994-1999. Only four diazinon detections were reported. All the detections occurred in 1994, at concentrations of 40 μg/kg to 60 μg/kg. Reporting limits ranged from 35 μg/kg to 400 μg/kg. OCPFRD does not currently monitor sediment for chlorpyrifos.

Atmospheric Deposition

Diazinon is one of the most frequently detected pesticides in air, rain, and fog (USEPA 1999a). In sampling conducted in California in 1988, diazinon was detected in approximately 90% of the sites sampled. Chlorpyrifos has a vapor pressure in the same range as diazinon, and can be expected to volatilize from treated areas. It is not as commonly detected in the atmosphere however.

A rainwater sample collected in the Newport Bay watershed during the 205(j) studies (December 1997) was reported to have a diazinon concentration of 13 ng/L and a chlorpyrifos concentration of 23 ng/L (Lee and Taylor 1999). For comparison, eight rainwater samples collected in urban watersheds in the San Francisco Bay area, had a mean diazinon detected concentration of 58 ng/L with a maximum of concentration of 88 ng/L (Katznelson and Mumley 1997).

Higher diazinon concentrations in rainwater have been detected in agricultural areas (over 5,000 ng/L in 1994-95, and ranging from 418 ng/L to 5,463 ng/L in 14 cities located in the Central Valley), but these are likely related to aerial spray applications to orchards – a type of use that is negligible in the Newport Bay Watershed. Rainfall collected in the winter of 1992-93 in the San

Joaquin basin contained up to 1,900 ng/L diazinon, and is "presumed to be droplets from dormant spray applications (not volatilization from treated crops)" (Novartis 1997).

Assuming the measured rainfall concentration is representative for all storm events, and assuming no degradation during runoff, the annual diazinon load derived from rainfall would be approximately 0.7 lbs. This would be about 2% of the mean annual load at the SDC-Campus station. For chlorpyrifos, the load would be 1.3 lbs., or about 15% of the mean annual load.

It is uncertain whether this contribution is from volatilization from use within the watershed, or from aerial transport from sources outside the watershed. For estimating loads, the contribution from rainfall is already taken into account by the runoff sampling in the watershed. Direct deposition (rainfall falling directly into Upper Newport Bay) would be negligible since the area of the bay relative to the watershed is less than one percent. The diazinon load would be less than 0.0072 lbs., or less than 0.02% of the annual load to the Bay. For chlorpyrifos the load would be 0.0127 lbs. or about 0.15% of the total annual load.

4.4 Approach to Calculating Current Loads

This section presents calculations of estimated diazinon and chlorpyrifos loads to San Diego Creek and Upper Newport Bay. Because the TMDL is concentration based, the load information is presented for information purposes only and is not used as a basis for assigning allocations.

Mean annual loads were calculated using mean water column concentrations from the SDC-Campus station. Mean annual baseflow and stormflow volumes were calculated using the flow data for the SDC- Campus station Baseflows are defined as flow rates less than or equal to 20 cfs at the SDC-Campus station. For the purposes of the diazinon and chlorpyrifos TMDL, stormflows are defined as flows greater than 20 cfs at the SDC-Campus station. Using these definitions, mean annual baseflow and stormflow volumes were calculated using 19 years of available flow data provided by the Orange County. Loads were then determined by multiplying the mean concentrations with the mean flows. As the SDC-Campus station represents over 95% of the flow in the watershed, loads were not calculated for the other tributaries.

Diazinon

The estimated mean annual diazinon load at the SDC-Campus station is about 32 lbs (Table 4-14). This amounts to about 0.3% of the estimated 10,800 lbs of diazinon (ai) used within the watershed in 1999. This finding is similar to the results of a recent study in the Castro Valley (urban) watershed. That study found that 0.3% of the applied diazinon (ai) was discharged into Castro Valley Creek, with 90% of the load delivered by storm runoff (Scanlin and Feng 1997).

Table 4-14: Estimated Mean Annual Diazinon Load
San Diego Creek – Campus Station

Flow	Mean Annual Flow (acre-feet)	Mean Conc. (ng/L)	Load (lbs.)	Load (%)
Base flow	6,323	200	3.43	10
Storm flow	26,950	445	32.6	90
Total	33,273	--	36.0	100

The intensive residential investigation in the Castro Valley Creek watershed (Scanlin and Feng 1997) revealed that a small number of individual residential hotspots (2% to 4% of the homes) produced the bulk of the diazinon loading to the Creek. Controlled experiments to evaluate diazinon runoff from individual homes demonstrated that even when diazinon was used properly, very high levels of diazinon would still be found in the runoff. Highest source areas were patios and driveways, followed by roof drains. These results are probably due to the lower rates of dissipation from these surfaces as compared to lawns or soil, where biodegradation would be much more significant.

Chlorpyrifos
Table 4-15 presents an estimate of the annual chlorpyrifos loading to San Diego Creek and Upper Newport Bay. The total annual mass of chlorpyrifos entering Upper Newport Bay is about 8 pounds. This is about 0.03% of the estimated 24,300 lbs. ai of chlorpyrifos applied in the watershed in 1999 (one-fifth of the Orange County total given in Table 4-6). This load is based on a conservative estimate of chlorpyrifos concentrations in tributaries to Upper Newport Bay. Actual concentrations in Upper Newport Bay would be reduced due to mixing and dilution.

Table 4-15. Estimated Mean Annual Chlorpyrifos Load
San Diego Creek – Campus Station

Flow	Annual Flow (acre-ft.)	Mean Conc. (ng/L)	Load (lbs.)	Load (%)
Baseflow	6,323	111	1.91	23
Stormflow	26,950	86.8	6.36	77
Total	33,273	--	8.27	100

4.5 Summary and Conclusions

The following conclusions are based on data collected in the Newport Bay watershed prior to implementation of EPA re-registration agreements for chlorpyrifos and diazinon:

- Reported and unreported urban uses account for over 90% of total chlorpyrifos and diazinon use in Orange County and in the Newport Bay Watershed.

- About 36 pounds of diazinon is discharged annually to San Diego Creek, mostly during storm events. This amounts to about 0.34% of the applied diazinon mass in the watershed. About 8 pounds of chlorpyrifos are annually discharged to Upper Newport Bay, with 77% of the load delivered during storm events. This amounts to about 0.03% of the applied chlorpyrifos mass.

- Surface runoff is the source of virtually all the loadings. Contributions from sediment remobilization and groundwater are negligible; however, loading from atmospheric deposition to Upper Newport Bay is potentially significant, though not well quantified.

- On a per acre basis, agricultural and urban land uses contribute diazinon and chlorpyrifos runoff at fairly equal rates within the watershed. Runoff derived from urban land uses accounts for about 88% of the diazinon baseflow load, and 96% of the stormflow load. Agricultural sources (including nurseries) account for the remainder of the load. For chlorpyrifos, runoff derived from urban land uses accounts for about 85% to 88% of the baseflow and stormflow loads, while agriculture (including nurseries) accounts for about 12% to 15% of the load.

- Average diazinon concentrations in San Diego Creek exceeded the chronic numeric target, and 95% of the observed concentrations were also above the acute numeric target.

- Average chlorpyrifos concentrations in San Diego Creek exceeded the chronic numeric target, and at least 59% of the observed concentrations exceeded the acute numeric target. The average chlorpyrifos concentration observed in Upper Newport Bay during a storm event exceeded the saltwater chronic numeric target, and 80% of the concentrations exceeded the acute numeric target.

- The diazinon re-registration agreement by EPA will likely end over 90% of current diazinon use in the Newport Bay watershed. If runoff concentrations show a corresponding decline, diazinon concentrations in San Diego Creek could decrease below the chronic numeric target (50 ng/L).

- The chlorpyrifos re-registration agreement by EPA will likely end over 90% of current chlorpyrifos use in the Newport Bay watershed. If runoff concentrations show a corresponding decline, chlorpyrifos concentrations in San Diego Creek and Upper Newport Bay could decline below the respective chronic numeric targets for freshwater and saltwater.

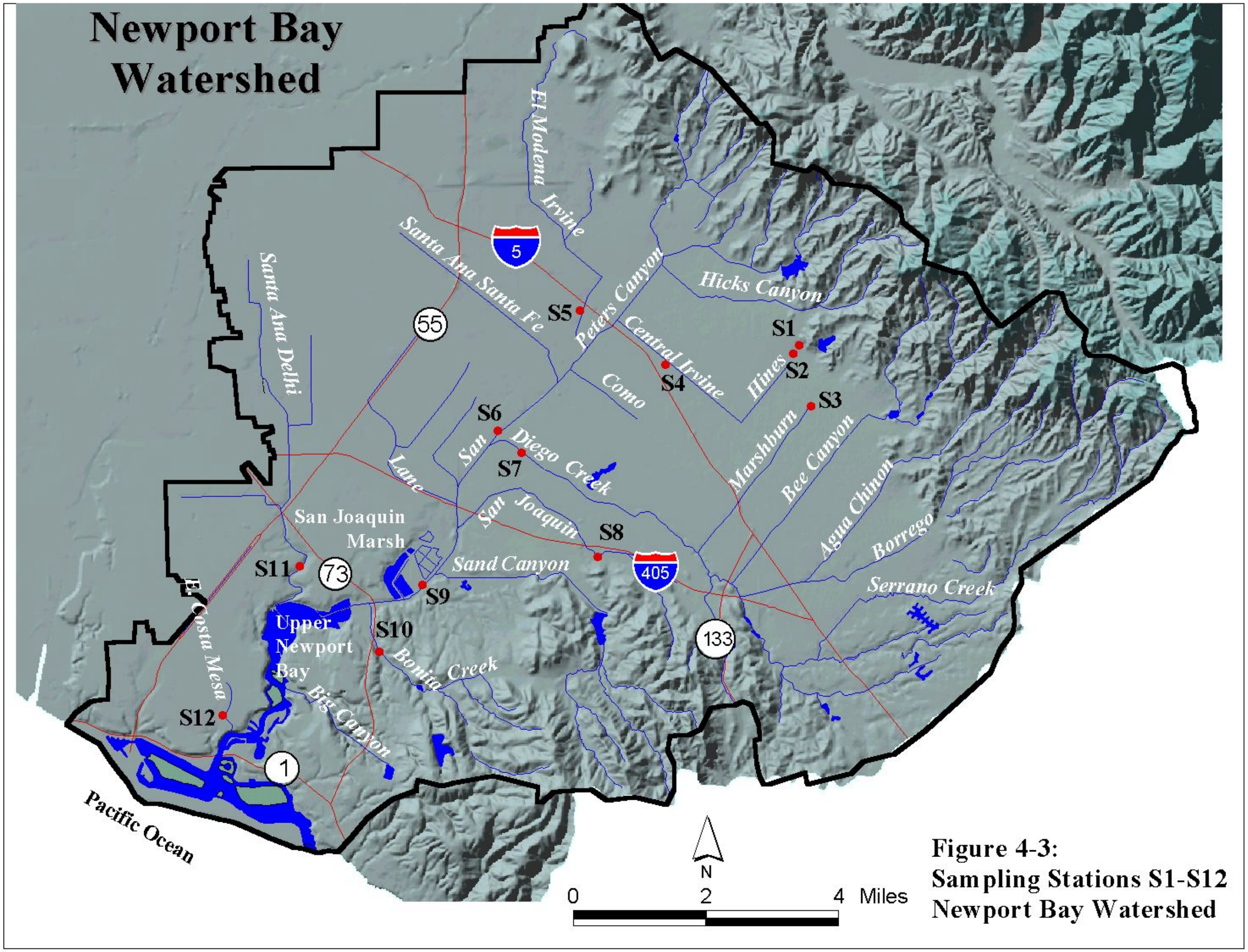


Figure 4-3:
Sampling Stations S1-S12
Newport Bay Watershed

5.0 LOADING CAPACITY/LINKAGE ANALYSIS

The diazinon and chlorpyrifos TMDL uses a concentration-based loading capacity and allocations for diazinon and chlorpyrifos. The concentration-based loading capacity will address the problems of aquatic toxicity within the watershed and Upper Newport Bay. These concentration-based TMDLs will protect aquatic life from short-term exposure via acute targets and long-term exposure via chronic targets.

The concentration-based loading capacity values are exactly the same as those selected as the numeric targets (see Table 3-1). For San Diego Creek, the loading capacity for diazinon has two components: the chronic or 4-day average concentration (50 ng/L), and a maximum 1-hour average (acute) concentration of 80 ng/L. The loading capacity for chlorpyrifos in San Diego Creek also has two components: the chronic or 4-day average concentration (14 ng/L), with a maximum 1-hour average (acute) concentration of 20 ng/L. For Upper Newport Bay, the loading capacity for chlorpyrifos has two components: the chronic or 4-day average concentration (9 ng/L), and a maximum 1-hour average (acute) concentration of 20 ng/L acute.

As discussed above regarding the numeric targets, this loading capacity (including the margin of safety discussed below) will result in achievement of the second narrative water quality objective for toxic substances (that concentrations of toxic substances shall not adversely affect beneficial uses) because these numeric targets arise directly from relevant aquatic toxicity tests.

6.0 TMDL AND ALLOCATIONS

The TMDL for diazinon and chlorpyrifos is being established at levels equivalent to the loading capacities identified above. Concentration-based allocations are also being used for both wasteload allocations (WLA) and load allocations (LA). The WLA applies to point sources in the watershed regulated under NPDES permits or Waste Discharge Requirements. The LA applies to non-point sources such as agriculture, open space and atmospheric deposition.

For its diazinon/chlorpyrifos TMDL, USEPA established an explicit (10%) margin of safety (discussed below); therefore, the concentration-based allocations were calculated as 90% of the numeric target level for each pesticide under acute and chronic exposure conditions. For example, the numeric target for diazinon under acute conditions is 80 ng/L. The wasteload and load allocations are set at 72 ng/L, after subtraction of 8 ng/L to provide the 10% margin of safety. This explicit margin of safety approach is included in this TMDL.

Allocations for Freshwater Water Bodies

Table 6-1 presents the concentration-based freshwater allocations for chlorpyrifos and diazinon; these apply to all point sources (wasteload allocations) and to all non-point sources (load allocations). The diazinon allocations apply to freshwater discharges into San Diego Creek Reach 1 and Reach 2. The chlorpyrifos allocations apply to freshwater discharges into San Diego Creek (Reach 1 and Reach 2) and freshwater discharges into Upper Newport Bay including Santa Ana Delhi Channel, East Costa Mesa Channel and other drainages to the Upper Bay. This includes discharges from agricultural and residential lands, including flows from the storm water systems. These limits apply regardless of season and flow; i.e., at all times of the year.

Table 6-1: Diazinon and Chlorpyrifos Allocations for San Diego Creek

Category	Diazinon (ng/L)		Chlorpyrifos (ng/L)	
	Acute	Chronic	Acute	Chronic
Wasteload Allocation	72	45	18	12.6
Load allocation	72	45	18	12.6
MOS	8	5	2	1.4
TMDL	**80**	**50**	**20**	**14**

MOS = Margin of Safety
Chronic means 4-consecutive day average

Allocations for Upper Newport Bay

Table 6-2 presents the saltwater allocations for chlorpyrifos; these apply to all point sources (wasteload allocations) and to all non-point sources (load allocations). It applies to saltwater allocations in Upper Newport Bay, defined from San Diego Creek at Jamboree Rd. down to Pacific Coast Highway Bridge. These limits apply regardless of season and flow; i.e., at all times of the year.

Table 6-2. Chlorpyrifos Allocations for Upper Newport Bay

Category	Acute (ng/L)	Chronic (ng/L)
Wasteload allocation	18	8.1
Load allocation	18	8.1
MOS	2.0	0.9
TMDL	**20**	**9**

MOS = Margin of Safety
Chronic means 4-consecutive day average

Needed Reductions

Table 6-3 summarizes the estimated needed concentration-based (load) reductions for diazinon and chlorpyrifos in order to achieve the TMDL numeric targets in San Diego Creek. Multiple samples are available from five separate storm events in the watershed from 1997-2000. The storm average concentrations in Table 6-3 are the maximum single storm averages at the San Diego Creek-Campus station. The difference between the current load and the allocation is the needed reduction. Chlorpyrifos concentrations may have begun to decline in 2000 and 2001, based on indications of a reduction in usage from the DPR database as well as from the Sales and Use Survey (Wilen 2001) conducted in late 2000. To date, there are no clear indications of declining trends in diazinon usage in the watershed. This table indicates the estimated needed reduction during average storm flows. As discussed above, the majority of the pesticide load derives from stormflow.

Table 6-3. Needed Load (concentration based) Reductions for San Diego Creek.

Constituent	San Diego Creek Campus Station		Allocation		Needed Reduction	
	Storm Average (ng/L)	Max (ng/L)	Chronic (ng/L)	Acute (ng/L)	Chronic	Acute
Chlorpyrifos	120	580	12.6	18	90%	97%
Diazinon	848	960	45	72	95%	93%

Chronic means 4-consecutive day average

Although the estimated reductions in Table 6-3 are very steep, the USEPA re-registration agreements discussed in Section 4.2 should result in significant declines in diazinon and chlorpyrifos use, and the resulting discharge concentrations to San Diego Creek and Upper Newport Bay. However, additional measures may be necessary to achieve the reductions set forth above.

7.0 SEASONAL VARIATION/CRITICAL CONDITIONS

Pesticide usage correlates roughly with the season, with increasing usage in the warmer months due to increased pest activity. However, runoff into the drainage channels is greatest during the wet season, and higher pesticide concentrations are observed during storm events. The higher pesticide concentrations primarily account for the toxicity observed in stormwater samples collected in the watershed. The chronic criteria used as the basis for the numeric targets are designed to ensure protection of aquatic life during all stages of life, including the most sensitive stages. Because the TMDL is being expressed as a concentration, a detailed analysis of critical conditions is unnecessary. The concentration-based allocations (Table 6-1 and 6-2) will apply and be protective during all flow conditions and seasons.

8.0 MARGIN OF SAFETY

An explicit 10% margin of safety was applied to the recommended criteria derived by the CDFG (2000a) and EPA (1986) for diazinon and chlorpyrifos. This explicit margin of safety is intended to account for uncertainties in TMDL calculation methods and concerning pesticide effects (e.g., potential additive and synergistic impacts from exposure to multiple organophosphate pesticides) that may aggravate water quality impacts due to diazinon and chlorpyrifos usage in the watershed.

In addition to the explicit margin of safety, conservative assumptions were used in applying the numeric targets within the watershed. These conservative assumptions serve as implicit margins of safety to provide additional protection for aquatic life and minimize aquatic toxicity.

1. No adjustment was made to reflect the possibility of pesticide breakdown from point of discharge to San Diego Creek. Scientists have measured that half-lives of diazinon and chlorpyrifos in water range from a few days up to six months, therefore some degradation is likely to be occurring after application and within flowing waters. Assuming discharges are within the specified concentration-based allocations, and that such degradation (via biotic and abiotic processes) occurs, there will be sufficient protection for aquatic life.

2. No adjustment was made to reflect the possibility of mixing and dilution within the drainage channels. In particular, the dilution capacity provided by groundwater seepage has not been factored into the TMDLs.

9.0 DRAFT IMPLEMENTATION PLAN

9.1 INTRODUCTION

Federal law requires that TMDLs be incorporated into the state water quality management plan (Basin Plan) upon USEPA approval. California law requires that Basin Plans have a program of implementation to achieve water quality objectives. The implementation program must include a description of actions necessary to achieve the objectives, a time schedule for these actions, and a description of surveillance to determine compliance with the objectives.

A TMDL does not establish new water quality objectives. A TMDL is intended to achieve existing narrative or numeric water quality objectives. An implementation plan must be developed to ensure that the TMDL achieves its purpose.

This implementation plan details the activities planned to ensure that the TMDL is achieved. The TMDL implementation tasks and schedule are presented in Section 9.2, while Sections 9.3 and 9.4 provide a brief economic analysis and identify potential funding sources.

The remainder of this introduction provides an overview of water quality studies underway in the Newport Bay watershed that may be relevant for implementation of the TMDL.

Relevant Studies In The Watershed

The toxics TMDLs adopted by the U.S. EPA follow adoption of the nutrient (1998), sediment (1998), and pathogen (1999) TMDLs for the Newport Bay watershed. A number of investigations and monitoring programs have been established in conjunction with the existing TMDLs. Some of the studies that may be relevant for implementation of this TMDL are listed below.

1. <u>Residential Runoff Reduction Study</u>. The objective of this study is to quantify the water quantity savings and water quality benefits from installation of advanced landscape irrigation controllers in individual residences. Over one year of diazinon and chlorpyrifos data from five separate neighborhoods is being collected. Upon completion in December 2002, this project should provide detailed information on pesticide export rates, and the effectiveness of education in reducing pesticide runoff.

2. <u>Evaluation of Urban BMPs for Nutrients</u>. This Proposition 13 project is being undertaken by Orange County in conjunction with the nutrient TMDL. The project will test the effectiveness of urban BMPs for nutrient load reductions, but it could also be broadened to include pesticides.

3. <u>Agricultural BMPs for Nutrients</u>. UC Riverside and the UC Cooperative extension office in Irvine are managing this project, which was initiated as part of the implementation plan for the nutrient TMDL. BMPs that are effective for nutrients may also be useful in reducing pesticide runoff.

4. CDPR RIFA Monitoring. The RIFA quarantine area includes the nurseries in the watershed. The RIFA program requires use of pesticides, and these pesticides may include diazinon and chlorpyrifos. Use of diazinon and chlorpyrifos in the RIFA program is considered a public health use and will not be affected by the USEPA re-registration agreements. As described in Section 2.0, the CDPR is monitoring RIFA pesticides in nursery runoff

5. Pest Management Alliance for the Containerized Nursery Industry. In 1999 and 2000, the CDPR funded work by the UC Cooperative Extension and the UC-Riverside Department of Entomology to evaluate pest management practices in the containerized nursery industry of California. The project surveyed existing practices and suggested that alternative methods to reduce pesticide use were available.

9.2 IMPLEMENTATION TASKS

Table 9-1 shows the planned tasks and schedule for implementation of the TMDL. These tasks are discussed in more detail in the following subsections. The USEPA re-registration agreements, while not tasks under the jurisdiction of the Regional Board, are included here due to their anticipated significance in reducing diazinon and chlorpyrifos use in the watershed. The Regional Board will verify implementation of the re-registration agreements through review of CDPR's pesticide use report database, and through analysis of monitoring data.

Table 9-1. TMDL Task Schedule

Task No.	Task	Schedule	Description
1	USEPA Re-registration agreements	12/2001 to 12/2006	Phase-out of uses specified in the re-registration agreements. Should end over 90% of usage.
2	Revise Discharge Permits	2005	WDR and NPDES permits will be revised to include the TMDL allocations, as appropriate.
3	Pesticide Runoff Management Plan	2004	A pesticide runoff management plan will be developed
4	Monitoring	2003	Modify existing regional monitoring program to include analysis for organophosphate pesticides and toxicity
5	Special Studies		
5a	Atmospheric deposition	2003	Quantify atmospheric deposition of chlorpyrifos loading to Upper Newport Bay
5b	Mixing volumes in Upper Newport Bay	2003	Model mixing and stratification of chlorpyrifos in Upper Newport Bay during storm events

9.2.1 USEPA RE-REGISTRATION AGREEMENTS

Re-registration of diazinon and chlorpyrifos by the EPA is the most significant factor affecting the implementation plan. The phase-out is a consequence of the Food Quality Protection Act (FQPA) of 1996. The FQPA was passed unanimously by Congress in July 1997, and signed into law in August 1997. The FQPA:

- Establishes a single health-based standard for all pesticide residues in food
- Provides for a more complete assessment of potential risks with special protections for potentially sensitive groups, such as infants and children
- Requires reassessment of all existing pesticide residue limits
- Expedites approval of safer, reduced risk pesticides
- Encourages development of safer, effective crop protection tools
- Ensures that all pesticides are periodically re-evaluated for adherence to current safety standards
- Expands consumers' "right to know" about pesticide risks and benefits

The provisions of the FQPA have an important bearing on implementation of the diazinon and chlorpyrifos TMDL. Reassessment of pesticide residues began with the organophosphates, a group of 48 pesticides. New risk assessments were developed for the two most widely used organophosphates, diazinon and chlorpyrifos. During this process, USEPA negotiated re-registration agreements with the manufacturers of diazinon and chlorpyrifos (USEPA 2000a, 2001). As discussed in Section 4.2, these re-registration agreements are likely to end over 90 percent of the usage (as of 1999) in the Newport Bay watershed.

While acting to restrict most uses of diazinon and chlorpyrifos, the USEPA has also taken action, in accordance with the FQPA, to expedite review of reduced risk pesticides, including biopesticides. Biopesticides are distinguished from conventional chemical pesticides by their unique modes of action, low use volume, lower toxicity, and target species selectivity or natural occurrence. USEPA's actions are intended to ensure that safer alternatives to diazinon and chlorpyrifos are available (USEPA 1999c).

9.2.2 DISCHARGE PERMITS AND COMPLIANCE SCHEDULE

The TMDL allocates wasteloads to all dischargers in the watershed. Since the TMDL is concentration-based, the wasteloads are concentration limits. These concentration limits will be incorporated into existing and future discharge permits in the watershed. A four-year compliance schedule (beginning in 2003) is outlined in Table 9-2, with interim targets that are based on ½ the LC50 values for *Ceriodaphnia dubia*. Compliance would be required as soon as possible but no later than the dates shown. Compliance schedules would be included in permits only if they are demonstrated to be necessary.

Table 9-2. Numeric Target Compliance Schedule

Category	Freshwater Target (ng/L)		
	Interim (By June 2004)	Final (By Dec 2007)	
	Maximum	Acute	Chronic
DIAZINON	220	72	45
CHLORPYRIFOS	30	18	12.6

The revised permits will include additional monitoring for organophosphate pesticides. The monitoring interval will depend on the type of discharge. For example, permits for groundwater dischargers may only need annual monitoring, while dischargers that use diazinon and chlorpyrifos products will require more frequent monitoring.

9.2.3 PESTICIDE RUNOFF MANAGEMENT PLAN

A pesticide runoff management plan (PRMP) will be developed for the watershed as a cooperative project between the Regional Board and stakeholders. The goals of the pesticide management plan will be to:

- Monitor pesticide usage
- Identify pathways leading to pesticide contamination of surface water
- Reduce pesticide runoff to the maximum extent practicable
- Summarize pesticide-related water quality activities on an annual basis

MONITORING USAGE
Table 9-3 shows selected pesticide use reported in Orange County. The pesticides are ranked by usage volume. Only those pesticides ranked in the top 50 that are potential water quality threats are listed. For example, the top three pesticides, soil fumigants that are gases at room temperature, are not listed below, as they are not expected to pose a threat to water quality.

Monitoring pesticide usage will allow management efforts to focus on those pesticides that are potential water quality threats. The available usage data indicate pesticides that should be targeted for water quality monitoring, and along with site-of-use data from the CDPR, may help to identify causes of toxic events in the watershed.

Table 9-3. Selected CDPR-Reported Pesticides Used in Orange County 1999

Rank.	Chemical	Usage (lbs ai)	Comments
4	Chlorpyrifos	79,990	Organophosphate, ag. & urban use (ants)
10	Captan	29,521	Fungicide, fruit & vegetable crops
11	Diazinon	24,452	Organophosphate, ag. & urban use (ants)
17	Permethrin	10,483	Ag. pests, nursery, termites
20	Thiram	6,509	Fungicide
21	Metaldehyde	6,214	Molluscide (snails, slugs)
23	Malathion	5,953	Ag. pests, urban
24	Cypermethrin	5,869	Ag. pests, structural
25	Fosetyl-al	5,330	Fungicide
26	Bifenthrin	5,257	RIFA use
27	Methomyl	3,181	Carbamate, ag. crops, dairies
41	Carbaryl	2,835	Wide spectrum insecticide
48	*Bacillus thuringiensis.*	1,974	Variety Kurstaki. Over 1,000 lbs of other subspecies also used.
49	Dimethoate	1,964	OP pesticide

IDENTIFYING PATHWAYS

The PRMP should address the significant pathways for pesticide runoff and discharge to surface waters. One of the most significant pathways could be direct disposal of excess pesticides into outdoor gutters. The Residential Sales and Use Survey (Wilen 2001) found that a majority of homeowners were not aware of proper disposal procedures for excess pesticides, or old/expired pesticides.

REDUCING PESTICIDE RUNOFF

Reducing pesticide runoff will require a coordinated effort among the stakeholders in the watershed, and a large education/outreach component to address homeowner use of pesticides. Following is a list of resources that will be used to help achieve reductions in pesticide runoff to levels at which pesticide-derived aquatic toxicity no longer occurs in the watershed.

1. <u>UC Integrated Pest Management (IPM) Project</u>

The University of California statewide Integrated Pest Management project (UC IPM) defines integrated pest management as:

> "*An ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.*"

The goals of the UC IPM project are to reduce the pesticide load in the environment while increasing the effectiveness of pest control techniques that are economically, environmentally, and socially acceptable. The mission of the UC IPM project also includes outreach to other agencies to promote IPM programs.

The UC IPM project provides eight advisors to help develop, demonstrate, and adapt IPM techniques for various regions in California. The advisor for the region that includes the Newport Bay watershed is Cheryl Wilen, of the South Coast UC Cooperative Extension station. The pesticide runoff management plan for the watershed will be based, to as large an extent as possible, on the existing IPM knowledge from the UC IPM project.

2. CDPR Pest Management Alliance

The Newport Bay watershed contains three large nurseries with waste discharge permits. While the TMDL source analysis shows that most of the diazinon and chlorpyrifos load is from urban areas, many of these uses are being phased out. In contrast, nursery and agricultural uses may continue and even increase due, in part, to quarantine requirements under the RIFA program.

The CDPR has funded two projects for the containerized nursery industry under the pest management alliance program. The first project, involving a survey and evaluation of pest management practices in the industry, was completed in 2000 (Costa et al 2000). The second project report will be available this year, and will contain specific recommendations on practices that will reduce pesticide runoff.

3. USEPA Alternatives To Diazinon And Chlorpyrifos

As described in Section 9.2.1, the USEPA has expedited review of reduced risk pesticides and bio-pesticides. USEPA has registered six new active ingredients that provide lower-risk alternatives to several organophosphates. Information on bio-pesticides can be found at the USEPA website: http://www.epa.gov/pesticides/biopesticides/

4. PEST Control Operators (PCOs)

Pest Control Operators apply approximately 40% to 50% of the diazinon and chlorpyrifos in the watershed. PCOs are licensed by the CDPR, except for those licensed by the Structural Pest Control Board or the Department of Health Services.

The TMDL source analysis shows that urban areas account for more than 80% of pesticide runoff. Runoff from urban areas could originate from homeowner use and/or from applications by PCOs.

PCOs are required to meet certain continuing education requirements to meet their license requirements. Included in the list of approved courses is one on environmental protection. The Regional Board will work cooperatively with the State Board and the CDPR to review PCO operations for potential impacts to water quality, and recommend methods to reduce pesticide runoff.

5. Urban Education

The Orange County stormwater permittees have developed and implemented a model plan entitled: *Management Guidelines for Use of Fertilizers and Pesticides*." The renewed stormwater permit (SARWQCB 2002) requires the permittees to review this plan, determine its effectiveness, and make any needed changes. The county is currently working with UC Cooperative extension and the UC IPM project to revise the plan.

Homeowners and other residential users applied roughly half the diazinon and chlorpyrifos in the watershed during 1999. Because of the USPEPA re-registration agreements, homeowner use will be largely phased out over the next few years. However, homeowners are likely to turn to other pesticides for control of ants and other household pests. Improper or excessive usage of the new pesticides may result in continued aquatic toxicity in the watershed. Therefore, it is important to implement effective public education and outreach programs. A review of education programs and their effectiveness will be performed as part of the pesticide runoff management plan.

ANNUAL EVALUATION REPORT

The Regional Board will produce an annual report summarizing information from all sources and evaluating the effectiveness of the PRMP. The annual evaluation report will integrate information from the Regional Board's Stormwater, NPDES, and Non-Point Source programs with data from other agencies and from monitoring projects in the watershed. A sample report outline is presented on the following page.

Sample Outline: Annual Pesticide Runoff Management Evaluation Report

1. Summary of Water Quality Data
    - Regional Monitoring Program
    - Nurseries
    - Other studies/investigations in watershed
    - State Mussel Watch (SMW) and Toxic Substances Monitoring (TSMP) Program
      - Compare to TMDL, permit compliance
      - Identify pesticide-derived aquatic toxicity
      - Monitor new pesticide water quality threats

2. Pesticide Usage
    - Reported uses – CDPR Database
    - Residential/homeowner use – Design mini-survey based on Residential Survey Report (Wilen 2001)
    - Identify trends in usage
      - Confirm reduction in diazinon/chlorpyrifos use
      - Monitor usage of pesticides with potential runoff/toxicity problems
      - Track adoption/use of bio-pesticides and reduced risk pesticides

3. Best Management Practices
    - Summarize research and development activities
    - Summarize implementation activities

4. Education/Outreach Review
    - Stormwater Permit programs
    - UC Cooperative Extension and UC IPM activities in watershed
    - CDPR Pest Management Alliance activities in watershed

5. Special Projects
    - RIFA program
    - Others

6. Summary and Recommendations
    - Evaluate effectiveness of PRMP
    - Recommend Changes

9.2.4 MONITORING

A Regional Monitoring Program (RMP) has been developed for the watershed as part of the nutrient TMDL. The RMP is intended to provide for efficient monitoring of the watershed through a cooperative, comprehensive monitoring program. The OCPFRD is the lead agency for the RMP. All dischargers are allowed to participate in the RMP in lieu of implementing separate, individual monitoring and reporting programs.

The RMP currently includes nine stations in the watershed and five stations in Upper Newport Bay. The number and location of the stations appears sufficient for implementation of the diazinon and chlorpyrifos TMDL. The existing monthly sampling frequency plus additional monitoring of storm events will provide the necessary data to ensure that the TMDL objectives are being achieved.

Aside from diazinon and chlorpyrifos, additional analytes for monitoring may include: bifenthrin (sediment and water column), carbaryl, dimethoate, malathion, and methomyl.

9.2.5 SPECIAL STUDIES

Two issues were identified during development of the TMDL that require further analysis:

(1) The significance of atmospheric deposition to Upper Newport bay as a separate chlorpyrifos source; and,
(2) The adequacy of the freshwater numeric targets for chlorpyrifos in the tributaries to Upper Newport Bay in achieving the lower saltwater numeric target.

The significance of atmospheric deposition for chlorpyrifos loading to Upper Newport bay will be quantified through analysis of rainwater samples in the vicinity of the Bay.

The existing hydrodynamic model for Newport Bay is being used to perform simulations that predict contaminant concentrations in the Bay based on various flow and management scenarios. The model results can be used to verify whether the numeric targets for chlorpyrifos in the watershed will be sufficient to achieve the TMDL in Upper Newport Bay.

Data from these studies may be used to refine the TMDL. Chlorpyrifos allocations for San Diego Creek may be changed, and additional targeted source control efforts may be incorporated into the implementation.

9.3 ECONOMIC CONSIDERATIONS

As previously stated, the Regional Board is required to include TMDLs in the Basin Plan. There are three statutory triggers for consideration of economics in basin planning. These triggers are:

- Adoption of an agricultural water quality control program (Water Code Section 13141). The Regional Board must estimate costs and identify potential financing sources in the Basin Plan before implementing any agricultural water quality control plan.
- Adoption of a treatment requirement or performance standard. The Regional Board must comply with the California Environmental Quality Act (CEQA) when amending the Basin Plan. CEQA requires that the Board consider the environmental effects of reasonably foreseeable methods of compliance with Basin Plan amendments that establish performance standards or treatment requirements, such as TMDLs. The costs of the methods of compliance must be considered in this analysis.
- Adoption of water quality objectives (Water Code Section 13241). The Regional Board is required to consider a number of factors, including economics, when establishing or revising water quality objectives in the Basin Plan.

It should be noted that in each of these cases, there is no statutory requirement for a formal cost-benefit analysis.

As discussed above, adoption of a TMDL does not constitute the adoption of new or revised water quality objectives, so the third statutory trigger does not apply here. However, implementation of this TMDL is likely to result in changes in agricultural (nursery) operations to control pesticide runoff. Similarly, implementation of this TMDL will likely necessitate changes in programs (including educational programs and BMPs) designed to reduce pesticide inputs from urban stormwater or other sources. It is necessary, therefore, to consider the costs and potential funding mechanisms for the implementation of new/modified agricultural water quality control programs, and the costs of other measures that may be necessary to achieve (and monitor) compliance with the TMDL.

The U.S. EPA re-registration agreements for diazinon and chlorpyrifos will result in dramatic reductions in the use of these chemicals and switches to alternative pesticides. While these new agreements are identified as a key part of this implementation plan, they are not within the Regional Board’s jurisdiction and the costs of their implementation cannot be considered TMDL-related costs.

Information concerning the costs of implementation of this TMDL will be solicited during the public participation phase of consideration of this TMDL. Specifically, potentially affected parties will be asked to evaluate the TMDL-related costs, as distinct from those associated with implementation of the re-registration agreements. Given that the re-registration agreements will eliminate household uses of these pesticides, the impacts of the TMDL on urban stormwater permittees are expected to be minimal. Expenditures beyond those now necessary to comply with the established areawide urban stormwater permit would likely be focused on increased/enhanced public education efforts to assure proper pesticide use and disposal. Higher costs are likely to be incurred by agricultural operations (nurseries) to assure that RIFA-related pesticide applications do not result in pesticide runoff. The following section identifies possible sources of funding.

9.4 POTENTIAL FUNDING SOURCES

Potential funding sources include the Prop 13 pesticide grant program, and EPA and State Board annual program funds for NPS activities and TMDL implementation. Local agencies or non-governmental entities may also have programs to support the implementation plan. Following is a list of identified funding sources:

A. Grant Programs

1. National Foundation for IPM Education. "The National Foundation for Integrated Pest Management (IPM) is a not-for-profit public foundation that promotes education, provides information and encourages research to increase the adoption of IPM." http://www.ipm-education.org/

2. EPA 319h Program The Division of Water Quality, State Water Resources Control Board (SWRCB) administers water quality grants funded by the Federal Clean Water Act (CWA) section 319 grant program. CWA section 319 funds may be used for implementing actions to prevent, control and/or abate nonpoint source (NPS) water pollution http://www.swrcb.ca.gov/nps/cwa_rfps.html

3. Proposition 13. In March 2000, California voters approved Proposition 13 (2000 Water Bond), which authorizes the State of California to sell $1.97 billion in general obligation bonds to support safe drinking, water quality, flood protection and water reliability projects throughout the state. The State Water Resources Control Board (SWRCB) will help allocate $763.9 million of these funds to local projects throughout California. The SWRCB created the following web page to provide a quick digest of available bond programs and information on how interested parties should submit proposals for available money. A portion of the Prop 13 funds have been set aside to support pesticide-related water quality issues. http://www.swrcb.ca.gov/prop13/index.html

4. UC IPM project grants
5. CDPR Pest Management Alliance
6. State Board/Regional Board Funds – NPS Program funding sources: http://www.swrcb.ca.gov/nps/ofundsrc.html

B. Private financing (corporations or individuals)

C. Public financing (local agencies)

1. State loan programs
2. Local tax funds

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